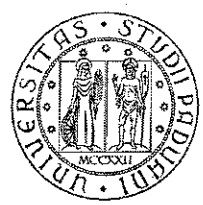

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SCUOLA DI DOTTORATO DI RICERCA IN
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CICLO XXIII

GREENING GLOBAL VALUE CHAINS: THE ROLE OF LEAD FIRMS IN FOSTERING ENVIRONMENTAL INNOVATIONS

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Abstract

The importance of the environmental agenda for the industry has been rising exponentially at the international level in recent years. Firms are increasingly challenged to introduce new products or processes that lower the impacts on the environment while consolidating their competitive advantage. The peculiarities of these innovations and the increasing disintegration of production at the global level challenge firms to coordinate with value chain partners in order to successfully reduce their overall environmental impacts. Through mixed method research, this Ph.D. thesis contributes to the literature by addressing how manufacturing firms cooperate with external partners, especially suppliers, on environmental innovation. The thesis comprises two parts: the first analyzes the peculiar importance of cooperation for green innovations using survey data; the second explores how lead firms interact with suppliers and coordinate their value chain's activities for the greening through a multiple-case study analysis. While keeping constant the unit of analysis – environmental innovations – the thesis is organized so that the focus broadens progressively, concentrating on the firm (chapter 1), on the buyer-supplier relation (chapter 5) and, finally, on the entire value chain (chapter 6).

The first chapter explores the impact of firms' R&D cooperation strategies on their environmental innovation propensity, contributing to the environmental innovation literature using 2008 Community Innovation Survey data on Spanish manufacturing firms. The analysis, controlling for selection bias, suggests that environmental innovative firms cooperate with external partners to a higher extent than other innovative firms. Suppliers and scientific agents emerge as partners which are even more important than for other innovations, corroborating theories on the interdependencies on skills and resources and the on increasing complexity that arise in the development of environmental innovation.

Contrast-oriented case studies in the Italian furniture industry support the discussion on green innovation management in value chains in part two. Chapters 2, 3 and 4 are propaedeutic to the followings, discussing, respectively the research questions and the relevant theoretical approaches and concepts, the research strategy used, and, finally environmental innovation and value chain strategies of the two lead firms. Chapter 5 contributes to the Green Supply Chain Management literature by developing a framework to understand how lead firms interact with suppliers to ensure the desired environmental performance. In particular, the cases' narrative suggests that firms engage, at once, in i) cooperation to the development of new products or processes, especially as far as technical aspects are concerned; ii) direct monitoring activities, or by the mean of standards and code of conducts or by more

informal mechanisms, and iii) supporting activities, by disseminating environmental knowledge. Results bespeak a shift from arm's length relationships toward more complex networks structures. In Chapter 6, I specify those governance structures, pioneeringly applying the Global Value Chain framework to the understanding of greening dynamics in a context of disintegration of production. Based on the empirical analysis, I identify two types of network, namely standard-driven and relational-driven and the main variables determining when one form or the other may arise. The analysis suggests also different tools that lead firms may employ to drive environmental improvements even beyond their first-tier suppliers, and different incentives, which may counteract costs that suppliers have to face to implement environmental innovations.

Despite focusing each on different aspects of the greening, the chapters converge on corroborating the peculiar importance of cooperation for environmental improvements along the value chain, with respect to other types of innovations. Case studies research allows completing the evidence of its substitute effect with internal R&D emerging from the quantitative analysis, by suggesting that this is the case for suppliers and sub-suppliers, but complementarities arise for firms leading the greening. Furthermore, analyses agree on the pivotal role of internationalization strategies and the business model in determining environmental innovations performance in value chains.

Sommario

Negli ultimi anni si è assistito ad un crescente interesse, a livello internazionale, per gli impatti ambientali delle attività produttive. La sfida per le aziende sta nell'introdurre nuovi prodotti o processi che riducano l'impatto sull'ambiente mentre consolidano il proprio vantaggio competitivo. Le specificità di queste innovazioni e la crescente suddivisione del lavoro su scala globale richiedono alle aziende di coordinarsi con le imprese della propria catena del valore per ridurre l'impatto ambientale complessivo. Attraverso un metodo di ricerca misto, questa tesi di dottorato vuole contribuire alla letteratura indagando come le aziende manifatturiere cooperano con attori esterni, in modo particolare i fornitori, per lo sviluppo di innovazioni ambientali. La tesi è composta di due parti: la prima analizza l'importanza della collaborazione con enti esterni per lo sviluppo di innovazioni ambientali attraverso un'analisi quantitativa; la seconda esplora in che modo le aziende leader interagiscono con i fornitori e coordinano le attività della catena del valore per ridurre gli impatti ambientali attraverso dei casi studio. Mantenendo costante l'unità di analisi – le innovazioni ambientali – la tesi è organizzata in modo che il focus dell'analisi si estenda progressivamente dall'azienda (capitolo 1), alla relazione fornitore-cliente (capitolo 5) e, infine, all'intera catena del valore (capitolo 6).

Il primo capitolo sviluppa la letteratura sulle innovazioni ambientali investigando l'impatto delle strategie di collaborazione con attori esterni sulla propensione a introdurre innovazioni ambientali, usando dati relativi alle aziende manifatturiere ricavati dalla Community Innovation Survey spagnola del 2008. Controllando per la potenziale distorsione da selezione campionaria, l'analisi suggerisce che le aziende che introducono innovazioni sostenibili cooperano più di altre aziende innovative. Fornitori, università e altri enti di ricerca risultano partner ancora più importanti che nel processo di sviluppo di innovazioni non ambientali, supportando teorie che affermano l'emergere di interdipendenze in termini di competenze e risorse e l'aumentare della complessità in relazione allo sviluppo di innovazioni a ridotto impatto ambientale.

Casi di studio nel settore dell'arredamento in Italia, selezionati per rappresentare esempi contrastanti, supportano la discussione della parte due. I capitoli 2, 3 e 4 sono propedeutici ai successivi, presentando, rispettivamente, le domande di ricerca e gli approcci e concetti teorici rilevanti, la strategia metodologica utilizzata e le strategie di innovazione ambientale e di gestione della catena del valore delle due aziende leader analizzate. Il capitolo quinto contribuisce alla letteratura sul Green Supply Chain Management sviluppando un modello per comprendere le

interazioni tra aziende leader e fornitori per il miglioramento delle performance ambientali. In particolare, i casi suggeriscono che le aziende leader si impegnano con i fornitori in tutti e tre i seguenti fronti: i) la cooperazione per lo sviluppo di nuovi prodotti e processi, ii) il controllo diretto delle loro attività, attraverso standard e codici di condotta o attraverso meccanismi informali e iii) il sostegno del loro sforzo attraverso la condivisione di conoscenze sui temi ambientali. L'analisi suggerisce, inoltre, un passaggio da relazioni di mercato verso più complesse forme di rete di imprese. Nel capitolo sesto approdondisco queste forme, utilizzando in modo pionieristico il framework sulle Global Value Chain per comprendere la riduzione degli impatti ambientali in un contesto di suddivisione della produzione su scala globale. Sulla base della ricerca empirica, identifico due tipi di rete, regolate da standard o da relazioni informali, e le loro principali determinanti. L'analisi identifica vari strumenti che le aziende leader possono utilizzare per ridurre gli impatti ambientali della propria catena del valore, anche oltre i fornitori di primo livello, e incentivi che possono stimolare i fornitori a sostenere i costi necessari per introdurre innovazioni ambientali.

Nonostante si focalizzino ognuno su diversi aspetti, i capitoli convergono nel riconoscere la maggiore importanza della cooperazione con la rete di imprese per lo sviluppo di innovazioni ambientali, rispetto ad altri tipi di innovazioni. Se l'analisi quantitativa aveva suggerito la sua sostituibilità con le risorse di R&S interne, i casi studio suggeriscono che questa valga nel caso di fornitori e sub-fornitori, ma vi sia invece un'importante complementarietà nel caso delle aziende che stimolino il processo di riduzione degli impatti. Inoltre, le analisi concordano sull'importanza delle strategie di internazionalizzazione e del modello di business dell'azienda nel determinare come vengano ridotti gli impatti ambientali lungo le catene del valore.

Contents

I Environmental Innovation and R&D cooperation with external partners **1**

1 Environmental innovation and R&D cooperation **3**
1.1 Introduction . . . 3
1.2 Conceptual Background . . . 4
1.2.1 A literature review of cooperative arrangements for innovation 4
1.2.2 Is green different? . . . 7
1.2.3 Recent empirical evidence on cooperation and environmental innovation . . . 9
1.3 Description of the empirical study . . . 11
1.3.1 The PITEC dataset and the empirical setting . . . 11
1.3.2 The variables for the analysis . . . 12
1.3.3 Descriptive Statistics . . . 14
1.3.4 Method . . . 15
1.4 Main Results and discussion . . . 16
1.4.1 Robustness analysis . . . 17
1.5 Conclusions . . . 20

II Green Innovation Management in Value Chains: insights from IKEA and Valcucine **23**

2 The challenge to green global value chains: a literature review **25**
2.1 The challenge to reduce environmental impacts along the VC . . . 25
2.1.1 How to green the supply chain with suppliers? . . . 26
2.1.2 Considering the entire VC: which governance for the greening? 26
2.2 A critical literature review on the greening of value chains . . . 27
2.2.1 Different approaches to the understanding of greening dynamics 28
2.2.2 Green supply chain management and the interactions with suppliers . . . 29
2.3 Global Value Chains and the governance of the greening . . . 32
2.3.1 The Global Value Chain framework . . . 32
2.3.2 The governance of Value Chains . . . 32
2.3.3 Governance, upgrading and innovation . . . 34
2.3.4 Previous evidence on governance and green innovation . . . 35

3 Methodology **37**
3.1 The method . . . 37
3.2 The empirical setting . . . 38
3.3 Case study design and case selection process . . . 39
3.4 Data Sources . . . 41
3.5 Data Analysis . . . 44
3.6 Strategies to ensure robustness of the analysis . . . 44

4 IKEA's and Valcucine's VC and green innovation strategies **47**
4.1 IKEA: the green giant . . . 47
4.1.1 Structural characteristics and history . . . 47
4.1.2 IKEA's value chain and value added activities . . . 49
4.1.3 Environmental innovations at IKEA . . . 51
4.2 Valcucine: the green kitchen SME . . . 53
4.2.1 Structural Characteristics and history . . . 53
4.2.2 Valcucine's Value Chain, suppliers and value added activities 54
4.2.3 Environmental innovations at Valcucine . . . 57
4.3 Environmental innovations at IKEA's and Valcucine's furniture suppliers . . . 60
4.3.1 Friulintagli . . . 60
4.3.2 Media Profili . . . 61
4.3.3 ILCAM . . . 62
4.3.4 Electrolux . . . 63
4.3.5 Biesse Crea . . . 64
4.3.6 Eureka . . . 65
4.3.7 Abet-laminati . . . 66
4.4 IKEA and Valcucine: a preliminary comparison . . . 67

5 Greening the supply chain together with suppliers **71**
5.1 Valcucine: the way of an SME to green its supply chain . . . 71
5.1.1 The importance of cooperation for the development of environmental innovations in Valcucine's supply chain . . . 71
5.1.2 Monitoring and supporting at Valcucine . . . 72
5.2 IKEA at the green challenge: greening a global supply chain . . . 74
5.2.1 Green innovations in IKEA's supply Chain . . . 74
5.2.2 The importance of monitoring and supporting in IKEA's GSCM strategy . . . 76
5.3 Understanding interactions to green supply chains . . . 79
5.3.1 Cooperation toward environmental innovations . . . 79
5.3.2 The importance of monitoring for environmental supply chains 81
5.3.3 Support and knowledge sharing to enable environmental improvements at suppliers . . . 83
5.3.4 Cooperation, monitoring and supporting: three pillars for leading the green change . . . 85
5.3.5 On the importance of long-term, network relationships for the greening . . . 87

5.4 Conclusions . . . 89

6 Which governance for the greening? 91
6.1 The tools for firms to lead the greening of their value chain . . . 91
6.1.1 On the importance of internal knowledge to enable the greening of the value chain . . . 94
6.1.2 Beyond first-tier suppliers . . . 95
6.2 Supplier's costs and incentives to reduce environmental impact . . . 98
6.2.1 The costs of greening the production process . . . 98
6.2.2 The importance of incentives . . . 99
6.2.3 The "power" of buyers to achieve their environmental goals . 102
6.3 The governance to green supply chains . . . 103
6.3.1 Does greening requires to identify different Value Chain's governance structures? . . . 103
6.3.2 Types of governance for the greening of the value chain . . . 105
6.3.3 Which variables affect the governance structure? . . . 107
6.3.4 A theory of environmental governance . . . 111
6.3.5 One, no one and one hundred thousand: the issue of multiple chains and governance structures . . . 113
6.4 Conclusions . . . 115

III Appendix 117

A Supporting materials for Chapter 1 119

B The furniture Global Value Chain 123
B.1 The furniture Value Chain . . . 123
B.1.1 Internationalization and the changing geography of furniture production . . . 123
B.1.2 The furniture Value Chain Input-Output structure . . . 124
B.1.3 Value chain governance and lead firms . . . 125
B.2 Furniture in Italy . . . 125
B.2.1 The history of furniture production in Italy . . . 126
B.2.2 Recent challenges to the Italian furniture producers . . . 126
B.2.3 The Livenza furniture district . . . 128
B.3 Furniture and the environment . . . 129

C The questionnaire 131
C.1 Innovation and environmental sustainability . . . 131
C.2 The implementation of environmental innovations . . . 131
C.3 Sustainability and supply chain management . . . 132
C.4 The company . . . 132

Bibliography 141

List of Tables

1.1 Environmental innovators, non-environmental innovators and non-innovators by industry, ordered by the relative importance of environmental innovators on the total. 14
1.2 Descriptive statistics of the regressors for environmental and non-environmental innovators. 15
1.3 Second Stage Logit Regression, explaining environmental innovative propensity across Spanish firms considering cooperation strategies. 16
1.4 Second Stage Logit Regression, explaining environmental innovation through the typologies of partners the firms cooperate with. 18
1.5 Second Stage Logit Regression, explaining environmental innovation using different specifications of the dependent variable. 19

3.1 Main features of the focal firms interviewed (in 2009). 40
3.2 Main features of IKEA and Valcucine's suppliers interviewed 41
3.3 Overview of interviews 43

4.1 Some metrics on input's environmental improvements at IKEA. Source: (IKEA Group, 2009). 52
4.2 Examples of environmental innovations introduced by IKEA. Source: author's elaboration based on corporate information and interviews. 53
4.3 Example of environmental innovations introduced by Valcucine. Source: author's elaboration based on corporate information and interviews. 59
4.4 IKEA and Valcucine value added activities and division of labor with suppliers. Source: author's elaboration. 67
4.5 A summary of the main environmental innovations in Valcucine and IKEA 68
4.6 Value Chain activities and supporting industry for which IKEA and Valcucine reduced the impact on the environment thanks to their innovation activities. Source: author's elaboration. 69

6.1 An overview of the typologies of costs and incentives for suppliers to reduce their impact on the environment accordingly to buyer requests. Source: author's elaboration. 101
6.2 Emerging governance structures for the greening of the value chain. Source: author's elaboration 108

6.3 Variables for the cross-case comparison. Source: author's elaboration. 109
6.4 Key determinants in environmental VC governance. Source: author's elaboration. 112

A.1 Simple correlations among the independent variables (n=5,801) . . 119
A.2 First Part Logit Regression, measuring innovation propensity across Spanish manufacturing firms 120
A.3 Fixed-effects second stage logit regression, explaining environmental innovation performance using data for 2003-2008. 120
A.4 I.V. regression explaining environmental innovation propensity, considering location as instruments for the variable cooperation 121

List of Figures

2.1 Governance structure typologies and key determinants. Source: Gereffi, Humphrey, and Sturgeon (2005). 34

4.1 IKEA's value chain[3]. Source: author's elaboration. 49
4.2 Number of suppliers, of personnel devoted to production activities and sales of IKEA, 2003-2010[4]. Source: elaboration of the author from IKEA's corporate documents. 50
4.3 Valcucine's Value Chain[7]. Source: author's elaboration. 55
4.4 Valcucine main suppliers' location[8]. 56

5.1 Supplier management and CoC implementation at IKEA. Source: author's elaboration based on interviews and documentary information. 77
5.2 Interactions with suppliers on innovation at IKEA and Valcucine[4]. Source: author's elaboration. 80
5.3 A visual representation of the model emerging from the empirical analysis. Source: author's elaboration. 85
5.4 A model to understand the nature of the buyer-supplier interaction to green supply chain. Source: author's elaboration. 87

B.1 The furniture Value Chain. Source: author's elaboration. 125

Part I

Environmental Innovation and R&D cooperation with external partners

Chapter 1

Environmental innovation and R&D cooperation: empirical evidence from Spanish manufacturing firms

1.1 Introduction

The importance of the environmental agenda for industry has been rising exponentially at the international level in recent years. On the one hand, increasing consumers' awareness of the environmental impact of their consumption choices and their willingness to contribute to reduce the ecological footprint creates new market opportunities for companies (Auger, Burke, Devinney, and Louviere, 2003; Harrison, Newholm, and Shaw, 2005; Orsato, 2006). On the other hand, increasingly restrictive policies that punish environmentally harmful behaviors, and the actions of NGOs and other environmentalism groups that raise the attention on firms' polluting behaviors, encourages firms to control the effects of their activities on the environment in order to reduce reputation risks and avoid additional costs (Spar and Mure, 2003; Porter and van der Linde, 1995).

The way companies integrate environmental concerns into their strategies while consolidating their competitive advantage is through environmental innovations. Despite the interest on environmental innovations is on the rise, research on this field is still limited and separated from mainstream innovation literature. In particular, there is still little empirical evidence on how these innovations are conceived and realized, notwithstanding the importance for policy and the development of firm strategies. Evidence that networking activities may be an important driver for environmental innovation (Mazzanti and Zoboli, 2005; Horbach, 2008) and especially that a strong partnership with suppliers and network partners may be a powerful spur to application of innovative environmental technologies has been found (Andersen, 1999; Geffen and Rothenberg, 2000; Andersen, 2002; Simpson, Power, and Samson, 2007). However, this literature is lacking in the empirical setting, being mainly qualitative or focused on specific geographic areas and, with the notable exception of Horbach (2008), does not allow for comparison with non-environmental innovations. Does environmental innovation requires an additional

degree of cooperation with external partner to be implemented, with respect to non-environmental innovations? Which are the peculiarities, if any, of the antecedents of the introduction of environmental innovations?

This chapter contributes to fill in these gaps by leveraging on mainstream innovation literature and testing for the impact of cooperation activities on environmental innovation performance through a large dataset on innovative performance of manufacturing firms, the Spanish Innovation Survey (PITEC). The dataset contains information on 5,801 manufacturing firms, their structural characteristics, R&D strategies and firm R&D cooperation activities. The analysis of this data contributes to the existing knowledge in many respects. First, I perform a comparative analysis on environmental and non-environmental innovations rather than focusing just on environmental ones, which allow to understand if such innovations require a differential effort in terms of cooperation and coordination. Second, extending Mazzanti and Zoboli and Horbach's reasoning, this chapter investigates the impact of different typologies of cooperative agreements - vertical, horizontal and lateral - acknowledging the evidence in the innovation literature that highlight the different role of these partners in the innovation process. Finally, this chapter aims to contribute to the literature by the choice of the methodology. For the first time, at the best of my knowledge, this analysis is performed by controlling for possible selection bias, due to the necessary exclusion from the analysis of non-innovative firms.

The chapter is organized as follows. Section 1.2 explores the literature on green innovation and cooperation and introduces the theoretical background and the previous empirical results that motivate the hypotheses. Section 1.3 describes the data, the variables and the econometric specification used in the empirical analysis and section 1.4 presents the results of the econometric regressions. Finally, section 1.5 contains the conclusions, the limitations of the study and indications for future research.

1.2 Conceptual Background

1.2.1 A literature review of cooperative arrangements for innovation

Studies on the influence of cooperation on innovative activities of firms have mushroomed in recent years suggesting that conventional explanatory variables of innovation performance need to be complemented by investigating collaboration. The early Schumpeterian model of stand-alone developed innovations has been surpassed by the recognition that firms rarely innovate on their own and rely on each other to exchange knowledge, pool resources and share risks (e.g., Håkansson, 1987; Powell, Koput, and Smith-Doerr, 1996). The increasing instability of demand, reduction of product life cycles, disintegration and globalization of production have contributed to take this discussion to the fore in innovation studies. The knowledge base of the companies may quickly become obsolete or insufficient to be competitive and cooperation with other actors of a network become a pivotal competitive factor. Such external partners represent both important sources of information and key

resources in the development of innovations (Powell, Koput, and Smith-Doerr, 1996; Von Hippel, 1988; Chesbrough, 2003; Laursen and Salter, 2006).

The management literature discussed the determinants and the modes of cooperation starting from different points of view. The Transaction Cost (TCE) Approach conceives cooperation toward innovative activities as a form of organization that enables resource access and a better control of the technological transfer while minimizing the risk of opportunistic behaviors thanks to the development of a mutually dependent relationship (e.g., Pisano, 1990; Williamson, 1991). The initial argument that interpreted innovation strategies through the *make or buy* dichotomy, namely investing in internal R&D departments or buying knowledge outside the firm, has been developed by the recognition that market and hierarchy are the end points of a continuum, in which network governance structures are increasingly important (e.g., Håkansson, 1987; Gulati, 1998). The resource-based view (RBV) literature, instead, interprets partnership and networking for innovation in terms of possibilities to access new skills and pool resources (Penrose, 1959; Powell, Koput, and Smith-Doerr, 1996). Through collaboration with external partners, the firms may actually exploit complementary know-how that can be combined with the internal knowledge base to enter new markets or develop new technologies. This strategy is even more valuable in the case of emergent or highly competitive industries or for innovations that are radical or imply knowledge and skills, which fall outside the firms' usual domain (Eisenhardt and Schoonhoven, 1996), which is often the case of innovations aimed at reduced the impact on the environment.

Starting from different points of view and recognizing peculiar advantages, these contributions agree on the pivotal importance for firms to cooperate with external partners on innovative activities. However, to cooperate with external partners is not necessarily a winning strategy *per se*. To effectively develop successful innovations, the firms have to be able to interact the information and knowledge flowing from these partners with the internal capability base. Studies on what has been coined "absorptive capacity" have found support for the hypothesis that the internal R&D efforts increase the effectiveness of incoming information and knowledge (Cohen and Levinthal, 1990). However, the relation between the two is complex. On the one hand, cooperation may be an important substitute for lack of internal resources and effort, on the other hand, the existence of strong absorptive capabilities may enhance firm's returns from the interaction with external partners. Empirical analyses have not solved the puzzle yet: evidence on both the substitution (Laursen and Salter, 2006; Vega-Jurado, Gutierrez-Gracia, and Fernandez-de-Lucio, 2009) and the complementary (Tether, 2002; Cassiman and Veugelers, 2006) arguments have been found.

Cooperation for innovation within the supply chain and beyond

The determinants and the impacts of cooperation on R&D activities vary not only because of firm's internal characteristics such as its absorptive capacity, or of innovation or industry peculiarities but also according to the typology of partners involved. Customers, suppliers and research institutes, in fact, may hold different complementary knowledge with respect to the firm's knowledge base, provide specific

competitive advantage and imply different cooperative modes and appropriability concerns.

The research of Von Hippel and others (see e.g., Von Hippel, 1976, 1986, 1988; Chesbrough, 2003; Franke and Shah, 2003) has highlighted the key role of consumers in defining innovations, supporting internal R&D effort and identifying markets' needs. The existence of information that is costly to obtain and use and of different market niches provide boost for the firms to cooperate with customers (Sanchez-Gonzalez, Gonzalez-Alvarez, and Nieto, 2009). Especially in case of highly complex or novel innovations, consumers and communities of consumption may represent powerful allies for firms, by contributing to reduce the risk implied by new product's market introduction and by improving technical features of the product.

Interest in the role of suppliers as co-innovators arose in the 1980s thanks to the success of the Japanese automotive and electronic industries, which was partly attributed to the suppliers' involvement in the firms' innovation activities. Collaboration with suppliers proved to enhance efficiency, reduce risks or be a necessary complement to the technological base of the firms in the development of innovations under conditions of technological uncertainty (Clark, 1989; Ragatz, Handfield, and Petersen, 2002). According to the literature (see e.g., Miotti and Sachwald, 2003), vertical co-operations on R&D positively impact mostly the ability of firms to introduce new products on the market, but is rather the cooperation with public institutions that lead to higher patenting attitudes.

The firm engage in cooperation on R&D activities not only with its business partners, but also with a broader range of actors that may be less industry-oriented but provides key knowledge on technical or commercial and organizational aspects of the development and market-introduction of new products or processes. Many scholarly contributions focused the attention on the role of cooperative agreements with scientific agents on innovation performance and on specific advantages that induce firms to engage in R&D cooperative agreements with such partners. The university-industry link has particularly attracted the attention of scholars and governments in recent years. Empirical analyses have found support for the hypotheses that both firm's characteristics, such as size and the industry context, and firm's innovation strategies, regarding the R&D effort, the degree of openness to a variety of information sources and the innovation's content, motivate and influence the extent of the interaction with universities (Laursen and Salter, 2004; Segarra-Blasco and Arauzo-Carod, 2008; Sanchez-Gonzalez, Gonzalez-Alvarez, and Nieto, 2009). Other than university, other specialist knowledge providers, including consultancies, private research organizations and public research laboratories are increasingly supporting the firm's R&D activities (Tether and Tajar, 2008). Such knowledge intensive business service firms may play a crucial role in the definition, development or commercialization of technological or managerial innovations and complement other external sources of knowledge. The influential study of Cohen, Nelson, and Walsh (2002) on public specialist knowledge providers reveals that they are used not only to help generate new ideas, but also in completing existing R&D projects. Firms seems to rely on universities and scientific agents especially in the field of scientific and technological knowledge, in science-based industries

and in the generation of product, rather than process, innovations (Reichstein and Salter, 2006; Vega-Jurado, Gutierrez-Gracia, and Fernandez-de-Lucio, 2009).

1.2.2 Is green different?

Despite the increasing interest of policy makers in innovations that lower the impact of firms' activities on the environment, the research on this area is still limited and not systematic. Different definitions of green, sustainable, environmental or eco-innovations have been developed by scholars, according to the different purpose of considering it the object for environmental regulations or administration or as an industrial growth area. In this setting I adopt the definition of environmental innovations as "new or modified processes, techniques, practices, systems and products to avoid or reduce environmental harms" (Kemp, Arundel, and Smith, 2001; Beise and Rennings, 2005). This definition is purposefully very broad, including all the changes in the product portfolio or in the production processes that tackles sustainability targets. Main environmental targets include the reduction of greenhouse effects, acidification, toxic impacts on ecosystems or on humans, loss of biodiversity and consumption of soil or resources in general to a higher rate with respect to natural reproduction. To address this concerns, firms may introduce eco-efficiency measures, employ machinery or production process that reduce emissions, eco-design their products to reduce their impacts along all their life cycle or manage wastes sustainably. In the literature, environmental innovations are usually classified into end-of-pipe or cleaner technologies, where the second are usually refers to as superior in term of both environmental and economic effects since they reduce products or process impacts at the source rather than reactively adapt them at the end of the production process (see del Río González, 2009). Later contributions have sharpened this classification, focusing on the different environmental object addressed or on the different ways in which a reduction of the impact on the environment is achieved (see Rennings, 2000). Despite the policy and managerial focus is still on technological improvements, eco-innovations may concern also service innovations or broader organizational and systemic improvements (see Rennings, 2000; Arundel and Kemp, 2009).

These innovations, which are increasingly at the center of policy action, represent a distinct sub-group of innovations in many respects. A first peculiarity, besides their positive impact upon the environment, is what Rennings (2000) defined as the "double externality problem". In addition to the spillovers of basic R&D effort studied by innovation economists, environmental innovations generate spillovers also in the diffusion phase, by internalizing the external costs of the impacts on the environment. The reduction of environmental impacts, in fact, is a costly activity for the firms, that implies a benefit for the society but that may not be appropriated by the firm. This double externality causes a reduction in firms' private incentives to invest in such innovations. Policy intervention is then advocated as a potential solution to this market-failure problem. By imposing minimum requirements or by offering specific incentives for virtuous firms, regulation may compensate for the low private incentive of firms to invest in environmental innovations. Determinants of eco-innovation turn out to be different from other innovations, which not suffer

from this second externality problem. The literature argues that regulation and policy intervention have to be included in the analysis other than the demand-pull and technology-push factors usually considered in mainstream innovation literature (Cleff and Rennings, 1999; Kemp, 2000; Jaffe, Newell, and Stavins, 2002).

The literature has stressed that environmental innovations are peculiar also for the importance of cooperative arrangements. Arguments in favor of a higher need for collaboration with external partners with respect to other innovations reflect the different perspectives on the determinants of cooperation over R&D activities discussed in the mainstream innovation literature (see section 1.2.1). They may be divided , in fact, into contributions following a TCE perspective by highlighting the risk for opportunistic behaviors and the specific coordination mechanisms to reduce them and contributions employing a RBV perspective, arguing for knowledge complementarities.

The environmental feature of a product or process is often a hidden attribute that cannot be disentangled even after the purchase, creating an information problem Darby and Karny (1973); Reardon, Codron, Busch, Bingen, and Harris (1999). Darby and Karny named the goods with these qualities *credence goods*, since their value cannot be evaluated in normal use but, if possible, can be assessed just by acquiring additional costly information. Just in very few instances, when purchasing a product, it is possible to understand if it has been done by the mean of a less polluting production process or by using a less impacting raw material. This feature creates information asymmetries at each stage of the supply chain in which an actor is looking to buy a product or a component with a lower environmental impact. To ensure customers about its environmental attitude, firms are impelled to understand the environmental features of components they are buying. These information asymmetries boost firms to have a higher degree of control over their suppliers' activities, which is often reached through closer relations with supply-chain partners. Voluntary environmental certifications are increasingly pointed to as tools to mitigate this information problem (Baksi and Bose, 2007), reinforcing the need for a closer relationship with value chain partners. Many of the eco-labels, actually, require firms to be responsible for the environmental performance of all the components of their products, reinforcing interdependencies among partners of the value chain.

On the other side, other contributions have rather highlighted the complementarities of the firm's resources and capabilities when it look to develop environmental innovations, which may imply changes in the overall product structure and in the activities of supply chain partners. Andersen and others (Andersen, 1999, 2002; Foxon and Andersen, 2009) defines environmental innovations as *systemic*, requiring a higher cooperative effort and implying higher complementarities with the activities performed by network partners. Cooperation with external partners becomes even more important in managing environmental rather than other innovations, because of the characteristics of the product's and process' enhancements. Environmental innovation very often requires changes in the raw materials or components used, the logistical and technical integration with external partners and the re-design of the product. Inputs with environmentally-friendly features

are not always readily available on the market, resulting in the need for the firm to engage in cooperation activities with new or established suppliers to realize product innovations (Geffen and Rothenberg, 2000; Meyer and Hohmann, 2000; Goldbach, 2003). To implement changes on the input side often requires a close collaboration with materials and equipment vendors, both to ensure that the new component or input fulfills the required features and to adapt the internal processes accordingly (see e.g., Seuring, 2004; Seuring and Müller, 2008). Technical and organizational interdependencies among firms are increasing as they attempt to close their production cycles and apply a "life cycle perspective". To use recycled products or to enable the recyclability of their own products, firms may need to engage in closer coordination mechanisms with industrial partners, i.e., suppliers and business clients (Andersen, 1999).

Similarly, other contributions within this stream of the literature suggest complementarities arising because of the complexity of the environmental innovations. To carry out a product that reduces the impact on the environment is a rather complex task and often requires information and skills distant from the traditional knowledge base of the industry. Exchanges of information on a continuous basis, capability developments and reciprocal learning between customers and suppliers have proved to be key to reach environmental targets (Andersen, 1999; Meyer and Hohmann, 2000; Foxon and Andersen, 2009).

1.2.3 Recent empirical evidence on cooperation and environmental innovation

Despite the growing body of literature, empirical evidence corroborating the importance of cooperation in seeking environmental innovations is still scant and sparse. Mazzanti and Zoboli (2005, 2009) provide useful insights on the relevance of cooperation to achieve environmental innovations by focusing on districts, through the analysis of survey data on 199 manufacturing firms located in the Reggio Emilia province, in Italy. Their results show that networking activities may be a major driver for environmental innovation mediated by R&D, especially as far as emission-related innovations are concerned. Interestingly enough, its effects seems even more important than structural characteristics of firms such as size. They interpret this result as evidence that cooperative agreements, what they refer to as "horizontal economies of scale", "might matter even more than internal economies of scale". However, their dataset, being tailored to analyze green innovations, does not allow to understand if the networking attitude of firms is dissimilar than that employed for non-green innovations. The analysis of Horbach (2008) of German manufacturing firms, aimed at understanding the determinants of green innovations, overcomes this problem and provides support to the greater importance of cooperation for green-innovators rather than for non-green ones, even though his results may be challenged since the econometric technique used does not control for possible selection bias coming from the exclusion of non-innovative companies from the analysis. Furthermore, his analysis does not inquire the relevance of different typology of partners. Nevertheless, as pointed to in many studies in the innovation literature, suppliers, clients and scientific agents may play very different roles as

innovative partners.

The role of suppliers in environmental innovation development has been particularly investigated, especially in the Green Supply Chain Management (GSCM) literature, as it will be broadly discussed in Chapter 2. Geffen and Rothenberg (2000), through a case studies analysis on the automotive industry, found that a strong partnership with suppliers is a powerful spur to the application of innovative environmental technologies. A number of studies, focusing mainly on case studies in traditional industries, suggest that cooperation with suppliers may strategic to introduce new products especially in the case in which a change in the firm's inputs is needed (see e.g. Meyer and Hohmann, 2000; Goldbach, 2003). Other contributions have focus on the pivotal role of consumers and suppliers as a source of information that can be even more important than for other innovations (Hemmelskamp, 1999; Theyel, 2006), whereas, to the best of my knowledge, no attempts have been done to specifically investigate the importance of cooperative agreements with public R&D labs, universities or other scientific agents.

Analogously to mainstream innovation scholars, *environmental* innovation scholars have investigated the relationship between cooperation with external partners and internal effort toward innovation. The econometric analysis of Rennings, Ziegler, Ankele, and Hoffmann (2006) based on survey data on EMAS-validated German firms points to the importance of internal R&D activities as determinants of environmental innovations, and that of Horbach (2008) provides support to the hypothesis that they are even more critical than for non-environmental innovations. However, evidence on the nature of the relation between R&D and external knowledge sourcing strategies is scarce and mixed. Hemmelskamp (1999), in a study of German firms, finds evidence to support the hypothesis that environmentally innovative companies have low R&D intensity, which is compensated by the use of external sources of information. This feature, which is stronger especially for product innovations, is seen as evidence of the dominance of end-of-pipe innovations that, being incremental, may require little R&D effort. Mazzanti and Zoboli's results suggest instead the existence of a synergetic effect between environmental R&D investments and networking activities: in their analysis, the impact of networking activities on environmental innovation is mediated by environmental R&D. The authors present the results as evidence of the "positive relationship between R&D and social capital in an impure public good framework".

In sum, empirical contributions have supported the hypothesis that the specificities of environmental innovations imply cooperation with external actors. However, those contributions does not allow to disentangle to what extent R&D cooperative agreements for environmental innovations differs from non-environmental ones and nor the different role of vertical, horizontal or lateral collaboration. In the following sections, I try to overcome important limitations of the above mentioned literature, by empirically testing the greater importance of collaboration for environmental innovations with respect to non-environmental ones. Secondly, I will analyze which partners may be more important for the development of green innovation. In particular, I expect suppliers and commercial customers to play a crucial role in green innovation dynamics, both as sources of information to conceive and

realize the innovations and as partner with whom to collaborate in order to obtain certifications and eco-labels that enable a successful leverage in final markets. Furthermore, I will analyze the relationship between networking activities and the internal innovative effort of the company, to contribute to the debate on their synergetic or substituting effect.

1.3 Description of the empirical study

1.3.1 The PITEC dataset and the empirical setting

To test these hypotheses I use data from the Spanish Innovation Survey, the Technological Innovation Panel (PITEC), which is carried out yearly by the Spanish National Statistics Institute[1].

The rational for the choice of this dataset is multifold. Firstly, being the purpose of the study to understand the peculiarities with respect to non-environmental innovations, this dataset seemed appropriate since it contains information on both type of innovations, rather than just on environmental ones.

Secondly, this dataset is based on the Community Innovation Survey (CIS) framework, which enables to compare the emerging analysis with results of previous literature on similar datasets. CIS surveys, administered by national statistical offices throughout the European Union and other countries, have proved to be a valid and reliable tool to understand innovation dynamics. They are among the most used in innovation studies (see e.g., Tether, 2002; Laursen and Salter, 2006; Reichstein and Salter, 2006) and have been employed in the pioneering studies performing comparative analysis on environmental innovations (Horbach, 2008)[2].

Finally, the peculiarities of the Spanish Innovation System enable useful comparisons with other countries, Italy - which would be the setting for next chapter analyses -among all, and the increasing relevance of environmental issues for the Spanish economy makes it a proper setting to investigate green innovations dynamics. Spain is a moderate innovators' country. Its main specializations are rather traditional industries, with significants development in more advanced industries in recent years. According to the Eurostat statistics, the average expenditure as % of the GDP in Spain in 2008 was 1.35% and it scored 0.37 in the Summary innovation Index (SII), an aggregate national innovation performance reported in the EU innovation scoreboard. This indicators place Spain in the lower end of the EU27 performance but very close to the Italian position. The average spending in R&D, in fact, was 1.9% of the GDP in the EU27 zone and 1.18% in Italy, whereas the SII was 0.48 and 0.35 in Italy. According to the EU statistics, Italy and Spain, together with Norway, are the most similar countries in Europe as far as innovation performance and their dynamics are concerned, being both moderate innovators and slow growers If they rank low as for private investments in R&D, Spanish industries benefit from the very active role of the government and higher

[1]The dataset, the questionnaire and the description of each variable is available free of charge at the website http://icono.fecyt.es/contenido.asp?dir=05%29Publi/AA%29panel

[2]See also Andersen (2007) and Kemp and Horbach (2007) for a deeper understanding on possible measure to detect green innovation.

education sectors, which in 2008 represented more than half (48.8%) of the total gross domestic expenditures in R&D, much higher than the 34.8% of the EU27 average for the same year but closer to the 44.2% of Italy. Furthermore, Spain has an increasingly high specialization in renewable energies production - being in 2008 the world's fourth biggest producer of wind power - and among the highest number of environmental certified firms through all the industries (first European country for ISO14001 and among the first five for number of EMAS and Ecolabel certifications).

The analysis of this paper is based on PITEC data for the year 2008, which provides information on 11,182 companies' structural characteristics, R&D strategies and innovative activities over the period 2006-2008. Acknowledging the differences in innovation activities and cooperation patterns between manufacturing and services firms, I restricted the analysis just to manufacturing activities, being left with 5,801 active companies.

1.3.2 The variables for the analysis

How to measure environmental innovation

Many different indicators and methodologies have been employed to evaluate the innovative performance of firms but all have been subject to the criticism to over or under-estimate innovations. Green innovation is not an exception. The difficulties to defined it make it rather more difficult to identify a clear-cut methodology to measure it. Environmental patents have been extensively employed as proxies for green innovations (see e.g., Jaffe and Palmer, 1997; Brunnermeier and Cohen, 2003; Nameroff, Garant, and Albert, 2004), yet shortcomings similar to those analyzed for general innovations warn against the use of those proxies, which could lead to under- or over-estimate innovation, for example in the case, very common in the business practices, of incremental innovations. This shortcoming apply also to the used of environmental R&D expenditures as a proxy of environmental innovation (see e.g., Jaffe and Palmer, 1997; Mazzanti and Zoboli, 2005, 2009), which is to be interpreted as an input rather than an output of innovation activities. Following the approach of Horbach (2008), I instead use data on the objects of innovation, as reported in the PITEC survey, using the question on the "importance of reduced environmental impacts" as one of the objects of the product or process innovation introduced. The dependent variable used in the econometric model, ENV_INN, is a dummy variable valuing 1 if, in the period 2006-2008, the company reported high or medium importance of this object on a four-point scale, 0 otherwise. Unfortunately, the questionnaire was not designed to investigate specifically green innovations: even if allowing important comparisons with similar works, the choice of this dependent variable could be criticized for being too broad. Different specifications of the dependent variable, including eco-efficiency measures, will be performed to test the robustness of the model.

Engagement in R&D and cooperation for innovation

To verify the hypothesis of the greater importance of cooperation for environmental innovation, I use data on a questions asking about active participation on innovation

activities with external partner. The dummy variable COOPERATION indicates if the firm reported to have cooperated on any of the innovation activities with external firms or institutions. The PITEC survey lists seven possible external partners: (1) suppliers of equipment, materials, components or software, (2) clients or customers, (3) competitors or other enterprises of the same industry, (4) consultants, commercial labs or private R&D labs, (5) universities or other higher education institutions, (6) public research institutes, and (7) technological centers. Dummies indicating if the company cooperates with each of those partners have been created to disentangle the different role of vertical, horizontal and lateral agreements toward environmental innovation. COOPVENDOR is a binary value equal 1 if the company cooperate with partner of typology (1), COOPCLIENT and COOPCOMPET of typology (2) and (3) respectively, COOPSCIENT if the companies cooperate with any scientific agent, so with the remaining partners listed in the survey. To understand the role of internal effort toward innovation and its relationship with external cooperative strategies, I employ different measures. The variable R&D_INTENSITY expresses Research and Development intensity as the ratio between the employees working in the R&D department and the total number of employees. Moreover, I included a dummy indicating if the company performed continuous R&D activities (CONT_R&D) and its interaction variable COOP_R&D with the variable COOPERATION to test for the complementarity argument.

Other than investing in R&D activities or interacting with external firms or institutions, firms may realize innovation activities benefitting from the acquisition of external knowledge. The PITEC database captures this dimension asking firms about extramural R&D acquisition. The variable EXT_R&D indicates expenses on external R&D activities as percentage of the total expenses devoted to innovation activities.

Structural characteristics of the firm and other control variables

Most empirical studies on innovation consider size as an important explanatory variable of firms' innovative performance: the bigger the firm the more it is likely to enjoy market power, economies of scale or having more resources to dedicate to the development of innovations. Similarly, studies on environmental innovation have stressed the role of size, emphasizing the difficulties of SMEs in facing the complexity of environmental innovations and the investments needed to switch to greener technologies (Hemmelskamp, 1999). Benchmarking empirical studies on innovation (see e.g., Reichstein and Salter, 2006), I measure size as the logarithm of the number of employees (SIZE). SUBSIDIARY is a binary variable assuming value 1 if the firm is a subsidiary and 0 otherwise, which controls for the possible reliance on the main firm's resources, skills and knowledge so as for the differential attitude toward environmental issues' experienced by firms affiliated with multinationals.

The dummy variable EXPORT is used to control for the impact of the export activities on environmental innovation propensity. The higher competitive pressures, policy restrictions or the different consumers' awareness that characterize each country's markets may actually spur or inhibit green innovation. Similarly, differences may be experienced when considering different industries (see for example Brunnermeier and Cohen, 2003): 13 industry dummies are included in the

Table 1.1: Environmental innovators, non-environmental innovators and non-innovators by industry, ordered by the relative importance of environmental innovators on the total.

	Tot no. of firms	% of envir. innov.	% of other innov.	% of non innov.
Chemicals	583	61.2%	23.8%	14.9%
Pharmaceuticals	156	54.5%	30.1%	15.4%
Non-metallic mineral prod. and basic metals	497	41.9%	33.2%	24.9%
Transport	329	41.3%	37.1%	21.6%
Plastics	363	40.8%	33.9%	25.3%
Food, drink and tobacco	741	38.6%	36.7%	24.7%
Electrical	655	37.3%	45.6%	17.1%
Machinery	785	35.9%	45.4%	18.7%
Other Manufacturing Activities	332	34.6%	38.9%	26.5%
Wood	107	34.6%	32.7%	32.7%
Paper and Printing	260	33.1%	29.2%	37.7%
Fabric. metal products	607	32.8%	39.2%	28.0%
Textile and footwear	386	29.8%	40.4%	29.8%
Total	5,801	2,298	2,157	1,346

analysis, capturing specificities regarding market structure, sources and direction of technical change. I control for the influence of policies using a proxy for incentives toward innovation. The binary variable PUB_FUNDS indicates whether or not the firm benefitted from any public funds for innovative activities (Mazzanti and Zoboli, 2005, 2009). Exploiting the time dimension of the PITEC, I investigate if past innovative performance affect the likelihood to introduce environmental innovations. The variable INNOVATION05 indicates if the firm reported to be an innovator in the previous wave (regarding the years 2003-2005).

1.3.3 Descriptive Statistics

Among the innovators that represent the 76.8% of the firms in the dataset, half (51.6%) were environmental innovators. In table 1.1, I analyze the distribution of green and non-green innovators by industry. The comparative analysis between environmental and other innovators highlights the existence of industry heterogeneity in environmental performance. Those differences may reflect the diverse advancements in terms of technological development for greener alternatives or differences in policy restrictions and consumers' awareness. In particular, few firms in low-tech industries, such as textile, footwear and plastics introduced environmental innovation. In industries implying more complex technologies, instead, there is more heterogeneity: in the chemical and pharmaceutical industries the majority of firms have introduced green innovations, whereas in the machinery and electrical ones this sub-group represents just a minority. Table 1.2 reports the descriptive results of the main variables comparing environmental and non-environmental innovators. On average, environmental innovative firms are bigger than non-environmental innovators, even though the variability within the first group is bigger than within the second. If the innovative effort of the two categories is rather similar in terms

Table 1.2: Descriptive statistics of the regressors for environmental and non-environmental innovators.

	Envir. Innovative		Other Innovative	
	Mean	S.D.	Mean	S.D.
cooperation	39.4%	0.49	23.6%	0.42
coopvendor	20.8%	0.41	9.9%	0.30
coopclient	14.1%	0.35	7.7%	0.27
coopcompet	7.0%	0.25	4.0%	0.20
coopscient	30.6%	0.46	17.4%	0.38
ext_r&d	10.3	20.22	8.5	21.44
r&d_intensity	11.3%	0.17	9.0%	0.17
cont_r&d	65.5%	0.48	40.5%	0.49
size	4.3	1.40	3.9	1.30
export	57.1%	0.50	55.1%	0.50
subsidiary	33.9%	0.47	25.5%	0.44
pub_funds	45.6%	0.50	31.9%	0.47
innovation05	91.6%	0.28	83.7%	0.37
	2,298		2,157	

of personnel devoted to R&D, many more firms claimed to perform R&D activities on a continuous rather than an occasional basis. Furthermore, green innovators seem to have been more able to attract public funds for innovative activities and seems more likely to be serial innovators.

Overall, it seems that the two groups of innovators differ especially in terms of degree of networking toward innovation: 39.4% of environmental innovators had at least one cooperative agreement toward innovation with external firms, versus the 23.6% of non-environmental ones. The higher reliance on cooperation is verified for each relation considered, vertical, horizontal and lateral, but seems to be even more important when it comes to vendors (20.8% vs. 9.9%) and scientific agents (30.6% versus 17.4%).

1.3.4 Method

Since the dependent variable is a dummy, a binary outcome model is used, controlling for possible selection bias arising from the exclusion from the analysis of non-innovative firms. I therefore apply a Two Part Logit Model (Cameron and Trivedi, 2005), a method that has proved to be appropriate for estimating actual outcomes and more suitable than an Heckman selection model since the dependent variable is binary and not continuous (Haas and Hansen, 2005).

In the first stage, the probability for a firm to become an innovator (PrINNOVATION) is calculated by regressing on INNOVATION exogenous variables available for all observations (innovative and non-innovative firms). As regressors, I used firm size (SIZE), a dummy signaling if the firm is part of a group (GROUP) and INDUSTRY DUMMIES as in Vega-Jurado, Gutierrez-Gracia, and Fernandez-de-Lucio (2009), plus variables indicating on a four-point scale strictly exogenous obstacles to innovation: the high cost of innovation (HAMP_HIGH_COSTS), if

Table 1.3: Second Stage Logit Regression, explaining environmental innovative propensity across Spanish firms considering cooperation strategies.

	(I) ENV_INN		(II) ENV_INN		(III) ENV_INN	
	Coef.	S.E.	Coef.	S.E.	Coef.	S.E.
cooperation	0.389***	(0.076)	0.515***	(0.074)	0.532***	(0.121)
ext_r&d	0.001	(0.002)	-0.000	(0.002)	0.001	(0.002)
r&d_intensity	0.280	(0.248)			0.296	(0.248)
cont_r&d	0.748***	(0.076)			0.808***	(0.086)
cooprd_cont2					-0.228	(0.149)
size	0.088**	(0.035)	0.083***	(0.032)	0.091***	(0.035)
export	-0.295***	(0.069)	-0.225***	(0.068)	-0.296***	(0.069)
subsidiary	0.065	(0.080)	0.068	(0.078)	0.067	(0.080)
pub_funds	0.230***	(0.073)	0.358***	(0.070)	0.232***	(0.073)
innovation05	0.527***	(0.102)	0.654***	(0.101)	0.529***	(0.102)
prinnovation	1.673***	(0.377)	2.353***	(0.369)	1.646***	(0.378)
industry dummies	included		included		included	
Constant	-2.524***	(0.277)	-2.890***	(0.270)	-2.551***	(0.278)
Observations	4409		4409		4409	
Pseudo R^2	0.0950		0.0752		0.0954	
Chi-square	502.1***		403.6***		504.8***	

Robust standard errors.
*** p<0.01, ** p<0.05, * p<0.1.

the market was dominated by established firms (HAMP_DOMIN_MKT) and if there was no demand for innovation (HAMP_NO_DEMAND). Finally a dummy indicating if the firm was involved in the Biotechnology industry (BIOTECH) has been included. The results of the first stage logit regression are displayed in Table A.2 in the Appendix A.

In the second stage, non-innovative firms are dropped from the analysis but the inclusion of PrINNOVATION controls for selection bias by including the effects of firms that did not innovate. A logit specification is used for both stages.

1.4 Main Results and discussion

Cooperative agreements and environmental innovation

Table 1.3 reports the results for the second stage logit regression, investigating the impact of the presence of cooperative agreements with external partners on environmental innovation propensity. Column (I) reports the complete model, whereas columns (II) and (III) report results to test the complementarity with internal R&D effort.

I find strong support for the hypothesis that cooperation promotes the introduction of environmental product or process innovations to a greater extent than non-environmental innovations. The coefficients of COOPERATION are in fact positive and significant in all models. The results are consistent also when excluding from the analysis the internal effort toward innovation, as in model (II).

The econometric analysis provides support to the hypothesis that internal R&D activities trigger environmental innovation. The R&D intensity (R&D_INTENSITY) is never significant, whereas the coefficient of the proxy for continuous R&D activities (CONT_R&D) is significant and consistently positive in explaining green innovative performance. The sign of the interactive variable COOP_R&D is negative, suggesting the existence of a substitution effect between external cooperation activities and internal R&D[3]. It is not more likely that green innovative firms rely on market relations to develop innovation: the coefficient of EXT_R&D is, in fact, never significant.

Table 1.4 reports the results when including, as regressors, dummies indicating the cooperation with specific partners. The results support the hypothesis that cooperating with suppliers drives green innovations to a greater extent than other innovations. The coefficient of COOPVENDOR is significant and positive, pointing to the existence of higher technological interdependences between green innovators and their vendors. The interaction with universities and other scientific agents (COOPKIBS) is significantly and positively correlated with environmental innovations. On the contrary, cooperation with clients (COOPCLIENT) does not seem to affect green innovation to a different degree than other innovations, as cooperation with competitors (COOPCOMPET).

The impact of firm's and market's characteristics and of internationalization strategies on environmental innovation

The impact of the control variables is consistent for all the models presented. Firm's size (SIZE) positively affect green innovation propensity, confirming that big firms are more likely to be environmental innovators. Being a subsidiary (SUBSIDIARY) is the only control variable that is not differentially significant in explaining green innovations with respect to other innovations. All the others, including the receiving of public financing (PUB_FUNDS) and the introduction of innovations in the past (INNOVATION05) are significant and consistently positive in explaining green innovative performance in all the models. Equally significant across all the models, export is negatively correlated with environmental innovations, indicating that having a local market may be more favorable to market green innovations, as respect to other innovators. As far as the industry dummies are concerned the regression confirms the significant positive impact of the chemical sector and the negative impact of the machinery and electric industry. Finally, the coefficient of PrINNOVATION is highly significant in all the models, therefore justifying the choice of using a selection bias model. Using models that do not consider the exclusion of non-innovative firms from the analysis would have, in fact, lead to biased results.

1.4.1 Robustness analysis

To test the reliability of the results, I performed robustness checks considering different specifications of the dependent variable and controlling for possible omitted

[3]A similar result was obtained also when considering instead the interaction between cooperation and the R&D intensity.

Table 1.4: Second Stage Logit Regression, explaining environmental innovation through the typologies of partners the firms cooperate with.

	(IV) ENV_INN	
	Coef	S.E.
coopvendor	0.496***	(0.111)
coopclient	-0.026	(0.130)
coopcompet	-0.127	(0.158)
coopscient	0.213**	(0.093)
ext_r&d	0.001	(0.002)
r&d_intensity	0.296	(0.248)
cont_r&d	0.742***	(0.077)
size	0.074**	(0.035)
export	-0.300***	(0.070)
subsidiary	0.078	(0.080)
pub_funds	0.232***	(0.074)
innovation05	0.516***	(0.102)
prinnovation	1.732***	(0.376)
industry dummies	included	
Constant	-2.504***	(0.277)
Observations	4409	
Pseudo R^2	0.0971	
Chi-square	509.6***	

Robust standard errors.
*** p<0.01, ** p<0.05, * p<0.1.

variables bias and reverse-causality endogeneity.

To control for the construct validity of the dependent variable, I considered eco-efficiency innovations – a sub group of environmental innovations consisting in reducing energy and inputs – as a different proxy of environmental innovation. To capture this dimension of environmental innovation, I used a question of the PITEC survey asking, on a four-point scale, if the object of the innovation was to reduce materials or energy used per unit produced. The variable ENV_INN2 is a dummy assuming value 1 if the firm declared that this effect was medium or high. ENV_INN3 is a binary variable measuring the combined effect of eco-efficiency (ENV_INN2) and the reduced impact on the environment (ENV_INN). The three measures are highly but not perfectly correlated. Columns (I), (V) and (VI) of table 1.5 reports the second stage logit regression using, respectively, ENV_INN, ENV_INN2 and ENV_INN3 as the dependent variable. Coefficients' signs and significance levels of the main regressors are consistent along all the models, even if the magnitude of COOPERATION's coefficient for the models including eco-efficiency measures (columns (V) and (VI)) are lower. The sub-group of energy- and material-efficient environmental innovations, which may consist in improving the efficiency of existing technologies and being likely incremental, may lessen the need for cooperation with external partners. Interestingly, the variable EXPORT lose significance when considering eco-efficiency as a proxy for

Table 1.5: Second Stage Logit Regression, explaining environmental innovation using different specifications of the dependent variable.

	(I) ENV_INN		(V) ENV_INN2		(VI) ENV_INN3	
	Coef.	S.E.	Coef.	S.E.	Coef.	S.E.
cooperation	0.389***	(0.076)	0.209***	(0.072)	0.197***	(0.076)
ext_r&d	0.001	(0.002)	-0.000	(0.001)	0.001	(0.002)
r&d_intensity	0.280	(0.248)	0.040	(0.221)	0.223	(0.235)
cont_r&d	0.748***	(0.076)	0.640***	(0.072)	0.640***	(0.078)
size	0.088**	(0.035)	0.037	(0.032)	0.093***	(0.035)
export	-0.295***	(0.069)	-0.037	(0.064)	-0.118*	(0.069)
subsidiary	0.065	(0.080)	0.162**	(0.074)	0.178**	(0.078)
pub_funds	0.230***	(0.073)	0.132*	(0.069)	0.166**	(0.073)
innovation05	0.527***	(0.102)	0.618***	(0.093)	0.598***	(0.111)
prinnovation	1.673***	(0.377)	1.732***	(0.345)	1.526***	(0.386)
industry dummies	included		included		included	
Constant	-2.524***	(0.277)	-2.412***	(0.253)	-2.956***	(0.286)
Observations	4409		4787		4409	
Pseudo R^2	0.0950		0.0584		0.0674	
Chi-square	502.1***		355.4***		355.5***	

Robust standard errors.
*** p<0.01, ** p<0.05, * p<0.1.

environmental innovations (column (V)), which may be explained with the different economic gains allowed by those environmental innovations, as will emerge also from the qualitative analysis[4]. The effort to reduce the use of energy and materials per unit produced, in fact, is sustained by an "internal" economic advantage - the reduction of costs - that do not need to be recognized by customers or external stakeholders. On the contrary, other forms of environmental innovations that need the consumers to be acquainted with in order to be profitable (e.g., innovations aimed at differentiate from competitors or requiring a premium price) benefit from the proximity to final markets.

To control for possible bias coming from firm's specific characteristics like managerial attitudes and the presence of voluntary environmental certifications, which are not observable but may affect environmental innovation propensity (see e.g. Wagner, 2007), I exploited the longitudinal dimension of the data-set running a fixed effect logit model using data from 2003 to 2008[5]. Results are reported in table A.3 in Appendix A. The magnitude and significance of the main regressor,

[4]See, for example, Orsato (2006) for a taxonomy of different environmental strategies.

[5]When comparing logit and fixed-effects logit regressions the reader should be aware of the following. To allow for higher variability, in the fixed effects analysis I employed a finer-grade definition of industries, using 32 instead of 13 dummies. Furthermore, because of changes in the questionnaire, the question used to identify the dependent variable in the waves precedent to 2008 refers to the *effect* of the innovations introduced, rather than the *object*. Moreover, that question asked jointly for impacts on the environment, of improved safety and security, rather than just on the environment as in 2008.

COOPERATION, are consistent with the analysis presented above, suggesting that results are not biased by time-constant not observable variables. However, differences occurs in other regressors. The transformations that the panel sample undergone between 2003 and 2004 may partly explain differences, especially when considering variables regarding R&D[6]. However, further analysis should be perform to inquire why serial innovation, public financing and export lose their significance in explaining environmental innovations when performing a longitudinal analysis.

To address the possible reverse causality between the main regressor, COOPERATION, and green innovation, I performed a regression using an instrumental variable approach. In the regressions presented above I analyzed the impact of cooperation on environmental innovation. Because cooperation with external partners entails exchange of information and the pooling of capabilities and innovation costs, it will likely induce higher green innovation propensity. However, it may also be the case that green innovation drives higher cooperation with external partners and that the two variables are simultaneously determined. If this would be the case, the results presented would be biased. To address this possible problem and control for the consistency of the estimation, I performed an instrumental variable (I.V.) regression –instead of a logit model as in the previous analyses – with bootstrapped standard errors, as suggested in the literature (Angrist and Pischke, 2009). Being the CIS datasets tailored to understand innovation dynamics, it is difficult to find variables that are uncorrelated with the error but correlated with the instrumented variable, reason why the majority of scholarly papers studying external cooperation and innovation through CIS datasets do not even address the possible reverse causality problem (see e.g., Miotti and Sachwald, 2003). The 2008 version of the PITEC dataset, however, includes a variable that seems a possible suitable I.V., LOCATION, indicating where the company is located. In fact, this variable possibly correlate with the choice to cooperate or not (COOPERATION) – e.g. a company located in an area where many other companies are located is more likely to find an industrial partner, or, if situated in a bigger city, to get in touch with consultants or universities for cooperation on R&D projects – but not with the choice to introduce innovations that reduce the impact on the environment rather than other types of innovations (ENV_INN). Results, reported in Table A.4 in the Appendix, suggest that the instrument is informative and that the hypothesis of exogeneity is accepted. In other words, using this dataset and the variable LOCATION as instrument, it seems possible to affirm that results presented in the above discussion are not biased by reverse causality problems or by time-invariant omitted variables, even if this analysis should be corroborated by further analyses. It is worth reporting at this point that all the estimations reported, passed the collinearity, goodness-of-fit and model specification tests.

1.5 Conclusions

This chapter contributes to the literature asserting that environmental innovation is a distinct sub group of innovation by inquiring on the antecedents of its successful

[6]See the PITEC website for more information of the different waves' samples.

implementation, and more specifically, on the impact of cooperation with external partners on environmental innovation propensity.

The econometric analysis, based on a dataset of Spanish manufacturing firms, confirms the hypothesis that cooperation boosts environmental innovation to a higher degree than other innovations, supporting theories asserting that environmental innovations imply higher interdependencies with external partners, both to conceive and finalize the products and to gain green profits in the market. More specifically, suppliers emerged as very important partners, corroborating the hypothesis of technological interdependencies on knowledge, skills and resources that arise in the development of environmental innovation. Similarly, the analysis suggested that scientific agents are partners more important than for other innovations. The complexity to handle sustainability issues may induce firms to rely to a greater degree than for other innovations on cooperation with universities and public or private research centers, which may provide knowledge-intensive competencies and break-through information. Conversely, coefficients regarding cooperative agreement with customers were never significant. This result does not deny the cornerstone contributions of Von Hippel and others on the relevance of lead users in the innovation process (Von Hippel, 1986, 1976), but simply reports that users are not more important partner for environmental than for other innovations. This result is not surprising: environmental features are often not easily detectable by end users (Andersen, 1999) and may require very sophisticated technical knowledge. If end users enter the firms' innovation process as far as products' use is concerned, environmental innovations seems to be still related mainly to the production domain.

Results indicate that environmental innovators diverge for the implementation of continuous R&D rather than for the relative amount of resources dedicated to internally research and develop new ideas and products, similarly to that detected in Horbach's analysis of German manufacturing firms. Moreover, I provide support for the presence of a substitution effect between internal R&D activities and cooperation with external partners. This evidence, which is in line with results emerging from analysis in the innovation literature that not distinguish between green and non-green innovations (see e.g., Laursen and Salter, 2006; Vega-Jurado, Gutierrez-Gracia, and Fernandez-de-Lucio, 2009), should be further verified considering the specific *environmental* R&D effort rather than to the *overall* R&D, as in Mazzanti and Zoboli (2005, 2009).

Firm's characteristics and internationalization strategies affect environmental propensity too. The analysis suggests that size is positively correlated with the choice to introduce innovations that reduce the impact on the environment rather than other innovations, in line with the literature asserting that SME's scarcity of resources, organizational structure and managers' scarce environmental training, among others, may inhibit the development of environmental innovations (del Brío and Junquera, 2003). Moreover, firms that already introduced new products or processes in the past seems to be more prone to explore environmental than other types of innovation. Also the ability of firms to attract public funds is correlated to environmental innovations as in Mazzanti and Zoboli's analysis, suggesting that

policy action in the form of public grants foster not only innovation but more specifically innovations that reduce the impact on the environment. Interestingly, serving an international market proved to be significantly and negatively correlated with environmental innovation: localization matters when trying to gain green profits in the market. The absence of uniquely recognized standards defining green features together with the fact that often "green issues are credence characteristics which are not apparent from the products " (Andersen, 1999) add to the importance of trust, reputation and direct communication efforts, which may be more easily acquired through proximity to the final markets.

The analysis of CIS datasets is useful to gain knowledge on a large number of observations yet has some limitations, as these datasets are not built to assess specifically green innovations nor to evaluate the nature of relations with external partners. Based on in-depth studies and observational research, next chapters will represent a necessary complement to this analysis, by further investigating both environmental innovations – better defining environmental innovations and considering differing typologies of innovations, including product vs. process and radical vs. incremental – and the network –considering the size and the typologies of relations. Case study analysis may overcome another limitation of this study, posed by its empirical setting: the fact that it does not distinguish between B2B and B2C industries, which may shed light on the role of users on environmental innovation. Furthermore, case studies may enhance this analysis by allowing to address possible rival explanations of the above presented evidence. Two possible rival explanations are considered: i) that the fact that the "environmental industry" is pretty young may mediate the impact of cooperation on innovation and ii) that environmental innovations represent just a minor part of the overall innovations introduced by the firm and therefore the higher impact of cooperation may be attributed not to the environmental attribute but to the general attitude of the company toward innovation. Thorough data on the timing of environmental innovations and on the overall innovation and networking strategies of firms, case studies will shed light on the robustness of the explanation fostered in this chapter versus these rival ones and will further analyze the emerging evidence.

Part II

Green Innovation Management in Value Chains: insights from IKEA and Valcucine

Chapter 2

The challenge to green global value chains: a literature review

2.1 The challenge to reduce environmental impacts along the Value Chain

Firms are increasingly challenged to include environmental concerns in their business activities, reducing their emission during the production process and offering products that imply a lower impact on the environment. To the extent that production activities are spread among different firms, geographically dispersed and independent one from the other, the challenge of firms is that to organize their value chain accordingly. How can firms drive the greening of their value chain?

The increasing awareness of consumer, the actions of spirited NGOs that raise the attention on firms' polluting behaviors and the increasingly stringency of national and supranational policies are encouraging firms to be responsible for impacts of all the activities that contribute to the values of their final products. The increasing fragmentation of production between independent firms spatially dispersed, which are responsible for different steps of the production process poses challenges to firms that wants to pursuit such strategies. If the division of labor with an ample network of suppliers of raw materials and preliminary products opens the door to new sources of competitive advantages, it also increases the complexity of the greening. Recent scandals that involved big corporation in the apparel and footwear industry, made companies, especially publicly visible ones, aware of the necessity to extend their Corporate Social Responsibility practices and environmental strategies outside their boundaries, to avoid reputation risks linked to poor environmental or social performance at suppliers or sub-suppliers (Zadek, 2004). More and more to control environmental performances means for firms to interact to various degree with their supply chain partners, especially suppliers, by managing boundary-spanning activities, related to supply chain management, such as green purchasing, green logistics and waste management.

2.1.1 How to green the supply chain with suppliers?

The number of studies that addressed the challenges and opportunities of the integration of environmental thinking into supply-chain management have burgeoned in recent years. Through theoretical and empirical contributions, scholars have analyzed the strategies of lead firms to improve the environmental performance of their suppliers (Seuring and Müller, 2008; Srivastava, 2007) and analyzed the efficacy of international standards and certifications as tools to manage supply chains for environmental improvements (Yang, Lin, hui Chan, and Sheu, 2010; Andersen and Skjoett-Larsen, 2009).

Notwithstanding the growing body of literature, evidence on how to manage the relation with supplier is still sparse and often lacking an underlying theoretical framework (Vachon and Klassen, 2006). How can firms ensure the desired environmental performance of their products along the supply chain? How does firms interact with suppliers on environmental issues? How do they influence or force the activities of their suppliers? To contribute to the understanding of how firms manage the supplier relation for environmental improvements, in chapter 5 I analyze the way in which two lead firms in the furniture industry interact with suppliers. The analysis contributes to the literature by suggesting a framework in which cooperative activities directed to develop and implement innovations and strict monitoring activities coexists together with supporting activities, explicitly implemented by firms to develop the supplier's technical knowledge and environmental awareness. Results point to the importance of implemented complex coordination mechanisms rather than arm's length ones in order to enable the effective implementation of environmental practices.

2.1.2 Considering the entire value chain: which governance for the greening?

In Chapter 6, I set out to complement the existing literature also by extending the *object* of the analysis – using the value chain rather than just the relations with first-tier suppliers as the object of the analysis – and its *focus* – analyzing the role of different typologies of network relations in the greening. In order to do so, I pioneeringly leverage on the Global Value Chain (GVC) framework that, despite being broadly adopted in the analysis of economic development and inter-firms dynamics it has not been developed yet to understand greening trajectories (interesting exceptions are Bolwig, Ponte, du Toit, Riisgaard, and Halberg, 2010; Riisgaard, Bolwig, Ponte, du Toit, Halberg, and Matose, 2010).

Despite the intentions, especially in the Green Supply Chain literature, the object of the analysis is often confined to the relation with first-tier suppliers, rather than on the entire value chain[1]. The "integration of trade and disintegration of production" (Feenstra, 1998), which took place in many industries as a consequence

[1]Despite often considered as interchangeable, the terms "supply chain" and "value chain" entails slightly different concepts and reference literatures. In the followings, I will use the term "supply chain" mainly in the context of the analysis of first-tier relationships (chapter 5) and "value chain" when considering a broader set of partners and in the analysis of the governance structure (chapter 6).

of globalization dynamics, challenges this approach. Theoretical and empirical contribution in the Global Value Chain (GVC) literature made clear the importance to expand the focus of the analysis to the entire value chain, in order to understand dynamics of trade and production in the globalization era and the role of lead firms in coordinating the activities of fragmented production networks (Gereffi, Korzeniewicz, and Korzeniewicz, 1994; Gereffi, Humphrey, Kaplinsky, and Sturgeon, 2001; Gereffi, Humphrey, and Sturgeon, 2005; Bair, 2009). In chapter 6 I argue that a similar approach should be employed also to understand the dynamics of greening of industries, because to ensure sustainability firms have to be responsible for all the activities that have been carried out to realize their products. Despite equally important in terms of impact on the environment, to monitor and influence the activities of second and third-tiers suppliers is more complex for lead firms than dealing with first-tiers ones, implying different incentives, coordination and control tools, challenging researchers to consider this additional degree of complexity in their effort. How does lead firms drive the reduction of the environmental impact along their value chain? How do they influence the activities of second- and third-tier suppliers?

Another contribution of the chapter is the focus on the analysis of the typologies of relationship for the greening. Despite in the majority of the empirical contributions addressing the challenge of greening value chains it emerges the importance of the coordination mechanism implemented as key explanatory variable of the effectiveness of green innovation development and application along the VC, an analysis of the different typologies is still missing. If the analysis in chapter 5 suggest a shift from market-based toward more complex forms of coordination, that in chapter 6 identify more specifically different forms of network governance structure. How does the governance structure implemented by firms affect the possibilities to implement green innovation in their value chains? Which governance structure are better suit to enable greening dynamics and under which conditions? How does lead firms govern the greening of their value chain? What are the challenges for suppliers to participate in the greening of the value chain and what are their incentives? By comparing the value chain strategies implemented by two very different lead firms, I identify different governance structures to coordinate the greening of value chains and identify the variables that play a large role in determining how value chain are "greened".

2.2 A critical literature review on the greening of value chains

Academic and practitioners contributions on the importance to control the environmental performance of production activities have mushroomed in recent years. More and more their analyses are asserting, on the one hand, the importance for firms to consider also the activities performed by their value chain partners, on the other hand, that those activities may represent a source of innovation and competitive advantage rather than a burden. In the following, I will present a literature review of those contributions, In section 2.2.1, I will briefly sketch which

streams of literature are involved, classified based on the focus of their analysis, to enable to appreciate the contribution of the use of the GVC framework as in chapter 6. Subsequently, I will present more deeply those contributions that more closely resemble the content of this analysis, to set off the specific contributions of my analysis. In particular, section 2.2.2 – discussing the literature on the interactions with suppliers for the greening – will be the starting point for the analysis presented in chapter 5, whereas sections 2.3.4 and 2.3.1 – presenting evidence on the governance of the greening and discussing the GVC framework, respectively – are propaedeutic to the analysis performed in Chapter 6.

2.2.1 Different approaches to the understanding of greening dynamics

Several disciplines address the impact on the environment of production activities along the supply chain.

Environmental studies, rooted in the ecological economics literature, analyze the impact of production activities on the environment. Their focus is on the *production activities* themselves and the specific impacts on the environment, rather than the underlying economic and managerial implications.

On the contrary, Management and Strategy (M&S), Corporate Social Responsibility (CSR), and Environmental Innovation (EI) studies are focusing mainly on the *firm*, taking on a managerial perspective. Contributions within the *Management and Strategy literature* have been focusing mainly on the strategies that firms pursue to jointly achieve environmental and economic results, focusing on specific issues such as green marketing and eco-design. The implications of these strategies as far as the supply function is concerned are sometimes addressed, but they are rarely at the heart of the analysis and they never focus on the suppliers' side. The CSR literature focuses on the companies', mainly big corporation social and environmental performance. If at the beginning the focus was mainly internal to the corporation, more and more it is enlarging to include activities of supply chains' partners including suppliers, customers and other stakeholders. In particular, contributions are focusing on tools, as Code of Conducts (CoC) and eco-labelling, which corporations can use to influence the activities of their partners. By now CSR studies have analyzed especially labor conditions, and more in general the content of CoCs and international standards rather than how these codes can be effectively implemented. Studies within the *Environmental Innovations* literature, born from the marriage of Innovation and Ecological studies, have analyzed especially the drivers of the greening, among which the impact of public policy and of managerial tools and auditing schemes play a predominant role, but just sometimes focused on supply chains implications[2].

Branching from *Supply Chain Management*, a new stream of literature has developed, focusing around what has been named Green, Sustainable, or Environmental supply chain management (GSCM). Studies within this stream of literature are explicitly focusing on the *supply chain* and on the relationship with suppliers.

[2]For a more thorough literature review on relevant paper in the EI literature recall section 1.2.

In the GSCM literature great importance is devoted to the triggers of greening, to the management of the supply function and to the study of specific aspects of the greening of the supply chain, like waste management, eco-design, greener manufacturing and operations. Studies within this literature are overlapping with EI ones as far as the analysis of the importance of the relationships with suppliers is involved. If GSCM studies focus specifically on how to manage the supply function to ensure the greening with a focus on technical and logistical integration, study in the EI literature focus on the importance to interact with suppliers in order to successfully develop innovations and implement them at suppliers.

These streams of literature provide great advancements of the understanding of the greening of industries focusing on different aspects. If environmental studies allow to better understand what the environmental impacts of production activities are, the M&S, CSR and EI literatures allow to better focus on firms' strategies and practices to reduce those impacts. The GSCM, and partly the CSR literatures extend the focus outside the firm's boundaries, shedding light on inter-firms dynamics toward the reduction of the environmental impacts of production activities, as it will be further discussed in the next section. However, they still very often limit to the analysis of first-tier suppliers not considering the entire value chain (Seuring, 2004; Seuring and Müller, 2008) or, when they does it, they focus on one single product provided by the firm, in a Life Cycle Approach fashion, missing the overall picture.

Against this background, the application of the GVC framework (that will be described in section 2.3.1) seems a useful integration to these contributions for several reasons. First of all, its main interest is the analysis of the management and coordination of production activities in a high fragmented setting. Despite its explicit focus on activities spanning international borders it acknowledge the importance of local and national institutions and of geographically rooted competitive advantages. Moreover, the GVC literature explicitly addresses the nature of the relationships among actors and its implication for development and upgrading possibilities. Focusing on the role of lead firms which decide "what is to be produced, how, and by whom" (Gereffi, Humphrey, Kaplinsky, and Sturgeon, 2001) and on the way, scholars within this stream of literature identified different typologies of governance, which seem useful for this analysis. Finally, much of the theoretical and empirical contribution of the GVC literature have explicitly focused on the opportunities in terms of learning and market access for suppliers as they participate in GVC driven by lead firms, which is referred to as "upgrading" (Gereffi, 1999). The insights developed within this stream of the literature seem particularly instructing because they link the upgrading or innovation possibilities of firms with different governance structures implemented by lead firms.

2.2.2 Green supply chain management and the interactions with suppliers

A wide variety of definitions, terms, and conceptualizations have been developed in the research and practitioner literature to refer to the consideration of environmental concerns in supply chain management. For the purpose of this analysis I adopt

Srivastava's definition of Green Supply Chain Management (GSCM), which attempt to include all its main features as emerging from an extensive literature review. GSCM is defined as "integrating environmental thinking into supply-chain, including product design, material sourcing and selection, manufacturing processes, delivery of the final product to the consumers as well as end-of-life management of the product after its useful life".

The GSCM literature suggest that the introduction of environmental concerns within firms' business activities requires them to interact with supply chain partners, suppliers in particular, to influence their activities, introduce environmental innovations and reduce the overall pollution levels.

On the importance of monitoring suppliers and enforcing standards to green supply chains

The choice to reduce the impacts on the environment of all the activities necessary to create their products add to the problem of coordination and control that firms deals with in everyday activities. The credence features of environmental-friendly products or components (see section 1.2.2) boost information asymmetries and adverse selection problems that call for other coordination structures than simple market interactions (Williamson, 1975). Credence goods, in fact, may require greater monitoring and supervision on the lead firms side, on the one hand to fill in the information gap, on the other hand to have enough arguments to ensure consumers of the presence of the claimed characteristics.

Mirroring this perspective, studies spanning from the CSR and the GSCM literature have focused on monitoring and control activities and on the tools that firms can use to enforce environmental innovations at suppliers. Within this perspective, the role of lead firms is conceived mainly as normative, imposing environmental standards to its suppliers or selecting suppliers that already achieved the needed standards. Contributions within the GSCM literature, have focused on "environmental monitoring", i.e., activities linked to evaluate and control suppliers (see Vachon and Klassen, 2006). These practices are mainly dealt with thought the purchasing function, which includes sustainability within the supplier selection by imposing environmental-friendly requirements in products specifications or requiring the compliance with environmental standards such as ISO14001 (Bai and Sarkis, 2010). Similarly the reduction of environmental impacts along the supply chain within CSR studies is conceived as an internal strategy that the firms pursue to reduce its own benefits, mainly the reduction of reputation risks (Frenkel and Scott, 2002; Zadek, 2004). Supply implications emerge as the firms attempt to apply their own labor and environmental standards also to suppliers, mainly by introducing Code of Conducts (CoC) (Andersen and Skjoett-Larsen, 2009), which may or may not be based on international standards but are barely developed together with supply chain partners. The implementation of auditing routines and the requirement of environmental certifications and standards positively affect the environmental innovative attitude of suppliers (Klassen and Vachon, 2003), but lead firms does not necessarily support this process directly. Supply chain management for reduction of environmental impacts consist mainly in controlling

and monitoring suppliers, influencing activities of actors over which lead firms have no ownership by exerting their purchasing power.

Cooperation to support environmental innovation at suppliers

Other arguments, basing on a Resource-Based-View approach, have underlined the complementarities arising among firms that aim to reduce the environmental impacts in all the activities needed to manufacture their products (Andersen, 1999, 2002). The systemic nature of environmental issues requires firms to cooperate on the development of innovations and to pool their resources to develop products that effectively reduce the impact on the environment. To apply a life cycle perspective on its product, lead firms are forced to interact with its suppliers and work together for innovations. Similarly, the willingness to implement voluntary environmental certifications that impose to firms to interact and exchange information with suppliers on a regular basis creates the incentives for long-term relationships and inter-firm collaboration for innovation (Baksi and Bose, 2007; Rao and Holt, 2005; Lim and Phillips, 2008). GSCM and EI literature's contributions have disclosed the positive impacts of collaborations between lead firms and suppliers in terms of manufacturing performances and innovation, other than environmental improvements. The results of Vachon (2007), for example, based on a survey on the package printing industry, suggest that supplier-customer environmental collaboration is positively associated with the introduction of pollution prevention technologies. Suppliers have been found to be useful source of innovative ideas for the development of environmental innovations (Geffen, 1997; Rothenberg, 1999). Their knowledge and expertise may represent a key complement of lead firms' resources, especially to implement process innovations (Geffen and Rothenberg, 2000).

Contributions seeking to understand how lead firms may manage the supply relations to achieve environmental improvements have been focusing alternatively on the increasing need for control on the suppliers' activities arising for environmental concerns and on the tools to enforce it or on collaboration among supply chain partners to achieve specific environmental innovations or to improve the firm's overall performance. Despite the important contributions, this attitude does not allow to understand the overall activities performed by lead firm to interact with suppliers for the greening and the complex network linkages as far as environmental improvements are concerned. I argue that both aspects, the environmental monitoring and the environmental collaboration, should be rather consider together, since they often co-exist The paper by Vachon and Klassen (2006), is one of the few that jointly consider mutual problem solving and inspection and risk minimization activities to improve supply chain environmental management. Using the internalization/externalization framework the authors compare how environmental monitoring and environmental collaboration affect logistical and technological integration with primary suppliers. However, their analysis does not allow considering the coexistence and the interaction between those two practices. Furthermore, being their analysis based on survey data, they do enable to understand in depth the content of those activities their impact on buyer's and supplier's activities. To fill in these gaps, in chapter 5 I develop in-depth analysis of two firms that have

successfully reduced the impacts of activities along the supply chain interacting with suppliers and subsequently develop a theoretical framework to understand interaction with supplier to environmental supply chain management.

2.3 Global Value Chains and the governance of the greening

2.3.1 The Global Value Chain framework

The global value chain approach (GVC) is emerging as a key tool in analyzing the division of labor between independent actors located all over the world and especially on the role of global players in shaping the development trajectories of such chains, their governance structure and the innovative activities. The GVC framework emerged in the mid 90s, firstly with the wording Global Commodity Chains (GCC), branching from world system and dependency theories (Gereffi, Korzeniewicz, and Korzeniewicz, 1994). It took steps to explain the emerging change in the organization of production dynamics from vertical integrated firms to organizational structures that spanned international borders and involved coordination with suppliers sparse in more or less developed countries.

The concept of Value Chain (VC) adopted in this framework differs from that of Porter (1990): taking the value chain itself rather than the firm as the object of the analysis, describes the full range of activities that are required to bring a good from its conception till its end use and beyond (Kaplinsky and Morris, 2003). Value chains are analyzed along four main dimensions: i) an input-output structure, which encompass all the activities of the value chain; ii) a geographical configuration, giving and account on where activities are located; iii) an institutional context, encompassing government and non government agencies but also rules that govern society and the economy, and iv) a governance structure, namely how activities are organized and coordinated (Bair, 2009).

2.3.2 The governance of Value Chains

Much of the GVC discussions have revolved around the concept of governance. Other than a special focus on cross-border activities, a key characteristic of the GVC literature is the focus on the strategic role of the relationships among firms in the effort to coordinate the chain. The different forms of coordination developed by lead firms to arrange the production activities have been termed governance, defined as "authority and power relationships that determine how financial material and human resources are allocated and flow within a chain" (Gereffi, 1994). Despite it basically consists of a discussion about coordination, authors in this body of literature prefer to use the term governance to underline the importance of the proactive involvement and participation of all actors of the chain (Pietrobelli and Saliola, 2008).

The concept of governance is multifold: different authors stressed different aspects of this concept and identify different forms of governance. Especially in the earlier contributions (see Gereffi, 1994; Gereffi, Korzeniewicz, and Korzeniewicz, 1994; Gereffi, 1999), this literature focused on the role of lead firms, as "key

drivers in the formation of globally dispersed and organizationally fragmented production and distribution networks" (Gereffi, Humphrey, and Sturgeon, 2005). By focusing mainly on low-tech manufacturing industries, empirical contributions identifies two main typologies of lead firms and therefore two forms in which global players, mainly US based, explicitly coordinated activities of first and second tier suppliers: buyer-driven or producer-driven commodity chains. This first interpretation of governance, which focus on lead firms, has been later defined *governance as driveness*, to differentiate it from a more recent approach named *governance as coordination* in which the analysis shifted toward the analysis of "how coordination takes place at individual nodes along a GVC" (Gibbon, Bair, and Ponte, 2008; Ponte, 2009)[3]. In the effort to describe the spectrum of forms of explicit coordination spanning between market-base relationships and hierarchy, Gereffi, Humphrey, and Sturgeon (2005) identify three network-like governance structures, making a synthesis of definition and classifications developed earlier on (Humphrey and Schmitz, 2000; Sturgeon and Lee, 2001; Humphrey and Schmitz, 2002; Sturgeon, 2002). The analytical structure identifies are:

- *Market*, is a governance structure in which firms producing at different steps of the value chain buy and sell products thanks to the mediation of price, with little interaction beyond exchanging goods and services for money. The information needed to conclude the transaction is easily obtained and knowledge that needs to be shared is relatively straightforward: the two parts can be easily exchanged.
- In *modular* value chains suppliers make products according to customers' specifications, take full responsibility for process technology and often use generic machinery that spreads investments across a wide customer base. This keeps switching costs low and limits transaction-specific investments, even though buyer-supplier interactions can be very complex.
- *Relational* governance structures are characterized by complex interaction between lead firms and suppliers, which often create mutual dependence and may be regulated through reputation, proximity and trust. This typology is characterized by the higher interchange of idiosyncratic information and knowledge across the partner.
- In *captive* value chains, small suppliers tend to be dependent for complementary, higher value-added activities on larger, dominant buyers. Such networks are frequently characterized by a high degree of monitoring and control by the lead firm.
- The end of the spectrum of explicit coordination is made up by *vertical integration*.

Different values of the key i) the complexity of the transactions ii) their codificability, and iii) the capability of the suppliers in relation to the requirements of the transactions will determine the governance configuration, as in figure 2.1. Each governance structure identified embeds a different degree of power asymmetry between lead firms and suppliers which, by turning into direct control, mirror

[3]See Sturgeon (2009) for a comparison of the two governance taxonomies, especially as far as network organizational forms are concerned.

Figure 2.1: Governance structure typologies and key determinants. Source: Gereffi, Humphrey, and Sturgeon (2005).

Governance Type	**Complexity of transactions**	**Ability to codify transactions**	**Capabilities in the supply-base**	**Degree of explicit coordination and power asymmetry**
Market	Low	High	High	Low ↕ High
Modular	High	High	High	
Relational	High	Low	High	
Captive	High	High	Low	
Hierarchy	High	Low	Low	

a different degree of explicit coordination. Both in the early contributions of governance as driveness and as coordination central to the research is the relative power of the actors within the VC. In this sense, the governance structure can be read as a balance between lead firms' *purchasing power* and the suppliers' *competence power* (Sturgeon, 2009).

2.3.3 Governance, upgrading and innovation

A distinctive feature of the GVC literature is that it takes as the object of the analysis the chain rather than a single firm. In this sense, it is possible to say that there are three main sub-components which, with different emphasis in different contributions, are at the center of the analysis in the GVC literature: lead firms, suppliers and the relations among them to coordinate activities. If lead firms enter the discussion mainly through the analysis of governance, as players that set and manage decisions on what has to be produced and how, suppliers have been under analysis mainly as far as the insertion in GVC opens up for them new opportunities, what in the literature is referred to as *upgrading*. Upgrading have been defined as " make better products, make them more efficiently or move into more skilled activities " (Kaplinsky, 2000) or "innovating to increase value added" (Giuliani, Pietrobelli, and Rabellotti, 2005). What in this literature is defined upgrading is pretty much overlapping with the concept of innovation used in the managerial literature and which is use within this thesis (see e.g., Kaplinsky and Morris, 2003; Giuliani, Pietrobelli, and Rabellotti, 2005)[4].

If early contributions have focused mainly on identifying different typologies of upgrading (see e.g., Gereffi, 1999) – namely product, process, functional and inter-sectoral – more recent contributions have analyzed how governance forms affects upgrading possibilities, at firms' or, more often, at districts' level (Humphrey and Schmitz, 2000, 2002; Giuliani, Pietrobelli, and Rabellotti, 2005). Quasi-hierarchical

[4]See Morrison, Pietrobelli, and Rabellotti (2008) for a discussion of pitfalls of the concept of upgrading with respect to that of innovation.

(Humphrey and Schmitz, 2002) or captive (Schmitz, 2006) relationships enable product and process upgrading at suppliers but hinder functional upgrading, namely acquiring new functions that increase the skill content of activities, whereas the opposite is true for the chains characterized by market-based relationships. Finally network is indicated as the governance structure that fosters more easily upgrading strategies (Humphrey and Schmitz, 2002). Furthermore, other studies demonstrated that the participation in Global Value Chain driven by global buyers and suppliers may be responsible for the upgrading of these firms, that learn "how to improve their production processes, attaining consistent and high quality and increasing the speed of response" (Piore and Duran, 1998; Gereffi, 1999; Dolan and Humphrey, 2000; Schmitz and Knorringa, 2000; Gibbon, 2001).

If by now the literature have focused mainly on economic, and in minor part, on social upgrading (Gereffi, 2005; Barrientos, Gereffi, and Rossi, 2010), I set out to leverage on the insights developed within this literature to understand how different typologies of governance emerging for the greening of industries affect the form and the intensity of environmental innovation in the VC.

2.3.4 Previous evidence on governance and green innovation

Despite not the main focus of the analysis, in many GSCM papers it emerges the importance of the typology of the relation implemented to enforce environmental improvement along the supply chain. In particular, many studies suggest that buyers are "going green" through partnership rather than market of vertical integration and that close interactions are likely to lead to higher environmental pro-activeness of suppliers. Meyer and Hohmann (2000), for example, proved the importance of partnership to realize successfully green products, through the analysis of a textile retailer that moved toward the use of organic cotton. To ensure the success of this important change in its raw materials it change the governance structure of its value chain from what in the GVC would be defined "market" to "relational". Inter-organizational learning, mutual trust, support and consultancy to farms were important to ensure the company a great market success. The offer of a stable demand and of financial and technical support motivate suppliers to undergone complex environmental innovations (Meyer and Hohmann, 2000; Simpson, Power, and Samson, 2007). Similarly Goldbach (2003), report on the importance of long-term relationships and of the reciprocal dependency arising among supply chain partners, in correspondence with the specific support that the buyer gives to its suppliers. The importance of trust emerges as a key commonalities among many examples provided in the literature, focusing on different manufacturing industry (Meyer and Hohmann, 2000; Carter and Jennings, 2002; Goldbach, 2003). The analyses suggest that it may be a coordination mechanisms even more important that for non-environmental supply chains. Similarly, other authors have indicated that working in harness with suppliers may be even more important than for traditional chains. The analysis of five case studies of the textile industry performed by Seuring (2004) support the idea that cooperation is needed to overcome transaction costs that are higher in the case of green products and generate mutual dependence. The importance of a relational network seems to

be more important the more sustainability takes on a systemic dimension (e.g. with LCA) and in general the more complex is the change in the product or the production process to be introduced. To Seuring and Müller's words "ensuring the quality of the product and the performance of the operational process might be as much of an issue as building partnerships for new product introductions".

Also studies spanning from the CSR literature have highlighted the importance of the typology of the relation among buyers and suppliers as enabling or inhibiting factors of its SCM environmental strategy. Recent contributions have pointed the attention to the importance of considering not only the content of the Code of Conducts, but also the way in which they are implemented, to understand their application's efficacy. Cooperative partnerships are more likely to lead to higher social and environmental performances at suppliers. Mamic (2005), through case studies analysis in the apparel, footwear and retail industries in developing countries, find that for an effective implementation of Code of Conduct there is the need for a close interaction among the buyer and the suppliers and the pro-activeness of both partners. The analysis on Nike's CoC application at its suppliers, performed by Locke and its research group (Locke, Kochan, Romis, and Qin, 2007; Locke, Qin, and Brause, 2006) yield to very similar results. Even the same code of conduct can be differently effective in fostering environmental improvements at suppliers. A governance characterized by close coordination with suppliers, trust and joint problem solving can be more effective than arm's length ones, based on simple monitoring.

Those studies agree on describing a deepening of the relations with suppliers in the development of green value chains, which resemble very closely relational coordination mechanisms, there is also evidence of the possibility to ensure the greening of the value chain by exerting power on suppliers. Through two case studies in the furniture and textile industries, (Kogg, 2003) analyze green innovations with supply chain implications. The analysis suggests the importance to create incentives and motivations for suppliers, that can be achieved both through the use of power or supporting the partners and cooperating with them. Similarly, analyses in the CoC literature suggest the importance to complement close coordination with support and monitoring and control of the suppliers activity.

Chapter 3

Methodology

3.1 The method

The methodology chosen to answer the research questions mentioned above is an inductive, multiple-case study. The case-study is a methodology that "focuses on understanding the dynamics present within single settings" (Eisenhardt, 1989). Building theory through case studies is a research strategy that, using empirical evidence on cases – i.e., instances of a class of events under scrutiny (George and Bennett, 2005) – "create theoretical constructs, propositions and/or midrange theory" (Eisenhardt and Graebner, 2007). The use of a case study approach is determined by considerations on the nature of the research questions and the aim of the research and on the amount of control that the researcher has on the variables under investigations.

Case study methodology is preferred to answer research questions of the "how" and "why" type (Yin, 2003) and seems therefore a perfect fit for a study interested in understanding intra- and inter-firms dynamics and the modes of cooperation in the development of environmental innovations. This methodology is especially useful to gain understanding on research areas in which theoretical insights are still not well developed, as the management of the supply relation for environmental innovations and the governance for the greening (recall the research questions in section 2.1.1) (Ozcan and Eisenhardt, 2009). The choice of this methodology seems appropriate as the objective of the study is to derivate new hypotheses and develop the existing knowledge (George and Bennett, 2005). Furthermore, this methodology is preferred in examining contemporary events in which the extent of control of the investigator over the events studies is limited, which is the case in this analysis (Yin, 2003).

One of the strengths of case study analysis is that it enables to explore causal mechanisms to a greater detail than other methodologies and to "model and asses complex causal relationships such as equifinality, complex interactions and path dependency" (George and Bennett, 2005). The quantitative analysis performed in Chapter 1 is well complemented by case studies analysis, which may rule out the possibilities of a spurious relation between environmental innovation and cooperation over R&D with external partners or the existence of non-observed variables bias. Through deep analyses on a limited number of cases, this methodology

enables to consider an higher number of variables and to understand the impact of idiosyncratic and contextual factors often impossible to detect through more quantitative approaches so as variables not readily quantified or already measured in existing data-set. Furthermore, it allows to better define the constructs and consider different sub-typologies.

3.2 The empirical setting

The setting for this study is the furniture industry, mainly located within the Livenza furniture districts, which seems an appropriate choice for reasons concerning both the environmental and the economic dimension.

First, in this industry eco-friendly practices are slowly getting mainstream, making it easier to track environmental innovations (see also Appendix B.3). Policy makers are increasing penalizing environmental-harmful behaviors of furniture producers. In Europe, for example, several directives related to the environment directly affect furniture industry: the Integrated Pollution Prevention and Control (IPPC), regulating the coating of furniture and wood preservation to reduce emissions and consumption levels; the Volatile Organic Compounds (VOC) Solvents Emissions Directive that limit emissions of VOCs linked with the coating, varnishing and surfaces treatments activities and the 2008/98/EC one, regulating wastes' production and management. Moreover, consumer awareness about environmental impacts of furniture products is relatively high, thanks to the action of spirited NGOs like FSC and Greenpeace, which have arisen attention on the contribution of the depletion of wood and forests on climate change and on the loss of biodiversity (see e.g., Gereffi, Garcia-Johnson, and Sasser, 2001).

Second, furniture is a large sector, accounting for almost 373 million US$ (in 2010) and for the 1% of the trade in manufactured goods worldwide (in 2007) (Purnomo, Achdiawan, and Parlinah, 2009; Csil, 2010)[1]. Being a large sector, it enables to understand the environmental improvements potential for a large number of firms; being traditional and low-tech, it allows to generalize results toward a large number of similar industries.

Third, furniture VC steps are traditionally split among discrete thought interrelated firms rather than implemented by vertical integrated firms, which allow to understand the role of different governance structures of the global value chain in enabling or preventing the greening. Being a sector in which the key players that set up and coordinate the activities within the value chain are buyers (Kaplinsky, Memedovic, Morris, Readman, and Way, 2003; Kaplinsky, Readman, and Memedovic, 2008), it allows to verify the bottom-up action of clients to green their value chain (see Appendix B.1.3 for a deeper analysis of the governance of the furniture value chain). The recent globalization of furniture industry seems an interesting set to test the importance of the global dimension to understand green value chains dynamics (see Appendix B.1.1).

[1]See Appendix B for a broader description of the industry, the furniture value chain and its features.

I studied two lead firms and their suppliers in Northern Italy[2]. Italy is the first country in Europe for employment and value added generated in the furniture industry, and it has just recently been toppled by China to gain the number one spot as exporter to the world market. Within Europe, Italy is the first furniture producer in terms of employment and value added, competing both in high-niche markets and in low cost ones – it ranks 3rd as supply location of the low-cost giant IKEA. Being well-known worldwide for innovation and design capabilities and for the ability to anticipate trends, its seems a good sample to study environmental innovations, a subset of innovations which is just recently emerging. Italian firms, traditionally organized in districts in which firms enjoy economies of specialization and coordinate their activities in collective and geographically-bounded networks, enables to understand the impact of inter-firms coordination and cooperation toward the greening of value chains. Within Italy, companies part of this study were located mainly in the Livenza district. The district is one of the biggest and more competitive in Italy, as is more thoroughly describe in the Appendix B.2.3. This choice enabled not only to focus on the most interesting firms as far as innovation was concerned but also to improve the empirical robustness. The cases, in fact, shared the same institutional setting and regional innovation system, reducing the possibility that these variables, external to the single cases, affected the results.

3.3 Case study design and case selection process

I choose to analyze two focal firms from the universe of furniture producers that successfully introduced environmental innovations on the market. The choice of multiple case studies enables more robust results than single-case: the replications of the analysis on more cases, in fact, allows a greater generalization and improve the external validity of the analysis (Yin, 2003). In addition, multiple cases enable broader exploration of the variables studied and of the research questions (Eisenhardt and Graebner, 2007). Also the choice of the number of studies under scrutiny is the result of an intended strategies and not a second-best alternative driven by resource scarcity. I selected two case studies because I wanted to control for similarities and differences between in two opposite cases and, through the empirical evidence, develop a theory on the possible opposite ends of a spectrum of governance structures for the greening.

I used an embedded case studies design, i.e., I am using more units of analysis within the cases. Being the object of the study an inquiry on the relationship existing between the focal firms and their Value Chain's partners toward the development of environmental innovations, I focused on the lead firms but also on its suppliers and their relationship. As suggested by Yin (2003), this design "can add significant opportunities for extensive analysis, enhancing the insights into the single cases". This methodological choice enabled i) to triangulate the information emerging from the focal firm, ii) to gain a deeper understanding on the existing

[2]See Appendix B.2 for an overview of the furniture industry in Italy.

relationship between the focal firm and the supplier, and iii) to understand value chain dynamics beyond first-tier suppliers.

Given the purpose of developing theory rather than testing it, in case study methodology the more appropriate sampling strategy is *theoretical* rather than *random* or *stratified*. As explained by Eisenhardt and Graebner (2007), the rationale of theoretical sampling is that cases has to be selected "because they are particularly suitable for illuminating and extending relationships and logic among constructs" rather than for obtaining statistical accuracy on variables' distribution within the population. Accordingly, the universe considered for this study consists of exemplary firms in terms of quantity and quality of green innovations introduced.

Based on interviews with leading experts and on analyses of secondary data sources, the companies Valcucine and IKEA have been chosen. The cases have been deliberately selected to offer contrasting situations in terms of environmental strategies, size, business model and innovation and internationalization strategies (see Table 3.1). They synthesize two archetypes of firms: Valcucine is the typical district firm, producing high-end furniture relying on the interaction with a wide network of local partners; IKEA the typical multinational, selling low-cost products that have been produced by a number of suppliers spread all over the world[3]. The choice of "least similar" cases, is very useful for the research purpose of this analysis: if some independent variables will have the same outcomes, it may be possible to infer about the contribution of that variable to the dependent variable, enabling a stronger argument in favor of the propositions and the model developed (see George and Bennett, 2005). Furthermore, the evidence may shed light on different paths that led to similar outcomes and on different shades of the outcomes and of the independent variables of interest.

Table 3.1: Main features of the focal firms interviewed (in 2009).

	IKEA	Valcucine
Employees	123,000	172
Turnover (million €)	21,500	36
Founded in	1943	1980
Export	>90%	~ 50%
Market segment	low-end	high-end
Number of suppliers	1,220	300

Suppliers' selection followed the same rationale. Table 3.2 summarizes the main features of the suppliers interviewed. In the case of Valcucine, suppliers

[3]IKEA is a huge company, involved in markets spanning from textile to electronic accessories, representing each a different value chain configuration, involving different environmental challenges and different innovation frontiers. Despite the interesting initiatives and environmental improvements in those industries, they will not be included in this study that will include just the wood-home furnishing industry. This sector represents both the core and traditional industry for IKEA and one of its more environmental-conscious areas of activities. In fact, it is the only macro-industry for which the firm has already implemented advanced programs to control the environmental performance of the entire value chain. On top of that, it is the sole industry for which the multinational directly owns production facilities and one in which it is involved the most in the design phase of the products.

have been selected based on the results of a survey administered to the purchasing manager. He was first asked to indicated which, among all suppliers from which the company buys on a regularly basis, were most representative. Focusing on that sub-group, he was then asked if they were considered strategic and why[4], if they provided any environmental products and the role of Valcucine in the development of environmental innovations[5]. In the case of IKEA, suppliers have been selected to include both suppliers that are working with IKEA since a long time and suppliers that just recently go into business with IKEA. Two firms, namely Electrolux and Eureka were supplying both focal firms, enabling to evaluate the different governance structure and value chain management strategies of the focal firms, from the point of view of the same actor. Furthermore, except for Abet Laminati, selected suppliers have facilities within or very close to the Livenza furniture district.

Table 3.2: Main features of IKEA and Valcucine's suppliers interviewed

Focal firm	1st-tier supplier	Manufactured product	Location (province)	Employees[a]	% sales to focal firm
IKEA	Media Profili	furniture	Treviso	430	<50%
	ILCAM	furniture	Gorizia	760	<10%
	Friulintagli	furniture	Pordenone	850	∼ 70%
	Electrolux	elect. appliances	Pordenone	50,633	<50%
Valcucine	Biesse Crea	component	Pordenone	20	∼ 50%
	Eureka	component	Treviso	100	∼ 50%
	Abet laminati	component	Cuneo	758	<10%
	Electrolux	elect. appliances	Pordenone	50,633	<10%

[a] Data refers to 2009.

3.4 Data Sources

Several data sources have been used for the analysis of the cases, each of them providing different insights but all contributing to a converging line of inquiry (Yin, 2003)[6].

Documentary Information

A first source has been documentation, including both *corporate* documents, such as corporate reports, sustainability reports, internal documentation, catalogues and

[4]The possibilities suggested were: a) quality/innovation, b) service/flexibility, c) costs, d) eco-friendly features, e) other.

[5]The possibilities listed were that Valcucine had a) stimulated eco-innovations, b) demanded eco-innovations, c) decided to work with that supplier because it was already offering eco-friendly products, d) environmental features were not important in supplier selection or development.

[6]The two cases were characterized by different data availability, which partly affected the data collection strategy. For the analysis of IKEA it was possible to triangulate the results emerging from the interviews with extensive documentary information. For the analysis of Valcucine, instead, the main data source has been interviews and direct observation, and to a lesser extent to information from specialized magazines and websites. To ensure reliability of data I conducted several interviews with different executives inside the firms, triangulating their statements also with those of suppliers and of industry experts.

non-corporate including newspapers' articles, analysis of blogs and forums discussions and academic contributions. Documentary information provided information mainly on firms' main characteristics, their historical development and partly, their environmental strategies. As described by Yin, documentation has many strengths as sources of evidence: it is stable, unobtrusive, exact and has a broad coverage, but it may be affected by reporting bias or incompleteness. The choice of using, when possible, qualified secondary sources such as academic articles, books and Ph.D. dissertation[7] was used as a strategy to mitigate such problems.

Fairs and Conferences

Attendance at industry fairs and conferences have provided general insights on industry trends and environmental concerns. Furthermore, they represented occasions to complement and control information emerging from interviews at the firms, when IKEA and Valcucine's environmental managers or CEO were among the invited speakers.

Interviews with leading experts

I conducted several interviews with leading experts, including industry associations (6 interviews), local agencies (1), industry service agencies (1) and trade unions (6). The interviews had an *open-ended* nature: experts have been asked to report their opinions about industry's trends, technological development, main environmental innovations introduced in the industry and who were the most interesting firms in terms of environmental innovativeness.

Focused interviews with firms' executives

The most important data source used has been semi-structured interviews with firms' informants, including entrepreneurs, environmental managers, R&D executives and purchasing manager. I conducted *focused interviews* which, when possible, were taped and transcribed within 48 hours of their occurrence. They lasted from 1 to 6 hours and were carried out at the firms' location between autumn 2009 and 2010.

First, three pilot interviews to firm's environmental managers have been conducted. The companies used for the pilot analysis were chosen because they introduced environmental innovations and were located in the same geographical area of the firms part of the main study, so to enhance contextual knowledge. The inquiry for the two pilot cases have been broader than the main interviews and enabled to refine the questionnaire and the research design, as suggested by Yin (2003). I conduct interviews both at the focal firms and at some of their representative first- and second- tier suppliers. Table 3.3 reports the number of interviews conducted and the titles of informants.

The interview guide had 4 sections. First, I asked about the environmental strategy of the firm, the environmental innovations introduced and about the drivers

[7]Among the publication used, all on the IKEA case, see: Reichert and Larson (1998); Dahlvig (2004); Avdasheva, Budanov, Golikova, and Yakovlev (2005); Andersen (2005); Konzelmann, Wilkinson, Craypo, and Aridi (2005); Edvardsson, Enquist, and Hay (2006); Tarnovskaya (2007); Tarnovskaya, Ghauri, and Elg (2007a,b); Baraldi and Waluszewski (2007); Baraldi (2008); Andersen and Skjoett-Larsen (2009); Ivarsson and Alvstam (2010a,b).

Table 3.3: Overview of interviews

Focal firm	1st-tier supplier	2nd-tier suppliers	Interviews	Title of informants
IKEA			2	Environmental Manager
	Friulintagli		2	Environmental and Quality Executive R&D executive
	Ilcam		1	Entrepreneur
	Media Profili		1	Environmental and Quality Executive
	Electrolux[a]		3	R&D executives
		Eureka[a]	1	R&D chief executive
Valcucine			4	Purchasing manager Communication executive CEO/Founder R&D chief executive
	Biesse Crea		1	Entrepreneur
		Oece	1	Sales manager
		Tecnospray	1	Sales manager
	Eureka[a]		1	R&D chief executive
	Abet laminati		1	Environmental and Quality Executive
	Electrolux[a]		3	R&D executives
Total interviews			18	

[a] The firm is supplying both to IKEA and Valcucine

of the change. Second, I asked the informant to describe how those innovations have been developed, investigating the role of internal R&D effort and cooperation with external partners. Third, I asked about the suppliers' management process, inquiring about the role of environmental concerns and asking the respondents to identify the key partners, to characterize their relationships and to trace their evolution over time. Finally, I asked more general questions about the firm's final markets, its organizational structure, size and the like. Appendix C gives a complete account of the questions. Not all of them have been asked to all the respondents, but they varied in the focal firms and suppliers' interviews and according to the title of the respondent. Furthermore, in case interesting evidence was emerging from the interviews , a specific line of questions have been asked to focus on that information. One of the strengths of case study methodology is the flexibility it gives in the analysis of the cases, with continuous feedback from the theoretical model to the case analysis and vice versa, enabling to detect specific events which may not be possible through other, more standardized, data collection process. However, the existence of a set of standardized questions posed to each case is essential to guarantee systematic comparisons and the adherence with the research objectives of the study, as suggested by George and Bennett (2005).

Direct Observation

Almost all interviews have been conducted at firms' facilities. Direct observation through field visits was meant to achieve multiple goals: i) to enable a deeper under-

standing of the technology used, ii) to provide additional information on companies' characteristics such as entrepreneurial attitude and technological equipments difficult to detect through other data sources, and iii) to verify some information from respondents.

3.5 Data Analysis

To analyze the data, I first wrote detailed individual case histories emerging from the interviews. Later, the evidence emerging from interviews' notes has been triangulated with information coming from other data sources and from other interviews.

I started the data analysis process after most of the data had been collected, so to guaranteed the integrity of the replication across cases. The analysis consisted in cross-case search for similar constructs and outcomes across the cases. To enhance the analytical power of the comparative analysis, I used the tactics suggested by Eisenhardt (1989). First, I listed similarities and differences in terms of structural characteristics, value chain organization, innovation strategies, value chain governance and environmental strategies in Valcucine and IKEA. Then, I focused on common patterns emerging from the comparison and on different combinations of independent and dependent variables' outcomes. I then refined the constructs emerging from the analysis through a continuous feedback process from and to the empirics, to sharpen definitions and measures and better identify causal relationships.

The presentation of each case study in the next sections will follow the same structure, to maximize the comparative power while highlighting the specificity of each case, including a first description of the main structural characteristics, its value chain and the environmental strategies implemented.

3.6 Strategies to ensure robustness of the analysis

Building theory from case studies has many advantages, enabling to combine the richness of qualitative evidence with deductive analysis (Eisenhardt and Graebner, 2007). However, similarly to other research strategies, it may have some limitations and potential pitfalls than need to be addressed to ensure the quality of the research (see e.g., George and Bennett, 2005).

To addressed the potential *informant bias*, a retrospective sensemaking which could affect the reliability of information given in interviews, I complemented the narratives emerging from the focal firm's informants with those coming out at the key partners. Furthermore, for the IKEA case, I matched interview data with archival and observational data. For Valcucine, instead, I interviewed more than one informant at the focal firm, to gain different perspectives on the phenomena under scrutiny (see Eisenhardt and Graebner, 2007).

Another important bias that could affect the reliability of the result is *case selection bias*. In case studies, this bias has a different meaning than in statistical research, being the sampling strategy purposely based on specific outcomes of the dependent variable, as explained in paragraph 3.3. However, severe bias could emerge if selecting only cases where both independent and dependent variables

vary as the proposed hypotheses would suggest, thus understating or overstating their relationship (George and Bennett, 2005). The choice of least similar cases should mitigate this possible bias.

To enhance the quality of empirical social research, I followed the suggestions of Yin (2003), which enable to meet four tests: construct validity, internal validity, external validity and reliability.

To increase *construct validity*, which means to establish correct operational measures, I defined variables and constructs leveraging on the existing literature, which was useful also in the analysis of the evidence, to help understand the constructs under investigation. In addition, multiple sources of evidence have been used and, when possible, respondents have been asked to review a draft of the case study report, written in their mother tongue, to corroborate the information presented and increase the accuracy of the analysis.

To improve the *internal validity* of the analysis – to disentangle causal relationships from spurious ones – I chose to use a "least-similar" case comparison, I addressed rival explanations and I leveraged on insights previously developed in the literature. Furthermore, by selecting cases within a specific industry and a specific geographic area, I controlled for the impact of variables not considered in the analysis, which could be responsible for different environmental innovative performance and governance structure.

The test of *external validity* concerns the generalization of the study's results beyond the cases under scrutiny. In the comparison with survey research, case study analyses are often blamed for lacking representativeness, drawing conclusions on a very small number of observations which are not perceived to be representative of large populations. However, external validity in case study analysis has a different meaning than in statistical analysis, since this research method does not relies on *statistical generalization*, but on *analytic generalization*, aiming at "generalize a particular set of results to some broader theory" (Yin, 2003). To enable this generalization, findings have to be replicated, in a similar logic to that underlying experiments. As suggested by the literature, I used a replication logic in the analysis of the findings, enabled by the two-case design strategy. Case study research does not produce universally-applicable knowledge, but rather "develop cumulatively contingent generalizations that apply to well-defined types of subtypes of cases" (George and Bennett, 2005). To ensure the external validity of the results is therefore useful to specify the extent of the scope and applicability of results. Findings emerging from this analysis will contribute to understand the strategies implemented by firms to green their value chain and the importance of the governance structure in the case of low-tech, traditional industries, lead by buyer firms in developed countries that are committed to the reduction of impacts on the environment.

Lastly, to enhance the *reliability* of the research, a case-study protocol was used to guide the data collection process, as suggested by Yin. Furthermore, the principle of maintaining the chain of evidence has been followed, to allow external observers to "follow the derivations of any evidence" and to possibly replicate the same study in other empirical settings.

To use the words of Ozcan and Eisenhardt (2009), "no method is perfect", but the research design and the tactics implemented likely mitigate possible biases and enhance the quality of the research.

Chapter 4

IKEA and Valcucine's Value Chains and environmental innovation strategies

4.1 IKEA: the green giant

4.1.1 Structural characteristics and history

The Swedish-based global company IKEA is by far the largest furniture retailer worldwide: in 2008 IKEA branded products lead the home furnishing and houseware industries, with a 5% and 3.4% market share in the global markets respectively (Euromonitor, 2009b). Founded in 1943 in the small village of Agunnaryd, in Sweden, by the seventeen years old entrepreneur Ingvar Kamprad, the company started as a mail-order business but began soon to sell directly to consumers through showrooms[1]. Despite the financial crisis that strongly affected the overall industry, in 2010 its turnover was 56% bigger than 5 years before, amounting to 23.1 billion Euros (IKEA Group, 2010). In the same year, the company employed 127,000 co-workers, located mainly (81.5%) in Europe. The IKEA products' range consist approximately of 9,500 products for every part of the home. As of 2009, the company was selling mainly in Europe (80%) and its main markets are Germany (16%), USA (11%), France (10%), UK (7%) and Italy (7%).

The group is continuously introducing new products or improving the existing ones, addressing the low-end segment of the market. IKEA value proposition consists in "offering a wide range of well designed, functional home furnishing products at prices so low that as many people as possible will be able to afford them". The value proposition, together with the importance of the company responsibility, is strongly embedded in its brand, recognized by its customers worldwide, and represents one of the most important competitive advantage of the firm (Tarnovskaya, 2007).

[1]For more information on the company history, its product range, the corporate environmental strategy, its Code of Conduct and more thorough metrics on its overall environmental improvements see also the corporate documentation available at the website http://www.ikea.com/ms/en_US/about_ikea/index.html.

> "*Keeping prices low is a cornerstone of the IKEA business idea, yet our low prices must not be at the expense of people or the environment*". IKEA Group (2009)

> "*We want sustainability to be a natural part of everyday work at IKEA [...] sustainability must be an integrated part of our business.*". IKEA Group (2009)

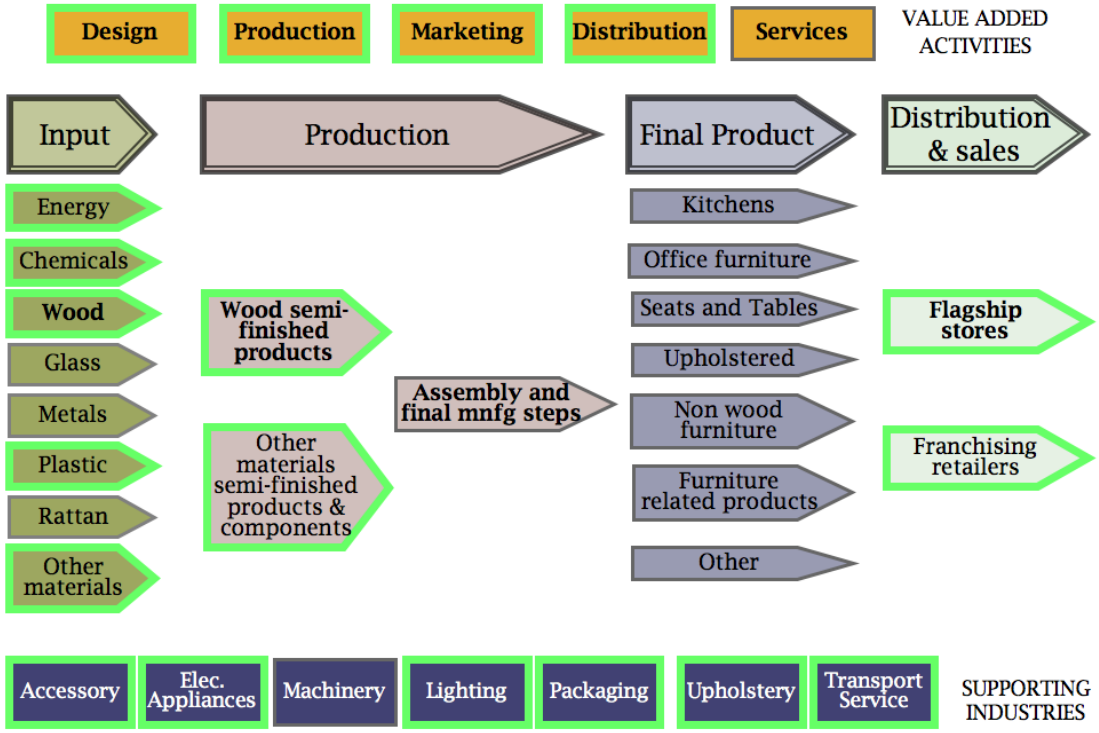
Despite today social and environmental sustainability are tightly linked with the firm's strategies, IKEA's environmental-friendly journey started relatively recently[2]. Initially, IKEA took up the environmental challenge as a response to policy pressures: in the early 80s one of its bestseller product, the bookcase "Billy", was found to exceed the new German standard for formaldehyde emissions, resulting in the development of innovations ensuring the respect to the strictest standards on those emissions. The increasing stringency of policy requirements on environmental performance of furniture production and the pressure from environmental groups persuaded IKEA that the reduction of the product's impact on the environment was a necessary strategy for the future. In 1990, IKEA, supported by the NGO "The Natural Step", formulated its first environmental policy, but it is just starting 2000 that those guidelines were developed into a coherent set of requirements to be applied throughout the entire value chain, by the mean of the IWAY code of conduct. The group's values, stated in its mission, of "the lowest price possible" and of "creating a better everyday life for the majority of people" represented a rich soil for the development of the environmental-friendly awareness. Materials and energy efficiency was meant as a continuation of the effort of the firm to keep prices low; the strive to reduce emission and the use of potential hazardous materials as a mean to improve everyday life of IKEA's customers.

To keep prices low and ensure such a vast range of products, IKEA outsourced a big part of its production, but kept key competencies and activities inside. Figure 4.1 is a visual elaboration of IKEA's value chain, indicating both the activities performed in-house (in bold) and outsourced. The four macro-steps of the value chain considered, following the habit in the GVC literature, are inputs, production, final product and distribution. The tables highlights also which are the value added activities and the supporting industries. In the following, I will describe the division of labor on value added activities with suppliers (section 4.1.2) and the environmental innovations introduced, by steps of the value chain (section 4.1.3) for each lead firm. The same structure of the narrative has been used to describe environmental innovation in the broader Italian furniture context in Appendix B.3.

[2]For a complete analysis of the driver of the change for IKEA and an analysis of the initial steps and achievements of the company please read Reichert and Larson (1998).

[3]In bold activities at least partially performed in-house. The green-bordered steps are those "greened" by the firm.

Figure 4.1: IKEA's value chain[3]. Source: author's elaboration.



4.1.2 IKEA's value chain and value added activities

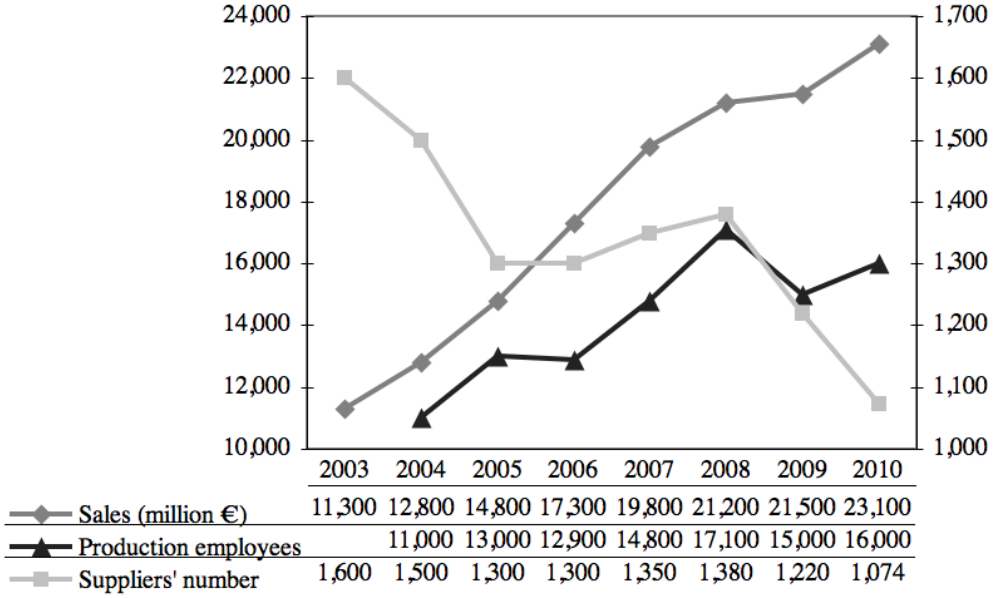
Design

At the beginning of its history, IKEA was simply a commercial business. It was just starting 1956 that it decided, urged by competitive pressures, to design its own products and since then design and product development became among its most important business functions. IKEA of Sweden, based in Älmhul, in Sweden, is the company of the group that design and develop the product range, organized in business areas based on product typology. IKEA is responsible for the aesthetic and technical design of all the products it offers, relying not only on a big internal R&D department but also on the cooperation with external designer. The creative work of designers is bounded by the well-defined design guidelines of IKEA: products have to embed a "Scandinavian design", have to enable a flat-packaging and be easy-to-assemble for the customer, result in a product with a moderate price, and minimize the use of resources and the environmental impact throughout the life-cycle.

Production

To provide the 9,500 products part of its range, IKEA relies on directly-owned productive facilities and on a wide and global network of suppliers, which provide the majority of the products. The production subsidiaries of the group are Swedwood and Swedspan, which employ 16,000 people. Swedwood is specialized in furniture processing, from sawmills operating to components and final product production. and is responsible for almost the 10% of the wood furniture range. Swedspan, founded in 2008 as a spin-off of Swedwood, manufacture particleboard and HDF.

Figure 4.2: Number of suppliers, of personnel devoted to production activities and sales of IKEA, 2003-2010[4]. Source: elaboration of the author from IKEA's corporate documents.



	2003	2004	2005	2006	2007	2008	2009	2010
Sales (million €)	11,300	12,800	14,800	17,300	19,800	21,200	21,500	23,100
Production employees		11,000	13,000	12,900	14,800	17,100	15,000	16,000
Suppliers' number	1,600	1,500	1,300	1,300	1,350	1,380	1,220	1,074

Those subsidiaries has been established with the explicit aim to keep and develop in-house manufacturing knowledge and skills that are useful both to inform the design stage and to understand the production challenges and the costs frontiers faced by their suppliers.

In the financial year 2010, the IKEA's network included 1,074 home-furnishing suppliers located in 55 countries. Their number has been steeply decreasing in recent years – being 2,300 in the mid 90s and 1,600 in 2003 [5] – despite the increasing turnover of the company, which was not offset by the slower increase in employees (see figure 4.2). Also the composition of the top purchasing countries changed over time: Sweden significantly reduced its importance (-37.5% with respect to 2004 figures) to the advantage of countries such as Poland (+33%) and China (+5%). As to 2009, the top 5 countries for amount of purchasing are both developing (China, 20% and Poland, 18%) and developed countries (Italy 8%, Germany 6%, and Sweden, 5%). Overall, the group purchases mainly in Europe (67%), and in Asia (30%) and to a much lower extent in North America (3%).

Marketing, distribution and services

IKEA's 27 distribution centers, spread all over the world, function as interface between IKEA's suppliers and stores. Shipped from suppliers, products are then stored and re-shipped to the stores. Transportation Service suppliers are in charge of shipping Swedwood's products from factories to the warehouses and of the logistics between IKEA's warehouses and stores for all the IKEA range products. Similarly to design, *marketing* is one of the most important in-house function of

[4]Data of employees in 2009 is missing information on Swedspan, which are included since 2010.

[5]See Reichert and Larson (1998) for a description of IKEA and its environmental strategies in the 90s.

IKEA, who is responsible for all the activities linked to the global brand of the company. All products are sold under the IKEA brand in owned proprietary or in franchising stores. On 31st August 2010, IKEA had 280 stores in 26 countries, mainly in Europe (73%). Being IKEA a retail-oriented company, the retail function represent a big part of its activities, employing the 76% of the overall workers.

4.1.3 Environmental innovations at IKEA

> "*Innovation is needed to build sustainable solutions into the IKEA range*". (Mikael Ohlsson President and CEO, IKEA Group)

Input

To reduce its environmental impacts, IKEA heavily acted on the *raw materials* used, resulting in both product and process innovations. In the long run, IKEA plans to use just wood from forests certified as responsibly managed, which as of today is just the Forest Stewardship Council (FSC) certification scheme, which is among the most prestigious and well-recognized certifications in the furniture industry. In 2009, 97% of suppliers respected a set of minimum requirements (see box 4.1) but just the 16% of the overall production was FSC certified (see table 4.1), percentage that increased consistently with respect to the past years mainly thanks to the contribution of IKEA subsidiaries. Moreover, many of IKEA's products are made by renewable, reclaimed and recyclable materials such as honeycombed paper, recycled plastic, plant leaves and the like. The company has been working to reduce the usage of solid wood in its product, to the advantage of board material, resulting in a reduction of 21% with respect to the same figure in the previous year.

Finally, the group is paying attention to the typology of energy used. It is heavily investing in the installation of photovoltaic solar panels and similar technologies in many of its production, distribution and retailing facilities, increasing the share of energy used produced by *renewable sources*.

Production

Many of the environmental innovations introduced by IKEA aim at reducing the impacts on the air, the soil and the health of the production processes to fabricate IKEA's products.

Box 4.1: Minimum criteria to be fulfilled by wood, layer-glued, veneer and plywood suppliers

- Not from forests that have been illegally harvested;
- Not from forestry operations engaged in forest related social conflicts;
- Not harvested in uncertified Intact Natural Forests (INF) or other geographically identified High Conservation Value Forests (hCvF);
- Not harvested from natural forests in the tropical and sub-tropical regions being converted to plantations or non-forest use;
- Not from officially recognized and geographically identified commercial Genetically Modified (GM) tree plantations.

Source: IWAY, forestry section (IKEA Services AB, 2008).

Table 4.1: Some metrics on input's environmental improvements at IKEA. Source: (IKEA Group, 2009).

	2006	2007	2008	2009
Solid wood, veneer, plywood and layer glued wood used in IKEA products meeting its minimum requirements	91%	94%	96%	97%
Wood used in IKEA products coming from responsibly managed forests	7%	6%	7%	16%
Renewable materials used in products	72%	71%	71%	71%
Renewable energy	39%	42%	47%	49%

IKEA is investing in the reduction of CO_2 *emissions*: in 2009 it decreased carbon dioxide emissions of 5% with respect to the previous financial year, thanks also to the investments in renewable energies. Furthermore, the company is continuously working on innovations that enable the use of materials, surface treatments and production techniques "with the lowest possible emission" and to use the "safest possible chemicals" (see IKEA Group, 2009). IKEA's policy consists in complying in all the markets with the law and safety standards of the strictest country it is present in, and when possible improve them. Case in point is the recent upgrade of the standard regarding formaldehyde levels accepted for wood based boards, which has been set to half of the EU standard E1.

Coherently with the policy of the firms to produce at the lowest costs, the firms continuously introduce incremental innovations aiming at reducing materials and energy used throughout products' life-cycle. For example, Swedwood, which is responsible for the 40.7% of the energy consumption of IKEA's overall operations, improved its energy efficiency of 23% with respect to 2005 figures and its share of energy coming from renewable sources raised by 63%. As another measure to improve the efficiency of materials used, IKEA struggles to minimize *waste* or re-use it. The group seeks to recycled the highest quantities of cardboard, paper, plastic, wood and other materials and, when possible, use waste from one manufacturing process in another one. For instance, waste recycled, reclaimed or used for energy production in Swedwood is 74% of the total.

Final Product

The majority of innovations introduced by IKEA affected the way products are processed or regarded a substitution of the raw materials and inputs with less impacting ones rather than the final product itself (see Table 4.2 for examples). However, IKEA is committed to include in its product range the highest number of product with environmental features: many of the home furnishing *accessories*, such as lamps and bulbs are highly energy efficient.

Distribution & Sales

Among the most successful innovation ever introduced by IKEA is the distribution model "assemble-it-yourself", salient part of the IKEA concept. Thanks to the flat-packaging design, which is continuously improved through incremental innovations, products are assembled and transported by the customers. Born as an additional way to keep costs at the lowest, it also allows lower emissions in the distribution

phase than for already-assembled products businesses, because allows optimized loads and fewer transports. Furthermore, the group patented special pallets made by recycled and recyclables plastic, which optimize storage and transportation and require that its products are shipped by low emission trucks.

Innovations in the sale step of the value chain, consist in i) physical investments in the stores, which allowed to reduce emission, improve waste efficiency, increase renewable energies, similarly to what pursued for the production subsidiaries and, ii) innovations allowing consumers to improve their own environmental performance, e.g., improving the public transport system or collecting products for recycling. The firm is actively promoting environmental awareness at various stakeholders. Finally, the firm's catalogue is made by paper certified as responsibly managed and printed by suppliers respecting the same Code of Conduct that regulate IKEA's activities.

Table 4.2: Examples of environmental innovations introduced by IKEA. Source: author's elaboration based on corporate information and interviews.

Model	Product	Description
Norden	table	Made of knotty top part of the birch tree, which is usually burned or ground for chipboard production.
Dave	laptop table	Reduced by nearly 40% formaldehyde emissions from the MDF the table is made of, to a level significantly below EU requirements, and removed all formaldehyde from veneer glue.
Lack	side table	Use of recycled, honeycombed paper to fill the wood-based frame of the table, with a reduction in raw materials with respect to particleboard products.
Teppas	drawer unit	Made of 100% recycled PET plastic
Gullholmen	rocking chair	Made of renewable and recyclable raw material: banana leaves.
Ellan	chair	Made of recycled polypropylene and wood fibres from sawmill waste.
Aläng	table lamps	Improved packaging allowing a 25% reduction of the loadspace.

4.2 Valcucine: the green kitchen SME

4.2.1 Structural Characteristics and history

Valcucine was founded in 1980 in Pordenone, in the North-East of Italy, and is specialized in kitchens and parts thereof. At that time, the four funding partners of the company, Cappellotto, Verardo, Centazzo and Corbetta, had manufacturing but no specific design or managerial experience in the industry, yet they transformed in few years one among many good Italian manufacturers into a top high-end kitchen producers. Started as a small enterprise, the company now employs 171 persons –

42% more than in 2000 – and has a turnover of more than 36 million Euros (2009), almost half sold in foreign markets.

The success of Valcucine relies on its business model, a mix of product quality, aesthetic design, technological innovation and sustainability. Valcucine's kitchens are made of metals, glass, and just in minor part of more traditional materials such as wood, and are characterized by being design-driven, high quality and ergonomic. Thanks to the attitude of the entrepreneurs, the tension toward the reduction of production and consumption's impacts on the environment characterized the firm's activities since the beginning but grew in the years till becoming one of its core competitive advantages, strongly built in its corporate culture and brand. Several prestigious awards acknowledged its design skills, its competitiveness and innovations capabilities and its eco-friendly design and sustainability strategies[6].

Differently from IKEA, Valcucine produces low volumes of high quality products, which sometimes are even customized on the client's requests. Each kitchen's design entails a different mix of the technology, the raw materials used, the possible basic product's units and often implies break-through product or process innovations. Figure 4.3 sketches the main steps of Valcucine's Value Chain, included value added activities and its supporting industry, mimicking the usual representation of the VCs. To realize such an heterogeneous and innovative product range, Valcucine relies on a wide and heterogeneous network of external suppliers, which is activated flexibly for each product's project. Valcucine outsourced most of the production activities needed to produce its products and is responsible just for the higher value added activities of its value chain, namely design and marketing. The next section will give an account of how Valcucine organizes the activities with suppliers to realize its kitchens, following the depicted organization in value added activities, and describe the network of suppliers. Later on (section 4.2.3), I will present which environmental innovations have been introduced by Valcucine, by each step of the value chain.

4.2.2 Valcucine's Value Chain, suppliers and value added activities

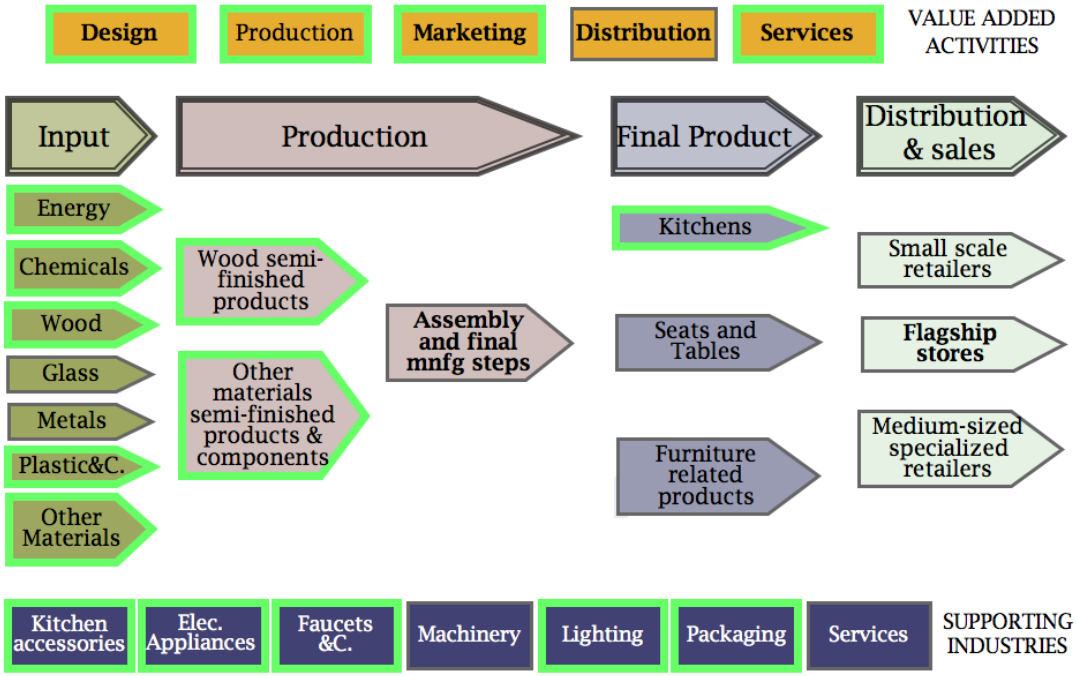
Design

Among the core competencies of Valcucine are the design skills. The charismatic CEO and main designer of the company, Gabriele Centazzo, lead the design and new product development department, setting the aesthetic guidelines that characterize the new kitchens. The internal capacity of the firm is responsible for the aesthetic design of almost all the new products and cooperate with suppliers about more technical features. Design is in-sourced because the company wants each product's design to be impregnated by its culture and because of the difficulties to find

[6] Among the most recent are, in 2008, the ICFF Editor Award (United States) and the mention at "Compasso D'oro" Award (Italy), and, in 2007, "The kitchen Innovation Prize", (Germany), "the Innovative Firm in Friuli" (Italy) and the "Best green design&Architecture" by Treehugger (United States).

[7] In bold activities at least partially performed in-house. The green-bordered steps are those "greened" by the firm.

Figure 4.3: Valcucine's Value Chain[7]. Source: author's elaboration.



external designer that have the high product and environmental competencies held within the firm.

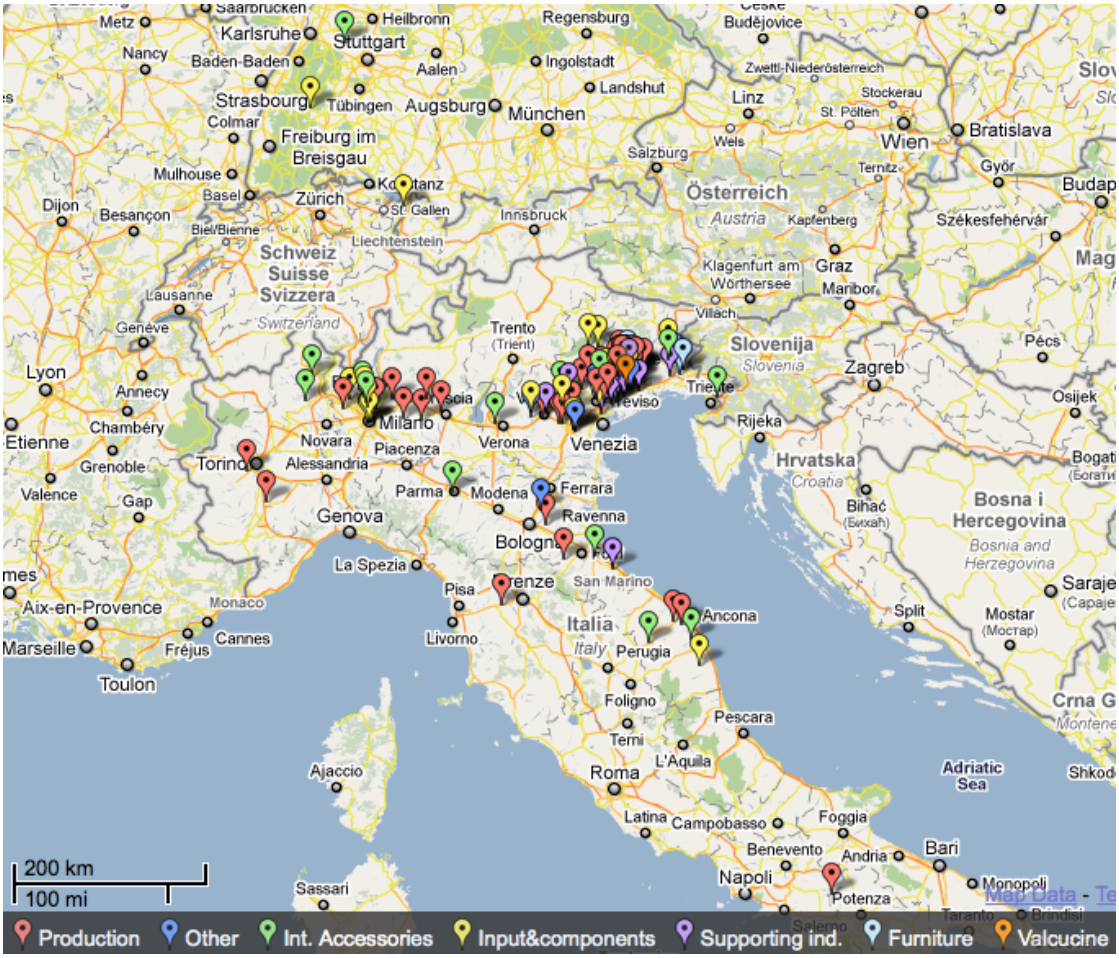
Production

Valcucine does not perform almost any production activity. The 70 blue collars working in the company mainly assembly the different components based on customer's specifications and package the final products. Furthermore they assemble its special door frames (see paragraph 4.2.3) and make inlaid decors on kitchen's doors based on specific designs of customers. Those activities, performed using patented proprietary machineries, are kept in-house because of appropriability concerns and flexibility reasons.

The production of semi-finished goods, furniture, doors, and components necessary to their kitchen is carried out by a network of almost 300 suppliers, among which 180 are suppliers from which the company buys on a regular basis. For *commodity products* – standard or low value ones – the company has at least two suppliers for each item, selected mainly based on costs and service characteristics and linked with Valcucine just at arm's length. For *special and strategic* components, Valcucine relies on specialized suppliers which are considered the sole that master the requested specific technology and guarantees the needed reliability, which are active co-partners for innovation. Those suppliers may be defined as *full package suppliers* or OEM (*Original Equipment manufacturer*): they produce based on the customer's specifications and are responsible for the necessary inputs and raw materials.

The great majority of Valcucine' suppliers are located within few miles of the firm's factory. Almost 70% of the overall suppliers is located within or in the proximity to the furniture District of Livenza. The remaining suppliers are located

Figure 4.4: Valcucine main suppliers' location[8].



in other Italian areas and just few of them are based abroad, mainly in Germany or Austria, which Valcucine has recourse to for products or components that are not available through Italian suppliers. Figure 4.4 gives an overview of Valcucine's suppliers location: each supplier is represented by a dot, whose color indicates the specific activity of Valcucine's value chain that is the main activity of that supplier.

Valcucine did not internationalize its value chain because of *economic*, *qualitative* and *reputation* reasons. Because of its business model, characterized on the one hand by low volumes, on the other hand by high customization and continuous

[8]The map was created thanks to the web-based application BatchGeo® based on Valcucine's internal database, which includes suppliers from which the company buys more often (n=135). Activities are grouped in six categories as follow: a) *input&components*, including wood, glued and similar, and small metallic insert (e.g., screws) and metallic small components (such as hinges, mounting plates, sliding items, corner units, pull-out units, wheels, lifts for doors,...); b) *production*, includes the production of moldings, panels, doors, frontal parts and other semi-finished goods; c)*furniture*, groups all suppliers of furniture pieces used in the kitchen such as chairs, tables, complements; d) *Interior Accessories*, include all the suppliers of complementary products such as electronic appliances, faucets, lighting, and accessories in general; e) *Supporting industries*, includes packaging, service, mechanics suppliers; f) *other*, includes firms specialized in floor production, construction and plastic manufacturing industries.

innovation, it would have no economic incentives to supply from firms located in countries characterized by lower production costs. Proximity with suppliers ensure higher interactions for innovation and more flexibility. Secondly, this strategic choice enables higher qualitative levels. The Italian manufacturing system, in fact, is characterized by an high number of very specialized, highly skilled and innovative firms. Valcucine's location is particularly suitable in this sense: it is at the intersection of the furniture District of Livenza and the mechanical district that developed around the former Zanussi, now Electrolux, which came at hand at Valcucine when choosing to manufacture metal-made kitchen. Thirdly, supplying in Italy, where environmental regulation is pretty high, the company is reassured about the suppliers' environmental performance. Finally, the choice of sourcing from Italian producers enables the firms to leverage on the final market in terms of reputation, marketing and branding, selling a *Made in Italy* kitchen.

Marketing, distribution and services

The marketing function is highly strategic for Valcucine and is completely internalized, to ensure that marketing and communication efforts are pervaded by its culture and sustainability propositions and an adequate positioning on the market. The internal marketing function, one of the biggest in the company, deal with each and every aspect of the marketing and advertisement campaign, including the product's photos for the magazine advertisement, which are shot in a specific company's facility.

Valcucine kitchens are sold under their brand by specialized retailers all over the world and, only in few cases and mainly abroad, through flagship stores. Recently, the company started to manage post-sales services, on the purpose to enable the recyclability of their products, but it is still in the embryonic stages, as more generally the customers' service.

4.2.3 Environmental innovations at Valcucine

> "*Innovation and sustainability are strictly connected [...] Sustainability* enables *innovation and therefore it is a source of competitiveness for us, it allows us to differentiate from competitors*" (CEO and designer, Valcucine)
> "*Every innovation has to be environmental-friendly and therefore also safe for the people [...] because sustainability is among our guidelines*". (R&D manager, Valcucine)

Valcucine is a highly innovative firm: every year it introduces about 1,500-2,000 modifications in its products. What reconcile all those innovations is their environmental orientation. The entire innovative effort of the firm is oriented toward the development of new ways to reduce the impact of the products and of the production process on the environment (see Table 4.3 for some examples of environmental innovations introduced).

Input

As for IKEA, a first set of environmental innovations developed regard the choice of the raw *materials used*. At the beginning Valcucine produced wooden kitchens;

starting the mid 90s, because of aesthetic and sustainability reasons, the majority of Valcucine's products were made of aluminum and glass – materials that, even if consuming more energy when produced, are better suitable to be recycled after consumption and requires lower glues and other chemicals for their applications. For the most recent products, secondary aluminium has been employed too. In 2008, the company obtained the FSC certification for solid maple elements, which characterize the drawer interiors and in the near future it plans to use FSC certified wood also for chipboard-carcass panels and for the entire Artematica Walnut kitchen.

Thanks to the design of the products, Valcucine has increased drastically the eco-efficiency of its products. A case in point of the *dematerialization* strategy implemented by Valcucine is the cutting-the-edge innovation for doors, realized for the first time for the kitchen *Artematica* in 1988 and now used in all the products. Leveraging on a technology developed in the automotive industry, Valcucine invented a special door consisting of an aluminum structural frame over which the glass, steel or wood panel is added. This technology allows to reduced the thickness of the door from 20 to 2 mm. Developed to reduce the impact on the environment, it allowed to drastically reduce the warehouse on doors and improve efficiency and customization; frames are produced to stock and panels, very customizable, are produced just-in-time by suppliers on the specifications of final customers. A similar technology has been applied also to worktops, reducing materials used up to 60% with respect to traditional ones. Dematerialization was the guideline also for the development of a new supply base unit for the model *Invitrum*, consisting in a horizontal structure with a single carcass side that is 10mm thick, 70% less than the traditional side-by-side installed supply-base-units.

Production

Valcucine introduced several process innovations to improve eco-efficiency, reduce toxic emissions and reduce waste, so that it was the first Italian kitchen manufacturer to obtain, in 2001, the ISO14001 environmental certification. To balance the emission of CO_2 produced, Valcucine has implemented reforestation projects through the ONG Bioforest that it founded, together with other companies, in 1998. Other than reducing carbon dioxide emission in the atmosphere, reforestation is meant to replace the wood used to make furniture.

Valcucine committed to reduce the level of formaldehyde and other toxic emissions linked with its products by developing a water-borne varnish, a key component in furniture production for its contribution to the aesthetic and technical performance of the product. This technology, never developed before for the specific applications needed by Valcucine, drastically reduced the use of traditional, synthetic, solvents and guaranteed no toxic emission and much lower formaldehyde levels (see also section 4.3.5). Valcucine decided to used just this type of varnish on its wooded products: applications for which this technology does not allow yet the same quality and aesthetic performance of solvent-based alternatives, such as the metal polish or polished effect varnishes, are not therefore on Valcucine's stream.

Table 4.3: Example of environmental innovations introduced by Valcucine. Source: author's elaboration based on corporate information and interviews.

year	model	description
1988	Artematica	The doors made for this kitchen were the first in the world to have an aluminium frame that was not visible from the outside, with a layered, 5mm thick HPL panel.
1996	Ricicla	The doors of this kitchen were made by an aluminium frame and a 2 mm door panel, allowing up to 90% reduction of material used.
2002	Aerius	A wall unit made completely by recyclable materials (aluminium and glass) and using LEDs, highly energy efficient lighting.
2007	Riciclantica	The doors for this kitchen are designed to be easily recycled: for the first time they are made of a single material.
2009	Invitrum	A base unit for kitchen is 100% recyclable since it is made just by glass and aluminium that uses 70% less materials than similar products.

Final Product

Through the careful design of the products, Valcucine's kitchens embed several features that make them cutting-the-edge environmentally-sounded products. Valcucine's kitchens are designed to be *technical and aesthetic durable*. The application of innovative technologies that make them extremely resistant to water, high temperature and humidity and the pursuit of a design that goes beyond ephemeral trends increase the lifespan of the kitchens therefore reducing the future consumption of materials and energy to replace them.

Most of Valcucine products are also highly *recyclable*. For example, the kitchen *Artematica Vitrum*, introduced in 2009, is 100% recyclable, thanks to the selection of the raw material used (glass and aluminium) but also of an innovative design that facilitate disassembly, namely the use of one-material components united by purely mechanical joints. At the end its useful life, the product will be easily disassembled and each component re-used or recycled. To ensure their recyclability, the company recently organized to directly collect those kitchen at the end of their life from the consumers, reusing the components in working order and recycling the others.

Finally, every *accessory* of the kitchen is chosen among the more environmental friendly available on the market. The rationale of this choice, other than a necessary coherence with the philosophical lines that guide the activities of the firm, is to extent the environmental attitude at the customers, within their everyday life. Valcucine's kitchens are *tools enabling sustainability*: by the use of the tap producing purified and sparkling water the final consumer can reduce the use of plastic bottles, by using the electronic appliances, of the highest energy-efficiency class, installed within Valcucine's kitchens and the LED spotlights she can reduce its emissions.

Distribution & Sales

All packaging at Valcucine's and at their main suppliers is made without using polystyrene, employing recycled cardboards and paper scotch type. Furthermore, Valcucine is actively involved to increase the environmental awareness of its consumers, both through direct activities (on- and off- line communications and projects) and by instructing its retailers in the environmental innovations introduced by the firms and more generally in environmental concerns in the furniture industry. A room within the company is the school where retailers are hosted for a multiple-days course to "qualify" as a Valcucine retailer.

4.3 Environmental innovations at IKEA's and Valcucine's furniture suppliers

In this paragraph, I will complement the analysis on the environmental innovative strategies of IKEA and Valcucine with their supplier's perspective. In the following, I will describe the main features of some representative suppliers at both firms (see Table 3.2), sketching the environmental innovations they introduced, with a special reference to the impact of the lead firms activities on the supplier's environmental strategies.

4.3.1 Friulintagli

Friulintagli is specialized in the production of paper and veneer wrapped profiles and doors, furniture elements and flat packed furniture. It was established in 1968 as an artisan furniture manufacturer but starting 1996 it undergone a deep internal re-organization that transformed it into one of the main furniture producers in Italy, employing 850 workers. The company is export-oriented: just the 7% of its turnover is made in the Italian market and more than 80% of is made in European markets. Friulintagli is certified ISO9001, ISO14001, OHSAS18001, FSC and achieved since a long time the IKEA's certification IWAY. Its main competitive advantage lies on its ability to produce large quantities of products ensuring low costs. For the majority of its products, it manufactures mainly on the specifications of customers but it also has an internal R&D and product development department, devoted to identify product and process innovations to be proposed to buyers and to ameliorate their product design for manufacturing purposes. It supply from both Italian and foreign suppliers, selected for the quality-costs ratio they ensure.

The company started to consider its environmental impact as a direct consequence of the requests of IKEA. IKEA is a customer since 1996 and covers the 70% of its production. Friulintagli environmental awareness grew incrementally, the more IKEA's environmental requests increased. Environmental innovations introduced by the company regard mainly the production process: Friulintagli have optimized its logistic, improved manufacturing efficiency – reducing the need for energy and using alternative energy – and lessened production wastes. Furthermore, the company decided to use mainly certified wood or recycled materials and reduced the use of glues and varnishes for its products. As far as other raw materials are concerned, the company still uses non-environmental friendly alternatives, because

of cost and quality reasons. Plastic is a case in point: the adoption of recycled plastic was inhibited by the high costs to ensure the quality needed. Process and product innovations that were developed to fulfill IKEA's requests turned out to be useful also to satisfy other buyers, where the company is able to gain higher margins that with IKEA, which allow low margins to its suppliers. Friulintagli has been supported by IKEA in their environmental-friendly path, which provided knowledge on the products, the process and the raw materials to be used. If at the beginning the environmental strategy of Friulintagli was "reactive", with respect to IKEA's requests, it may now be defined as "strategic". Also thanks to IKEA's influence, the management recently realized the importance to proactively improve the environmental performance and started many projects to integrate its own suppliers in the logistical system, to improve its share of energy from renewable sources and to invest in R&D to introduce product innovations.

4.3.2 Media Profili

Media Profili is a lead firm specialized in the production of furniture surfaces (doors, shelves, sides and the like) covered by laminates, decorative paper finishes, polymeric materials and the like. Media Profili is a group employing 430 workers, which is based in the furniture district of Treviso. The company produces mainly on the specifications of the customers but for some clients it also produce on its design. In fact, it has an internal R&D department that is responsible not only to test the in-coming and out-coming products but also to develop new technologies, mainly process innovations, which in some cases have also been patented. The company heavily invest in R&D and in new technologies: each year it devotes from 8 to 10 million Euros to these activities. It sells mainly to foreign mass retailers (export is up to 90%) and its main competitive advantage is that to offer products at low costs that ensure the needed quality. It became a supplier of IKEA just recently: even if it is a big customer, the company does not feel to be dependent on it. In 2009, its turnover increased by 31.7% with respect to pre-crisis levels (2007) and in kept increasing in 2010, and similarly did its margins, passing from 6.6% to 14%. Media Profili relies on a big network of suppliers, selected on the base of their ability to keep prices low rather than for their location or service capabilities.

Environmental sustainability for the group is mainly a way to make business with the biggest retailers, one of the many requests it has to satisfy to stay on that market. In Media Profili environmental innovations regard mainly the inputs and the production process. The company uses just materials that are non-toxic in the manufacturing and disposal phases. Furthermore, on request, it uses PEFC or FSC certified wood, for which is the bigger user in Italy. To reduce toxicity and pollution levels of its activities, Media Profili recently substituted traditional glues and solvents with polyurethane ones, even if, at the time it started to adopt them, they were 5-times more expensive that the traditional ones. The companies did many investments to reduce the ecological footprint of its production processes: it substituted the existing boiler with a more efficient one that burn production wastes and changed several old machineries and equipments with more environmental-friendly ones. Thanks to the support given by IKEA under the SEEP project, it

recently reduced even further its energy consumption (-30%), by investing in the lighting and manufacturing systems and improving the environmental behaviours of employees through training. In all the cases, innovations were introduced or to reduced the costs, or to meet the requirements of the buyers, IKEA among others. When it started business with Media Profili, it had already done many of the investments in machinery and managerial systems that the Swedish group usually requires, even if IKEA's support proved to be essential to move forward its eco-efficiency. Media Profili completely delegated to its sub-suppliers the tasks to ensure and achieve the needed environmental performances: it requires to them self-certifications but does not perform any direct activity to verify (other than the usual tests on the product) or to support them.

4.3.3 ILCAM

Founded in 1959, ILCAM is now a group that grew for acquisition and is now made of 4 companies: ILCAM, specialized in the production of furniture frontals, ILMED, specialized in MDF components (both based in the Gorizia province), ILMEST in furniture components and ILROM providing the raw materials and semi-components for the group (based in Slovenia and Romania respectively). In 2009, the group employed 760 people overall. Similarly to Friulintagli and Media Profili, ILCAM group invested heavily in automation: thanks to its cutting-edge equipment it is able to compete with low-costs countries'. The group sells just the 20% of its production on the Italian market: Northern Europe countries (mainly England), where environmental awareness is higher, are its main markets. The company is certified ISO9001, FSC and PEFC and recently introduced several organizational and process innovations to achieve the ISO14001 certification, required by IKEA.

As for Friulintagli and Media Profili, ILCAM started along a sustainability path because it was a specific request of its foreign buyers. At first, it started to offer products made by FSC certified wood, among the first companies in Italy, to satisfy an English customer. Since, at that time, it was difficult to supply high quantities of FSC certified wood on the market, the company decided to certify its own subsidiary in Easter Europe, to internally provide the wood. Furthermore, to reach IWAY standards, ILCAM group started a very costly process to optimize its production processes and re-design its products. The company substituted PVC and traditional glues to the advantage of new materials, which ensured lower levels of formaldehyde emissions. It also revisited its logistical and packaging systems, to reduce waste and the use of nonrenewable materials. Because different customers requires different standards, the company equipped both with pallets in recycled plastic, required by IKEA, and with rent-and-re-use pallets, required by other customers, If having different customers interested in reducing environmental impacts represents an advantage for the firm, which can spread the investments on bigger volumes, it can also be an problem as far as there is not an agreement on what is the best technological alternative.

ILCAM has just recently started business with IKEA and at the time it was interviewed, it was not an approved supplier yet, supplying still just small batches. Nonetheless, the group has undergone heavy investments to reach the strict stan-

dards required by IKEA, which has provided ILCAM with detailed specifications on how to implement the environmental innovations. The rational for bearing these costs was both the possibility to gain in term of reputation and improvements of the manufacturing and environmental capabilities. Furthermore, the high volumes that IKEA ensures to all its suppliers represented a powerful spur to undergone deep changes in the organization of the production within the company.

4.3.4 Electrolux

Electrolux is a multinational based in Sweden with manufacturing facilities in Italy, Germany and other Eastern-European countries which, in 2009, employed almost 51,000 persons. It is specialized in the production of electronic appliances for medium-high markets. The company, leader in its market, is highly innovative. Electrolux defines itself as a consumer-driven company and continuously introduce innovations that improve the usability of the products while reducing costs and the impacts on the environment. The group has a global sourcing network and does collaborate with suppliers, universities and private and public research groups to develop new products and processes. The 93% of the group's facilities is ISO14001 certified and many of its products were acknowledge with prizes for their innovativeness and improved environmental performance.

Electrolux started to consider its impact on the environment in the 80s, as a reaction to the sharpening of the international laws on hazardous materials. If at the beginning, sustainability was mainly *reactive*, consisting in substituting polluting inputs in products to respect the laws, after few years Electrolux developed a rather *proactive* sustainability strategy. The reduction of the impact on the environment became increasingly important for the firm till becoming the main goal of the innovative activities and the key advantage over competitors. Starting 1995, it introduced several "green" products and now offers an entire range of environmental-friendly products, including cutting-edge technologies to reduce energy in the usage phase, appliances using renewable energies and other innovative solutions to reduce the impact on the environment. Using a LCA approach, the company improved the environmental performance of its product at different steps of its own value chain:

- At the input, by selecting raw materials following eco-criteria stricter than the current legislation would require;
- At the production process, by reducing energy used (-21% with respect to 1997 figures), wastes produced (-43%), and water (-25%) and raw material used (-7%);
- At the logistics and distribution steps, implementing an intermodal integrated transportation system that favor train to trucks;
- At the use of the product, enabling the reduction of energy, water, detergents to be used in its products and enabling their recyclability up to 90%.

To ensure the same environmental performance also at all its suppliers, Electrolux developed an internal Code of Conduct and supported their change when necessary, diffusing environmental knowledge and suggesting how to reach the environmental (and social) goals set.

Environmental innovations have been introduced following a precise internal strategy aiming at differentiating the group from competitors and to systematically anticipate environmental legislation, rather than because of requests of any buyer. It was rather the buyer that selected Electrolux because of the high environmental standards it achieved, as was the case for both Valcucine and IKEA. Electrolux, whose facilities are located in the same industrial area where Valcucine lies, is the sole electronic appliances supplier for its kitchens since a long time. It accepted also to participate in the NGO founded by Valcucine, Bioforest, aiming at restore natural environments and compensate emissions. Despite the deep relationship with Valcucine, it never introduced any innovationsfollowing Valcucine's requests, because its low volumes does not make it a profitable strategy. On the contrary, it developed a new line of products just to suits IKEA requests, which is a very recent client Electrolux conquered thanks to its proved environmental performance. IKEA has a dedicated office within Electrolux's R&D department and collaborated to develop the new products, which have a much lower price than the average Electrolux's products.

4.3.5 Biesse Crea

Biesse Crea is a small, family business, specialized in the production of semi-finished goods and doors for kitchens', bedrooms' and office furniture's producers. The company, founded in 1974, has 20 employees, the double than 10 years ago, and is well known in the district of Livenza, where it is based, because of the high quality it guarantees and its ability to cope with innovations. The company sells just to 30 customers, located mainly in the Pordenone area, among which Valcucine accounts for the lion's share, covering almost half of its production. Biesse does not have a formal R&D department but the entrepreneur and its employees cooperate with the customers on innovations and develop incremental innovations to target new buyers. Biesse Crea produces to order and relies on local sub-suppliers to tackle peaks in the demand or to help out in the innovation process. It just recently obtained the FSC certification, the only environmental certification it achieved (see also Box 6.1).

The company introduced many environmental innovations in recent years, all because of requests of Valcucine and co-developed with it. Before 1999 it was just one among the many wood suppliers of Valcucine, which is a buyer since its foundation (the two entrepreneurs were previously employed at the same furniture producer). Starting 1999, it accepted to participate in a project of Valcucine involving all its wood doors suppliers to develop a less harmful varnish. The first idea was to realize an oil-based varnish, which was abandoned after many trials few years later, because it was poorly performing. Because of its commitment to work together to develop environmental-friendly innovations, Biesse Crea was then selected, as unique supplier, to develop a water-based varnish. Starting 2003, Biesse Crea worked in harness with Valcucine and its varnish and machinery suppliers to develop this technology: after an infinite number of incremental innovations, they manage to develop a high quality and aesthetic performing water-borne varnish. Even if this technology already existing, it was not already as performing as the

more-harmful alternatives as far as the applications requested by Valcucine were concerned. The ability to deal with that environmental-friendly varnish allowed Biesse Crea higher margins than traditional products and, in more recent years, enabled it to reach new customers. Furthermore, it became the major supplier for Valcucine and gained in reputation. Despite the environmental-friendly line is more profitable, at the time of the interviews it represented just the 30%-40% of its overall production, since not all the customers was requiring it. Other than this major innovation, Biesse Crea started to use FSC wood and an environmental-friendly packaging, both according to Valcucine's requests, but has no formal or informal system in place to monitor the environmental performance of its suppliers or contractors.

4.3.6 Eureka

Eureka s a firm based in the Treviso province specialized in the production of aluminium doors, wardrobe doors, furniture structures, support systems and aluminium elements for furnishing. Established in 1987, it grew by acquisition to enhance its capabilities and is now a group employing 100 workers. The company produces mostly according to the customer's specifications. However, at least one tenth of its turnover is realized by its own-designed products, sometimes patented, which the companies owes its success in its early days. Other than developing new products, the internal R&D department works on the development of the customer's products, based on their aesthetic and cost targets. Its competencies in the mechanics and in the manufacturing of different materials such as aluminium, zama alloy, plastic and the like, together with quality and flexibility, represent its major strengths. To ensure competitive prices, it invested in state-of-the-art equipments. It sells worldwide, exporting mainly in Europe and in the Middle East, but its main customer is Valcucine, customer since 2005, which absorbs half of its production. The company is highly vertical integrated, performing all the activities of its value chain except the production of raw materials, including design, cutting, manufacturing and oxidation of the metals and packaging of the final product. In case of peaks of demand and for the processing of specific products or activities, it relies on a global network of suppliers. For example, for a specific processing of the aluminium, which needs to be hand-made to ensure the high quality, it relies on a consolidated group of Chinese suppliers, with whom it works in harness to complement their knowledge base, improve their capabilities and also verify that they comply with minimum social and environmental standards. The company does not have in place any formal mechanisms to control the environmental performance of suppliers, and does not seems to be even too concerned about it as soon as they obey with the product specifications of their customers.

In Eureka, the awareness about environmental issues is very low. Despite it is well-equipped to ensure healthy working conditions and non-toxicity in its products it does not consider environmental concerns as strategic. For instance, it did equipped with a very advance machinery to reduce emissions and water pollution yet the purpose of this investment was to reduce risks and anticipate policy requirements rather than the fruit of an environmental strategy. In some

cases, environmental upgrading was hindered by technological barriers: as by now, no environmental-friendly alternative has been develop to substitute the most impacting activity it deals with: oxidation. Despite its reactive attitude, Eureka have reduced the environmental impacts of Valcucine' products, both because of its specifications and of the products' design it provided. Following a specific requirement of Valcucine, its products are packaged just using recycled paperboard and no plastic at all. Furthermore, Eureka strongly reduced its consumption of energy and the use of chemicals for most of Valcucine's products. Valcucine, in fact, developed a special design that ensured the supplier to reduce energy consumption and to dry-manufacture (i.e., not to use chemicals) its products. Even if not higher margins, working with Valcucine allows Eureka to increase its reputation[9] and a stable demand.

4.3.7 Abet-laminati

Abet-laminati, established in 1957 in the Cuneo province, is a leading manufacturer of decorative laminates, including high pressure laminates and laminates in continuous, for both exteriors and interiors. The company, which employs 758 workers, sells all over the world, having a commercial presence in Europe and in North America, but all its production facilities are concentrated in Italy. Since the 60s, the company distinguished itself in its innovation propensity and in its design attitude. Having collaborated with various famous designers, it was granted prestigious design awards such as the Italian "Compasso d'Oro" and the "European design award". Other than on the design and the aesthetic performance of the products, the company has a strong focus on their technical performances. Thanks to the activity of its numerous R&D department, it introduces several innovations that is some cases are patented. The company, certified ISO9001, developed a mild Code of Conduct that apply just to internal activities.

Generally speaking, environmental innovations in Abet-laminati were motivated mostly by the willingness to respect and prevent legislation and to improve its eco-efficiency. Abet-laminati introduced many environmental innovations during the years: the most important is "Tefor", patented, which is a laminate completely made by production wastes and that is 100% recyclable. Through special machineries the company collects the slacks emitted during the production of the other laminates, which are then transported within a specific facility where they are processed and transformed into Tefor laminates. The company started the development of this new product to face the problem of slacks produced in the manufacturing process, which was both very costly to dismantle respecting environmental laws and perceived as a waste of potentially useful materials. Other than addressing an environmental and economic problems, Tefor, which still represent a minor part of the overall production, allowed also the company to enter a new market, namely

[9] I think it is interesting, at this regard, to complement the information from the interviews with an evidence from direct observation. Valcucine, in fact, is the only name displayed on the products exposed in the internal showroom of the firm, which include many products manufactured for other customers. Asked about that peculiarity, the interviewee asserted that it was motivated by the willingness to "show off" to other potential customers that Eureka has been selected to supply Valcucine.

Table 4.4: IKEA and Valcucine value added activities and division of labor with suppliers. Source: author's elaboration.

IKEA	Suppliers	Activities	Valcucine	Suppliers
		Design		
		Product development		
		Wood processing		
		Other-inputs processing		
		Wood-furniture manufacturing		
		Other-inputs furniture manufacturing		
		Assembly and final manuf. steps[a]		
		Marketing		
		Distribution[b]		
		Retail[c]		

Dark grey-colored are activities mainly performed in-house; light grey-colored are activities just partially performed in-house; white-colored are completely outsourced activities. Activities are grouped by the categories of value-added activities as in Figures 4.1 and 4.3, namely design, production, marketing, distribution and service.

[a] IKEA's products are assembled by customers.

[b] IKEA and Valcucine relies on logistic suppliers to ship their products to retailers.

[c] Valcucine's product are sold by independent retailers.

applications on commercial vehicles' covering, thanks to its peculiar technical and aesthetic qualities. The company attempted also to develop an applications for the furniture industry. After the development of some trials working in harness with Valcucine's personnel – customer of the company since some years of its traditional products – that project was however abandoned because of its poor aesthetic performance. Moreover, the company reduced its impact on the environment by substituting traditional with FSC certified paper for the manufacturing of some products, and equipped with cutting-edge machineries as far as eco-efficiency and reduction of emission is concerned. Finally it has a "waste-to-energy" incinerator, which produces vapor that is used within the production process from production wastes.

4.4 IKEA and Valcucine: a preliminary comparison

The picture emerging in the narrative of the previous paragraphs suggest that the two lead firms at the center of this analysis have some similarities and some differences in their value chain strategies. Table 4.4 helps the analysis, attempting to visually summarize the division of labor with suppliers on value added activities of IKEA and Valcucine as in paragraphs 4.1.2 and 4.2.2, completed by the supplier's point of view as in paragraph 4.3. Both firms have outsourced the majority of the activities needed to realize their products, focusing mainly on higher value-added activities such as design and marketing. They represent neat examples of the "manufacturers without factories" described in the literature on buyer-driven value chains (Gereffi, 1999): companies with well-known brands that carry out very little manufacturing activities. However, differently from Valcucine, which performs

Table 4.5: A summary of the main environmental innovations in Valcucine and IKEA

VC step	Valcucine	IKEA
Input	Recyclable and recycled raw materials, FSC certified wood, dematerialization	Recyclable and recycled raw materials
Production	Eco-efficiency, emission compensation, water-borne varnishes	Eco-efficiency, Reduction of emissions, use of renewable energy, low emissions glues and varnishes, waste management
Final Product	Technical and aesthetic durability, recyclability, environmental-friendly accessories	environmental-friendly accessories
Distributions & Sales	Eco-packaging, consumer awareness	Distribution model and flat-packaging, eco-packaging, renewable energy, consumer awareness

just assembly activities and the like, IKEA is directly involved in almost all the manufacturing steps of the wood furniture VC, even if its own subsidiaries are responsible just for a minor part of the overall products range. Started as a *retailer*, IKEA is now resembling more a *branded manufacturer*, to use the categorization of Gereffi (1999). Despite in its most recent history design and marketing gain much importance, the retailing function is still the most important activity for the firm: IKEA-branded products are sold just through IKEA stores. For Valcucine, instead, design and marketing are the sole and major activities that are performed. As will be described more thoroughly in the following chapter, the two firms differs also in the way they rely on external partners as far as the design and innovations activities are concerned, other than the geographical distribution of their supply networks.

As emerged in previous paragraphs, also the innovations strategies of the two firms differ considerably. It is worth noting at this point that it is not easy to compare between green and non green innovations within the two cases. Environmental awareness is so much knitted with the firms' strategy and every-day activities that almost every innovation has an environmental character, i.e., every change in the product range or in the production process necessarily attempts to keep low the impact on the environment, other than gaining any economic profit. This evidence suggest that, for front runners of the race for sustainability, innovation and environmental innovations are not separated. Rather, environmental concerns are leading the innovations process and are among the guidelines for innovations. This evidence, which should be complemented by a study on a larger number of firms to be considered conclusive, contradicts the rival explanations on results in chapter 1, adducing that environmental are just a minority of the overall innovations introduced by firms (see paragraph 1.5). Difference therefore are not in the percentage of green products on the overall product range, but rather on the typology of (environmental) innovations introduced. To compare the two

Table 4.6: Value Chain activities and supporting industry for which IKEA and Valcucine reduced the impact on the environment thanks to their innovation activities. Source: author's elaboration.

IKEA	Value Chain Steps	Valcucine
	Energy	
	Chemicals	
	Wood	
	Glass	
	Metals	
	Other materials	
	Wood semi-finished products	
	Other materials semi-finished products & components	
	Assembly and final manufacturing steps	
	Final products	
	Distribution	
	Retail	
IKEA	**Supporting Industries**	**Valcucine**
	Accessories	
	Electronic Appliances	
	Machinery and Mechanics	
	Lighting	
	Packaging	
	Services	
	Other supporting industries	

Dark grey-colored are activities for which the environmental impact has heavily been reduced; light grey-colored are activities for which is was partially reduced; white are activities not interested yet by the environmental innovation effort of the firm. Activities are grouped by the categories of value-chain steps as in Figures 4.1 and 4.3, namely input, production, final products, distribution & sales.

strategies, I consider different dimensions of the innovations introduced: i) their typology, ii) the "radicalness" of the innovations, iii) the environmental dimension addressed, iv) the value chain steps. Tables 4.5 and 4.6 will support the discussion, by summarizing the main environmental innovations introduced in the value chain leaded by IKEA and Valcucine, considering the steps of the VC they affected.

Overall, IKEA's are more often process innovations, whereas Valcucine's are more often product innovations. Furthermore, Valcucine's innovation are more often systemic – involving all the different components of that product, and affecting how it is used – and break-through – changing the product concept or the overall architecture or the way some components are manufactured – than IKEA's, which very often result simply in substituting the raw materials used in a product with environmentally-certified or recyclable one. Even if they imply a strong effort at the firm and often also at the suppliers, IKEA innovations appear rather incremental, resulting in improvements in the way a product is done that very often are not even acknowledged by consumers.

Both firms are committed to reduce their impact on the environment. However, they differ in the priority they gave to the different environmental problems and

on the way they go for it. IKEA's priorities, cross-cutting the different innovations introduced, seems mostly, on the one hand, to reduce emissions, on the other hand, to reduce the exploitation of natural resources. The first environmental concern is addressed both by the use of renewable energies and through eco-efficiency, reducing environmental impacts while enhancing efficiency; the second by using recyclable or recycled raw materials and wood coming from responsibly managed forests. Valcucine's priorities instead, seems that of reducing the amount of materials used for products, reducing the environmental impacts in the use of the product and improve the recyclability of its products.

Both IKEA and Valcucine attempted to address their environmental concerns throughout the entire VC, but with different emphasis and different intensity. Other than reducing the impacts at the input step, Valcucine focuses mainly on innovations on the final products, whereas IKEA on the production and distribution & sales steps (see table 4.5). Lee and Rhee (2007) define the environmental strategy as the firm's choice of the width and depth of eco-friendly activities. In that setting, width refers to the number of activities and decision areas of the firm in which environmental concerns are taken into account, whereas depth is rather a measure of intensity of the integration of sustainability guidelines into those activities. The extension of these concept to the entire Value Chain rather than the firm's activities, seems a useful exercise to compare Valcucine and IKEA. In fact, it enables to evaluate different strategies considering both the number of VC steps targeted by environmental innovations and how much these innovations have affected products or processes with respect to the business-as-usual benchmark. Table 4.6 support the analysis, attempting to visually summarize the environmental innovation effort of the two firms, considering of each steps of the value chain. Overall, IKEA have introduced eco-changes in more steps than Valcucine, but Valcucine's innovations have resulted in a stronger reduction in the environmental impacts and in more radical changes – not limiting to reach basic and easy-to-measure environmental performance. To say in other words, IKEA attempted to reduce the environmental impact along its Value Chain widthwise, whereas Valcucine depthwise.

This chapter highlighted the peculiarities on the one hand, of the value chain strategies and division of labor with suppliers, on the other hand, of their environmental innovation performances. Aim of the next chapters will be to identify how these two aspects interact toward the development of environmental-friendly value chains.

Chapter 5

IKEA and Valcucine: greening the supply chain together with suppliers

Many of IKEA and Valcucine's environmental innovations, described in the previous chapter, were not developed standalone but in close cooperation with suppliers. Furthermore, in order to reduce the overall impacts along the value chain, they influenced the innovative activity of their suppliers, boosting the reduction of their ecological footprint. This chapter sets out to investigate how firms interact with their suppliers for the greening, using the cases presented in the previous chapter to answer to the research questions listed in paragraph 2.1.1. In this chapter I will contribute to the discussion in the GSCM and the CSR literature, by identifying a framework for how lead firms influence the environmental activities of its suppliers, cooperating with them on innovation, monitoring and controlling their activities and supporting their action. The chapter consists of a within-case analysis for the Valcucine (section 5.1) and the IKEA (section 5.2) case, followed by a cross-case discussion on key similarities and differences emerging (section 5.3), which are encapsulated in a series of propositions.

5.1 Valcucine: the way of an SME to green its supply chain

5.1.1 The importance of cooperation for the development of environmental innovations in Valcucine's supply chain

In Valcucine, research and development of new products is dealt mainly by the R&D department, which is supported in its effort by product development officers and by purchasing and marketing managers that collect inputs from suppliers and consumers respectively. The R&D employees continuously improve their skills and competencies through training, readings and the interaction with external partners and by the study and observation of technologies adopted in other industries, like the automotive. Despite the design activity is concentrated in Valcucine's hand, the firm also heavily cooperates with suppliers. Suppliers are important sources of knowledge and technical information for environmental innovations and sometimes propose new materials or applications that are evaluated by the

internal R&D department and eventually developed together with the supplier. The firm engages in cooperative activities mainly with *strategic suppliers*, highly competent suppliers that accepted to be challenged by Valcucine's innovative requests. Collaboration takes place mainly for product development rather than the to discuss the aesthetic design and the product concept, which is a Valcucine's prerogative. In fact, the company collaborates with its suppliers to verify the feasibility of the projects, improve the kitchens' technical performance, and adapt the original design for production purposes. Valcucine R&D, purchasing and product development officers work shoulder to shoulder with the main suppliers to address technical problems, enhance the performance of the products and evaluate new proposals. There is a continuous flow of knowledge from and to Valcucine, thanks also to frequent meetings at Valcucine's or at suppliers' facilities, which contribute to the development of both product and process innovations.

> "*The suppliers are those that test the production process, they improve it, whereas Valcucine makes the design. They say: "this is our line", or "you have to reduce costs by 10%" and then we try but at the end it is up to them to decide, because they are proprietary of the global vision [on the product]*". (R&D manager, Eureka)

For the development of more complex innovations, Valcucine's R&D officers activate and manage a dedicated *network* of suppliers. In some cases, it groups first and second tier suppliers, in other cases it pools the competencies of suppliers of the same industry but with different specializations. For example, to develop the water-borne varnish technology Valcucine cooperated both with its wooden-door supplier (BIESSE-CREA) and with its varnish (OECE) and machinery (TECHNOSPRAY) suppliers (see section 4.3.5). Conversely, to develop a new technology for the worktops and the doors of the kitchen, the company fostered the cooperation of a supplier specialized in glass production with another one that mastered a technology for surface treatment. The three actors collaborated together to realize a glass-based technology with superior performance in terms of resistance to scratches and to the use. In a similar fashion, Valcucine promoted the collaboration of two different firms in the textile industry the company has never worked before, to realize a kitchen's doors made of washable fabrics.

5.1.2 Monitoring and supporting at Valcucine

Collaboration with suppliers is a very important component of environmental innovation activities within Valcucine. However, there is also a strong emphasis on monitoring and control. Valcucine gives detailed specifications to the suppliers, regarding quality, health and environmental concerns. The company has an internal department devoted to make tests about these features on in-coming products and components and relies on a specialized service-provider for more sophisticated tests. With *strategic* suppliers, Valcucine does not only perform meticulous controls when it receives the products, but also at the suppliers' location. As far as *commodity* products are concerned, instead, the company complements its internal controls by requiring third-party managed certifications, which concerns both environmental and quality features of the products and components.

> "*Valcucine has a quality department picking nits, they are so precise! Our machinery, for example, has a margin of error of 2mm and they ask us 1mm. You have to be very good and have machinery that can do it, but also you need to control everything*". (R&D manager, Eureka)

If the control of product environmental features is guaranteed by the tough internal controls system, the control of suppliers' manufacturing process is less formalized. The achievement of environmental product or process certifications is usually not a prerequisite to be in business with Valcucine. The purchasing manager at the company justified this choice by mentioning the limitations of those instruments relatively to Valcucine's business. On the one hand, small, family-run suppliers with which the company usually deals with, cannot afford the high organizational and economic costs needed to implement such managerial systems. On the other hand, those instruments are not considered to value some of the more innovative applications for reducing the impact on the environment but to recognize just the development of more "standardized" improvements. The use of recycled aluminum, for instance, has been hindered by the fact that it prevent the firm to achieve quality certifications for the products in which it is applied, other than not being valued in any way by environmental certifications. An exception to this rule of thumb regard the FSC certification: recently Valcucine required BIESSE-CREA to use just FSC-certified wood for some products, to ensure about the environmental conditions of the forest of provenance.

> "*We compelled our wood suppliers to buy FSC-certified wood, otherwise we won't have buy from them anymore*". (R&D manager, Valcucine)

Instead of relying on formal systems to ensure about the environmental performance of suppliers' manufacturing process, Valcucine personnel visit their production facilities to verify the equipments and the manufacturing processes used. In some cases, it supports the reduction of their impact through a careful design that, leveraging on Valcucine's knowledge on the suppliers' production process, enables to reduce their impact on the environment even at suppliers that still have low awareness about environmental impacts, as it was the case at EUREKA. Valcucine's managers believe that the attitude toward the environment of managers and entrepreneurs is a key factor in explaining environmental performance at suppliers, influencing their willingness to invest in new technologies and the effort they make to develop new technologies and control the impact on the environment. Therefore, on the one hand, it invests in enhancing suppliers' awareness, on the other hand, it "trusts" them, as far as many environmental aspects of the production process are concerned.

> "*The sensibility of the [suppliers'] CEO is important as far as selection of suppliers based on environmental-friendly features is concerned!*"(Purchasing Manager, Valcucine)

> "*Trust, relationships, credibility, and the personality and attitude of people are what we control at.*" (CEO and designer, Valcucine)

> "*They haven't ask to us any environmental certifications, but they came to visit our production facilities [...] and they know very well our technology*". (R&D manager, Eureka)

> "*They promote their association [Bioforest], I know they spoke with the management. However, they not oblige us to do anything. They know very well the production process [of the aluminum] and they make us precise specifications*". (R&D manager, Eureka)

The development of its suppliers is a key object in Valcucine, which aims at grow together with them. Its support in terms of knowledge transfer and co-operation on innovation activities was important especially for suppliers with lower internal resources devoted to R&D activities, like BIESSE CREA, whereas it was less important for those with an higher number of customers and more internal resources as ABET-LAMINATI. Valcucine shares knowledge about technical and environmental aspects, suggesting which are the most impacting activities and how to reduce their impacts.

Other than transferring technical knowledge to the suppliers, Valcucine aims at improving their environmental performance by increasing their awareness about environmental concerns and offering a way to compensate their emission through the NGO Bioforest.

> "*Suppliers are heavily involved also regarding sustainability, we go often to visit them [to make them aware about it] and they also come in our company and then they copy us, then is easier for them to make things in a more environmental-friendly way also in their company, even if they are just artisans*". (R&D manager, Valcucine)

> "*We have helped them to change [...] and they understood that it was working for them too.*" (Purchasing Manager, Valcucine)

5.2 IKEA at the green challenge: greening a global supply chain

5.2.1 Green innovations in IKEA's supply Chain

Similar to Valcucine, IKEA carries out the design of its products internally, at IKEA of Sweden (IoS) offices (see paragraph 4.1.2). The design and product development activities are pretty routinized. Once IoS have developed the design for a new product, trading service offices (TSO) find suppliers to manufacture the first series. The original design can then be improved by IoS and in some cases by suggestions from the suppliers and, once it is completed, it is sent again to the TSO to find suppliers to manufacture them (see also the analysis in Ivarsson and Alvstam (2010b)). This routine, valid both for product and process innovations, may be complemented by an initial phase, in which suppliers propose the new products or ameliorations to IoS that evaluate and eventually adapts it before asking a supplier to manufacture it, especially in the cases in which strategic and highly competent suppliers are involved.

In some cases, suppliers propose new products and technologies from scratch, but in most cases it is IKEA that asks them to develop new products, bounded to detailed specifications, regarding costs, environmental and quality requirements and are then adapted to become part of the IKEA range. An example of the first typology of interaction to the development of innovation is the production of a new material for wooden furniture, entirely developed by MEDIA PROFILI. Thanks to investments in research activities and to the acquisition and development, together with a supplier, of specific equipments and machinery, MEDIA PROFILI developed a polymeric material based on methacrylate to produce glossy panels that it proposed to the Swedish-owned multinational. MEDIA PROFILI is now the sole IKEA's supplier for this product, which grants the company higher margins than the other products it manufactures for IKEA. An examples of the second case is the kitchen FRIULINTAGLI developed to compete with an existing hardwood kitchen manufactured by another supplier based in Poland. The internal R&D department developed it to meet a 500-euro upper-boundary set by IKEA, employing its internal knowledge on the manufacturing process to reduce to the minimum the production and material costs while ensuring the environmental and quality specifications required by the customer[1].

> "*IKEA gives you the targets and you have to fulfill them. You are absolutely free to decide how to achieve them, but you have to respect some requirements*". (Environmental manager, Media Profili)

Even in the cases in which suppliers have actively proposed innovations, the collaboration with IKEA is vital for the development of new products or processes. IKEA's personnel periodically visit the plants and co-work on the design and the implementation of the innovation projects to ensure the adherence to its guidelines and goals. There is a intense and steady exchange of information and documentation between IKEA and suppliers. The big corporation provide detailed manuals and guidelines about which features the final products are required to fulfill, how the production process should be performed, which specific economic, environmental and quality target should be reached and how. Suppliers, instead, share information on the performance of their manufacturing process and their products in the shape of formal reports and informal discussions with IKEA personnel about products and processes.

> "*For each project, IKEA has some people that follow the semi-finished product, the hardware that you use and you know how you have to speak with, you discuss with them and you propose some ideas based on their specifications and objectives and they tell you what they think about*". (Environmental manager, Media Profili)

> "*We believe we can accomplish more by sharing experiences and learning from others than we could have done by working on our own*". (IKEA Group, 2009)

[1]The development of the LACK table described by Baraldi (2008) is another interesting example of a product IKEA developed jointly with suppliers.

5.2.2 The importance of monitoring and supporting in IKEA's GSCM strategy

Controlling and monitoring is an essential part of IKEA's strategy to ensure the greening of its supply chain and is performed not only on incoming products but also at the production facilities. IKEA developed a Code of Conduct, IWAY –the IKEA Way on Purchasing Products, Materials and Services – that summarizes its environmental and social requirements. The CoC represents the core of the GSCM strategy of IKEA, heavily affecting the selection process and the management of the supply relations. Figure 5.1 gives an overview of the process of suppliers' selection and maintenance based on IWAY. In order to make business with IKEA, potential suppliers have to comply with the pre-conditions indicated in IWAY that, as far as environmental conditions are concerned, requires the prevention of severe environmental pollution and safety hazards. If suppliers fulfill these and some other basic criteria – related to management, production, controlling systems, raw materials used, finance and corporate citizenship[2] – IKEA will start buying just small batches, since audits will attest that all the other requisites listed in the CoC. Whenever new or tougher requirements are introduced by IKEA, as it happen at least every second year, suppliers will pass through this process again. IKEA does not require suppliers to environmentally upgrade all of a sudden, but employs rather a stepwise approach, starting with requests of minimum environmental (and social) conditions and just after some time pretending more complex innovations at the suppliers, letting suppliers the time to adapt. The compliance to IWAY standards, together with other metrics regarding costs, quality and managerial capabilities, heavily affects the relation with suppliers. Even if not automatically, non-compliance to IWAY and to the subsequent action plan co-developed with IKEA auditors, will eventually end up with termination of business, even if all other aspects such as costs and quality are met, as happened with 10 suppliers in 2009, the 19% of the overall cessations globally.

According to the current edition of IWAY, before becoming approved suppliers, firms are required to comply with applicable laws and regulation as far as air, noise, ground and water pollution and the use and handling of chemicals and waste are concerned and to commit to reduce energy usage and any other environmental impacts from production and operations. Suppliers of solid wood, plywood, veneer and layer-glued materials are also required to obey with IWAY standards included in the forestry section, regarding mainly the traceability of wood used through FSC or similar chain-of-custody certificates. IWAY standards are embedded in the detailed product specifications that IKEA gives to suppliers.

> "*At IKEA they are great in codifying, they tell you everything you have to do: they explain to you it all. They have a team of people devoted just to handle environmental topics!*" (Environmental manager, Media Profili)

[2]See Ivarsson and Alvstam (2010a) for a detailed list of critical areas IKEA considering in the supplier's selection process, based on authors' survey data.

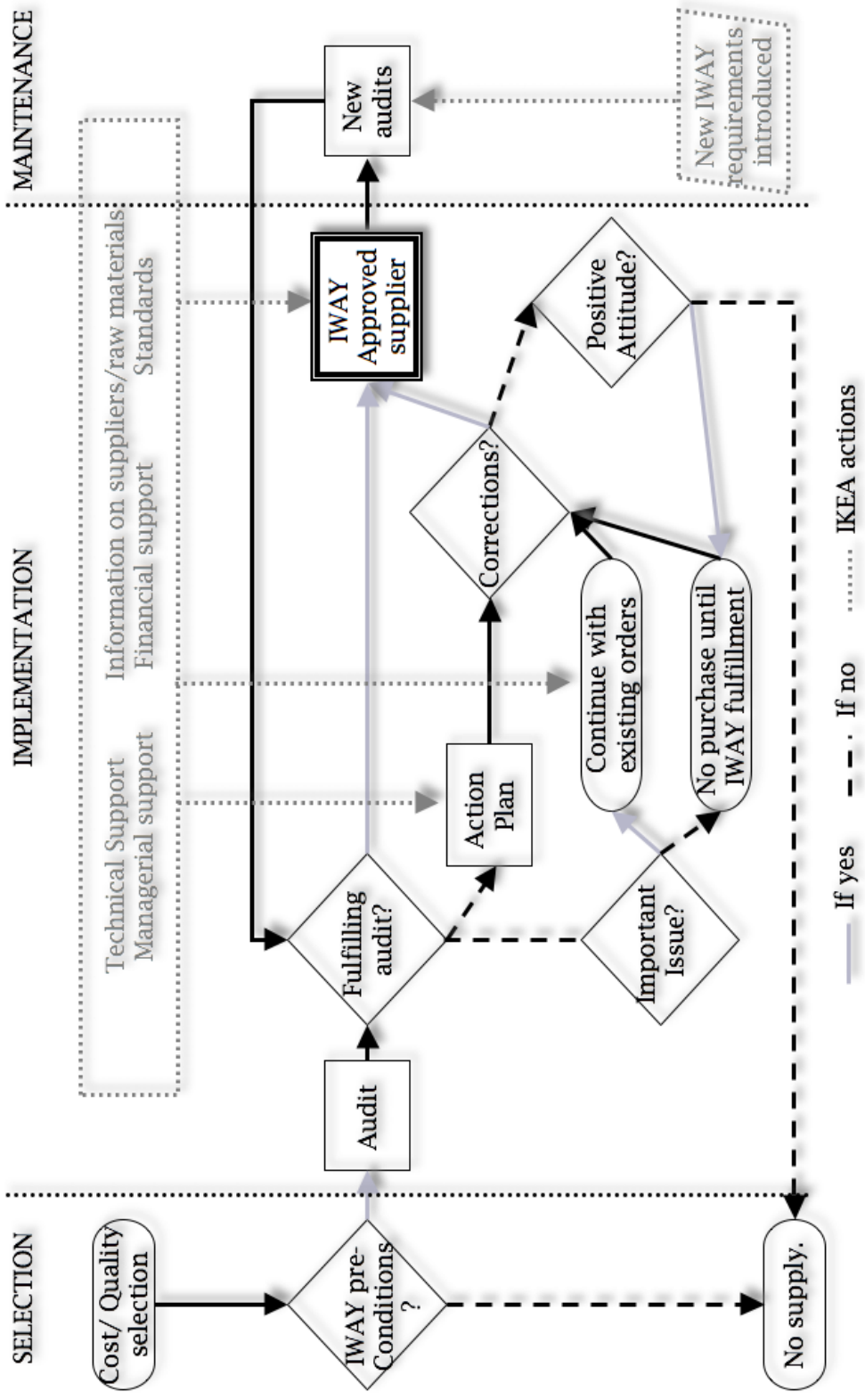


Figure 5.1: Supplier management and CoC implementation at IKEA. Source: author's elaboration based on interviews and documentary information.

> "*We give very detailed specifications about environmental characteristics of the products, and suppliers have to respect them in detail*". (Environmental manager, IKEA Italy)

Monitoring characterizes the relationships with all suppliers, even if with different recurrence. Announced and not announced audits are performed not only at the beginning of the relation, to ensure they deserve being an IKEA supplier, but also later on, both to verify the compliance to the new requirements introduced and to verify the ability to maintain the environmental levels required. The implementation of IWAY at suppliers and the monitoring of their performance are handled by the purchasing function. The purchasing function is made up by regional Trading Areas (TA) responsible for the definition of procedures and routines to implement IWAY at suppliers, encompassing 29 Trading Service Offices (TSO) that have direct responsibility to control and implement IWAY. Each TSO comprises a Purchasing Team (PT) for each material sourced and Auditors (AU), monitoring and supporting daily suppliers' performance. PT and AU are also responsible to agree on action plans in cases IWAY audits are not fulfilled. Other than through audits by IKEA personnel – that at Italian suppliers usually happen every second year – compliance monitoring is performed yearly by the supplier itself and, with lower recurrence, by third parties[3].

TSOs are not only responsible to monitor suppliers but also to increase their awareness about environmental problems, support the implementation of the CoC and train the personnel to enhance both their environmental and organizational capabilities. Similarly, part of the job of Product Developer and Technicians of IoS is to help suppliers to solve technical issues so as sometimes does Swedwood employees. In some cases, external actors, mainly consultants, exert the support to suppliers. IKEA established formal projects to transfer know-how to suppliers that accepted to collaborate, regarding energy and water efficiency and, mainly for suppliers at developing countries, to reduce pollution by waste. The Supplier Energy Efficiency Project (SEEP) is an interesting example of how IKEA's support enables the achievement of both economic and environmental benefits at the supplier, which are then spread between the two actors. Under SEEP, suppliers, like MEDIA PROFILI, are supported for free by highly competent consultants that develop ad hoc solutions together with them. IKEA offers support also on the procurement, by suggesting IWAY-certified raw materials' suppliers or other suppliers IKEA has special agreements with or by selling directly to them. IKEA serve as a supplier mainly for products and materials for which it can achieve better economies of scale and adequate quality and environmental levels than the single supplier, like plastic materials and specific semi-components (at this regard see also Ivarsson and Alvstam, 2010a).

> "*It is not true that IKEA is an evil company that just wants to exploit suppliers. They are patient, they support you [...] and they are really committed to environmental stuff: they are willing to eventually pay more to have the greener product*". (Founder and CEO, ILCAM)

[3]See Ivarsson and Alvstam (2010a) for an analysis of IKEA's auditing routines at developing-countries' suppliers.

> "*They [IKEA] proposed us the project [SEEP] and we decided towork with them on it. Of course for them is a way to make us work better and for them is important to have environmental-friendly suppliers since they are an ethic company. However, for us works well too, because they give us very good consultancy services and for free. They sent us a great consultant that I would have not known where to find otherwise*". (Environmental manager, Media Profili)

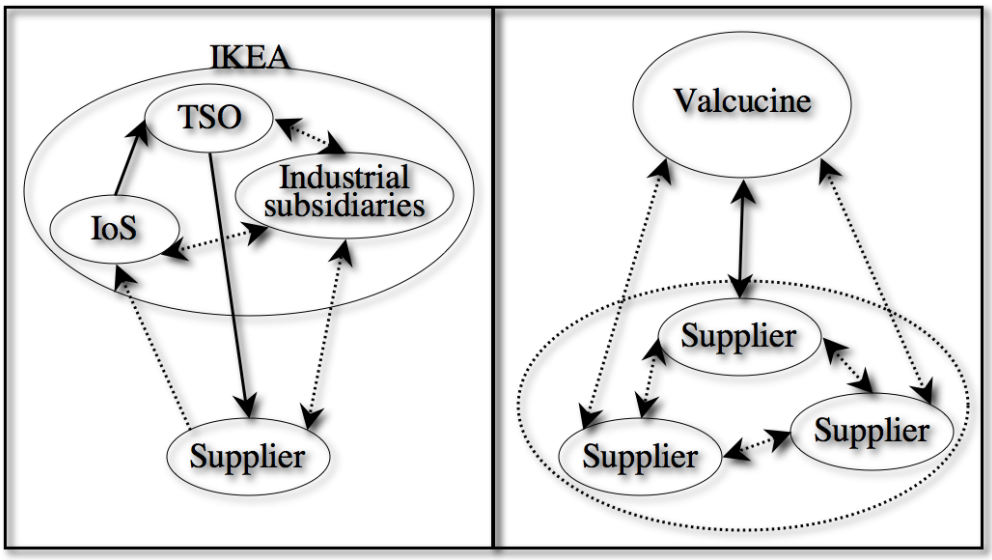
5.3 Understanding the interactions to reduce the environmental impacts along the supply chain

Even though they have very different environmental innovation strategies, structural characteristics and, more in general, business strategies (see chapter 4), IKEA and Valcucine interestingly displayed some similarities in their strategies to ensure the greening of the supply chain. The cross-case analysis enabled to identify three main constructs representing the content of the relations: collaboration on innovative activities (paragraph 5.3.1), monitoring and controlling (paragraph 5.3.2) and support to the suppliers' activities (paragraph 5.3.3).

5.3.1 Cooperation toward environmental innovations

The environmental dimension of the innovations to be introduced add to the complexity firms deal with. Other than achieving an economic advantage, e.g., reducing costs, increasing quality or enabling customization, the innovation is to be done to achieve also environmental advantages, e.g., lower emissions, lessen the use of resources or improve recyclability, restricting the practicable action space. Collaboration with suppliers proved to be very important to counterpoise this complexity and implement environmental innovations. Both IKEA and Valcucine heavily collaborate with suppliers to develop innovations. Lead firms' employees worked in harness with suppliers' R&D personnel to develop many of the new products or processes introduced, and made on-site visits. Suppliers of both Valcucine and IKEA are highly knowledgeable. Valcucine cooperates just with highly specialized suppliers, able to deal with the complex and highly innovative products requested by the Italian kitchen SME. Similarly, IKEA selects suppliers based on their proved managerial, manufacturing and R&D skills. Thanks to their knowledge on the production process, suppliers complement the capabilities of the lead firms and their R&D effort especially as far as product development is concerned, by proposing new applications to improve the eco-efficiency and addressing possible technical problems, whereas lead firms keep the responsibility for the product concept, the design and the setting of costs, quality and environmental goals. The emerging pattern can be explained not only in terms of knowledge complementarities, in line with what predicted by the existing literature, but also in terms of business strategies and features of the furniture supply chain. Design is among the most strategic functions, defining the product's positioning. This is even more true in a buyer-driven industry like furniture: given its importance for the firm's competitiveness, buyer keep design completely internalized to ensure the coherency with the firm's brand and the intended goals.

Figure 5.2: Interactions with suppliers on innovation at IKEA and Valcucine[4]. Source: author's elaboration.



Interestingly, both firms collaborate on innovation just with a sub-group of suppliers: the strategic suppliers, namely firms that are relevant with respect to the sources of competitive advantage of the lead firm. IKEA did not co-innovate with suppliers that have not already achieved its standards, even if they would be capable of, like in the case of ILCAM. Even among its certified suppliers that the company does business with since a long time, the company has a differential attitude. The analysis of Ivarsson and Alvstam (2010a) on IKEA's Asian suppliers, suggests that Italian suppliers represent the most strategic suppliers among its global suppliers' portfolio, those with which it is more likely to cooperate with for innovations that are then implemented at suppliers worldwide. Similarly, Valcucine does not collaborate with suppliers of commodity products but just with those that are strategic, considered how much they contribute to the overall environmental impact or to the overall performance of the final product.

Proposition 1 *In order to introduce innovation that reduce the impact on the environment, a firm is likely to cooperate on innovative activities with strategic suppliers, as far as product development is concerned.*

If both collaborate on innovative activities, IKEA and Valcucine differs in the intensity they do it, meaning both the frequency of the collaboration and the extent of collaborative activities. While almost all Valcucine's new products have been developed thanks to intense collaboration with suppliers, at least as far as the technical solutions were concerned, many IKEA's products are manufactured by suppliers just according to the specifications given by the Swedish group (see also figure 5.2). Even the contribution of the supplier is different, being bounded to stringent targets in the IKEA's supply chain, while more open and contingent to specific innovation projects in Valcucine. On top of that, Valcucine's suppliers are

[4]Solid lines refers to more intense collaborations on innovation, dotted lines to less intense ones.

more often involved on more phases of the innovation activities, whereas in the IKEA case often suppliers collaborate just on few, specific issues.

This difference in intensity is motivated both by differences in the size of the two lead firms and in their innovation activities. Having a much bigger organization, IKEA can benefit of a larger and more diversified pool of personnel devoted to R&D activities and on knowledge developed by its industrial subsidiaries. Valcucine offsets its smaller internal resources by heavily relying on suppliers and by organizing networks of suppliers, activated for each innovation. Differences may be explained also by referring to the different complexity in terms of products and process the company deals with, and on the type of innovations introduced. The more radical and new-to-market is the innovation to be introduced – as it is more often the case at Valcucine – the more cooperation with suppliers became important.

Corollary 1 *The amount of internal R&D resources of the lead firm and the complexity of its products and processes affect, negatively and positively respectively, the intensity of the collaborative activities between the lead firm and the suppliers.*

5.3.2 The importance of monitoring for environmental supply chains

Interestingly, in both cases firms were heavily involved in the controlling activities, in line with the theoretical approach that suggests the rising importance of monitoring and enforcing control mechanisms to ensure the effective greening along the supply chain (see the discussion in paragraph 2.2.2). Innovation activities entail necessary a degree of uncertainty, consisting in the exploration of the unknown, which calls for an additional monitoring effort than non-uncertain activities. Control mechanisms are meant by lead firms to reduce the uncertainty on the collaboration's outcomes and increase confidence in their activities (see Das and Teng, 1998). In the case of environmental innovations, the need to control is higher, both because of the credence attribute of these innovations (Darby and Karny, 1973; Reardon, Codron, Busch, Bingen, and Harris, 1999) – which is not easily controllable through simple market mechanisms – and because of the "novelty" of these innovations, for which lead firms are not confident about supplier's activities. In fact, environmental innovations still represent a frontier in the furniture industry: few suppliers already developed less-polluting technologies or equipped with the necessary machineries and production processes required by the pioneering lead firms. Even if they have very high manufacturing capabilities, interviewed suppliers very often lack on *environmental* knowledge. Environmental knowledge and skills could be defined both as technical, including knowledge on the raw materials, machinery and production process that turns into lower impacts on the environment, and managerial, encompassing the knowledge on how to handle environmental certifications and the ability to envision medium-long term strategies linked with the shift toward a low-impact production model. Because of this lower knowledge and capabilities at the suppliers' side, with respect to non-environmental innovations, lead firms may exert an higher monitoring effort.

Both IKEA and Valcucine exert a high control on products and on the production processes of suppliers. Lead firms exert products' monitoring both *ex-ante*, by giving

detailed product specifications, and *ex-post* through specific tests and auditing and third-party certifications. Furthermore, in both cases the control exerted by firms is not confined to the initial set-up of the relation with suppliers but throughout the entire relationship-time, nor consists simply of controlling incoming products' compliance but extend also to on-site visits and controls.

Proposition 2 *To ensure the greening along the supply chain firms are likely to enforce a great degree of monitoring and control both on incoming products and on the production processes of suppliers.*

In this case, it is not the *intensity* of the control that vary across the cases, but rather the *mode* in which it is exerted. The two firms analyzed show divergent attitudes toward the implementation of monitoring activities and the use of standards and environmental certifications to control suppliers' activities. In particular, it seems interesting to notice that, if both firms exert a similar control on products, they differ in the way they monitor process' performance, namely through formal or informal control (see Dekker, 2004, for a discussion of these two control mechanisms in inter-organizational relationship).

The IKEA way of controlling the manufacturing activities of suppliers has been to develop and apply its own standards. Those standards regulate both partner's *outcomes* – in the form of detailed product's specifications – and their *behaviours* – through the Code of Conduct – to use the classification of formal control mechanisms identified in the literature (see Dekker, 2004). In the effort to uniform and upgrade the environmental performance of suppliers, IKEA spent a huge effort to transform its requests into clear rules and routines and to set up an internal organization devoted to enforce and verify the application of these standards. If in IKEA the control of environmental standards takes the form of standardized requests and procedures, in Valcucine it is more informal but still very stringent. All suppliers have to undergo tests that ensure the observance of the products' specifications, and strategic suppliers are subjected also to direct monitoring and control activities on products and processes. Valcucine personnel visit their factories and adopts a "teaching and convincing" strategy, transferring knowledge on better technologies and techniques and sensitizing the personnel about environmental concerns during the frequent personal interactions. The informal or social monitoring of Valcucine enables more flexibility in evaluating what environmental impacts means at each suppliers and opens up the possibility for the supplier to improve "autonomously" its environmental performance also for different applications than those initially identified by the lead firm.

If trust is not the control mechanism of the lead firm by itself, as instead is often pointed to in the literature (see Das and Teng, 1998; Dekker, 2004), it is definitely an important part, or better a facilitating factor, of the non-formal monitoring system at Valcucine. As also Valcucine's managers explained, its strategy is facilitated by the fact that the great majority of suppliers are located in Italy, and that they are very close to Valcucine's facilities. Being Italy a country where regulation about pollution of manufacturing activities is relatively strict, Valcucine can "delegate" to public authorities the responsibility to assure the respect of minimum eco-friendly

standards, which IKEA has to perform itself since it operates also in many less developed countries. Similarly, the proximity to Valcucine guarantees the possibility to interact frequently on a face-to-face basis, perform on-site visits and leverage on trust and reputation without incurring in prohibiting costs. The fact that (strategic) suppliers are relatively few, at least as compared to IKEA's ones, is another important feature to explain the different strategy of Valcucine with respect to IKEA. The higher the number of suppliers a lead firm deals with, the higher the costs to perform an informal and flexible control mechanism. If the *internal dimension* of the firm emerged as a determinant of the intensity of co-innovative patterns, its *external dimension* affects the way lead firms control their suppliers. Furthermore, enforcing the monitoring through standards ensure the achievement of homogeneous yet basic environmental improvements at all suppliers. The more breakthrough and systemic innovations to be introduced or, more generally, the more complex the products or processes to be handled by suppliers, the more a formal way of monitoring will not be sufficient to control the performance of suppliers.

Corollary 2 *The way firms enforce the monitoring of (process) environmental performance of suppliers, namely formally or informally, is affected by the geographical and numerical size of their supplier's network and by the complexity of products and processes to be handled by suppliers.*

5.3.3 Support and knowledge sharing to enable environmental improvements at suppliers

Other than cooperating and controlling, in both cases emerged also clearly the importance of supporting suppliers in their effort, in order to foster the effective greening of the supply chain[5]. Even though they are highly competent as fas ar manufacturing and (just in the IKEA case) managerial knowledge is concerned, suppliers lack in environmental knowledge. Buyers, on the contrary, are often the actors in the chain that developed knowledge on where the higher environmental impacts are generated and how to address them, thanks both to their internal R&D resources and the possibilities to pool knowledge from different suppliers. The asymmetry between the buyer and the supplier's environmental knowledge promotes the higher demand for support, with respect to non-environmental businesses; buyers need to spur suppliers environmental capabilities in order to achieve an effective reduction of the supply chain's environmental impacts. The empirical evidence suggest that the support from the lead firm can be one-shot or ongoing and varies in intensity depending on suppliers and on the entity of changes that need to be implement. In any case, lead firms may support suppliers by providing them with knowledge on the products, the processes or organization and, less often, through financial support.

[5]The triangulation of results emerging in this empirical analysis with documentary information provides further support to this statement: Ivarsson and Alvstam (2010b,a), for example, give a detailed analysis on the importance of supporting activities for IKEA and on the typologies of support.

> "*We have helped them to change toward more environmental friendly technologies [...] but they also understood that was working.*" (Purchasing Manager, Valcucine)

Buyers' R&D employees devote a considerable amount of time working in harness with suppliers, often at their facilities, to develop new products, solve problems and give continuously feedback on products. Cooperation on common projects is the occasion for a continuous and intended flow of information and knowledge from the buyer to the suppliers. Visits emerged in both cases as another important tool to support suppliers. When at suppliers, they represent occasions to work in harness, but when at buyers, they are intended as explicit way to improve capabilities and awareness of suppliers, by teaching them specific technologies, as is the case especially in IKEA, or simply by showing best practice to sensitize them, as for Valcucine. Part of the supporting activities consists in disseminate knowledge and stimulate environmental awareness at suppliers: for many suppliers the buyer has been the first and only spur to the consideration of their ecological footprint. Therefore, they need not only to learn from the buyer about specific technical or organizational aspects of the greening but also the benefits that they may achieve and the contribution of their activities to the overall pollution levels. The drawings and the detailed specifications provided, embedding cutting-the-edge knowledge and solutions, represent another important sources of support. In more than one case, suppliers recognized their importance as source of information for innovative activities, inspiring also other products for other customers.

Financial support seems to be less recurrent, even if there have been cases at both IKEA and Valcucine, in terms of joint investments and favorable payment conditions. Evidence from the literature suggests that this form of support may be more important in less-developed countries, such as Russia (Tarnovskaya, Ghauri, and Elg, 2007a) and Asia (Ivarsson and Alvstam, 2010b,a), but seems to be less recurrent at developed countries' suppliers like Italian ones.

Proposition 3 *To enable the effective introduction of environmentally sound practice along their supply chain, firms provides suppliers with support, namely product, process and organizational knowledge or financial support.*

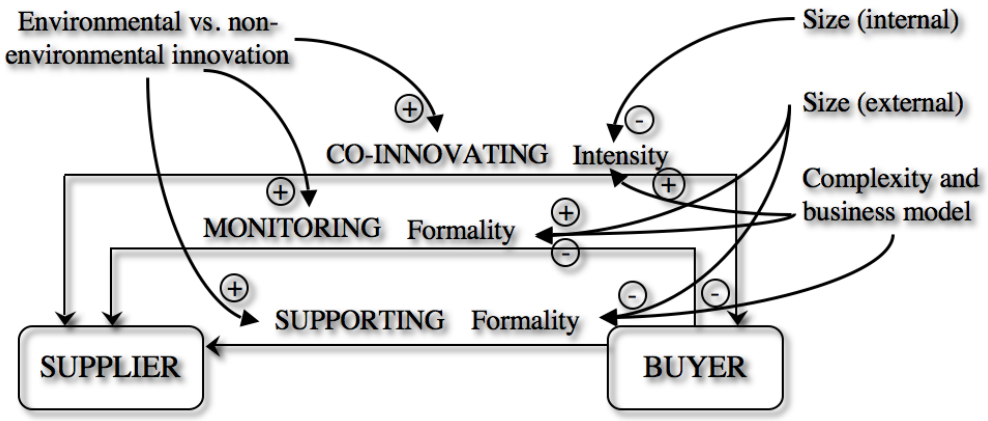
As for monitoring activities, IKEA and Valcucine not behave differently in terms of intensity but rather in the mode and in the extent of the support. In Valcucine support takes on more often the form of knowledge transfer (when it comes to environmental impacts) and even co-operation (when it comes to technical issues), whereas IKEA's support takes rather the shape of knowledge transfers from a multinational to its suppliers. If Valcucine's way is through personal relations, recurrent visits and exchanges of knowledge in a trust-based context, IKEA way is mostly based on providing documentation and detailed information. However, its support is definitely vaster than Valcucine's: in fact, it gives also suggestions on how to find low-costs raw materials that meet eco-friendly requirements, provides free consultancy aiming at enhancing eco-efficiency of suppliers and teaches how to implement IWAY and environmental certifications such as ISO14001 or FSC. The differences in the organization of the two firms, which partly explained their different

recurrence to suppliers' knowledge for innovation, accounts also for the different way they support suppliers. Valcucine's business model is based on the manufacturing of few products, which embeds many and often breakthrough innovations. On the contrary, IKEA business model is based on the possibility to gain from economies of scale linked with the production of high volumes of products, which very often undergone just incremental innovations along their very long life[6]. Because of the multiple sourcing strategy, the company can gain economies of scale by producing a formal body of knowledge to be transfer to them. On the contrary, the high number of innovations introduced by Valcucine and its low volumes do not justify the effort to codify this knowledge to be transferred to suppliers, even if the possibility to codify would be high.

Corollary 3 *The dimension of the supplier's network and the firm's business model are likely to affect the way a firm supports the greening of its suppliers.*

Figure 5.3 summarize the propositions developed so far in the analysis, indicating the impact of environmental innovation management in supply chains with respect to non-environmental one, described in propositions from 1 to 3, on the left, and the variables affecting the different intensity or modality of each construct, depicting corollaries from 1 to 3, on the right.

Figure 5.3: A visual representation of the model emerging from the empirical analysis. Source: author's elaboration.



5.3.4 Cooperation, monitoring and supporting: three pillars for leading the green change

The cross-case analysis suggests that cooperation with suppliers is important to the development and introduction of innovations, given the knowledge complementarities between suppliers and buyers. Furthermore, the study provides support to

[6]The "Lack" table, whose innovation process was described by Baraldi (Baraldi and Waluszewski, 2007; Baraldi, 2008), is an interesting case in point. This table, introduced in 1981, undergone since then several (environmental) innovations to reduce its production costs by de-materializing and using different raw materials and coating systems but its design remained constant since then. More than 2.5 million units of this single table are sold yearly worldwide.

theories asserting the great importance of monitoring to enforce environmental behaviors of suppliers, because of the increasing complexity and the credence features of low-polluting characteristics. Similarly, the analysis highlights the importance of lead firms' support to suppliers, remedying for their lack inenvironmental knowledge through on-site visits, detailed documentation or personal interactions. The existing literature already addressed each of these concept, but separately (see discussion in paragraph 2.2.2). The empirical evidence emerging in this chapter suggest, instead, that firms do not implement those efforts by themselves: cooperation, monitoring and supporting are rather co-existing and complementary. The fact that this is the case both of the multinational that is concerned about standards and measurable performance and of the small producer relying on the interaction with a network of small but highly-specialized suppliers strengthens the emerging evidence, even if in the two companies these three constructs are mixed at a different degree.

> "*Many ideas for design and product development are born on the factory floor when IKEA co-workers are on-site [at suppliers], and this close relationship opens up for frank and honest dialogue also about more difficult topics related to environmental and social issues.*". (IKEA Group, 2009)

> "*Rather than controlling, we implement forms of collaboration. We do not present ourselves as controllers, but when we go to make audits it is always a way to grow together, we make some requests but if they not comply we do not kick them out*". (Environmental manager, IKEA Italy)

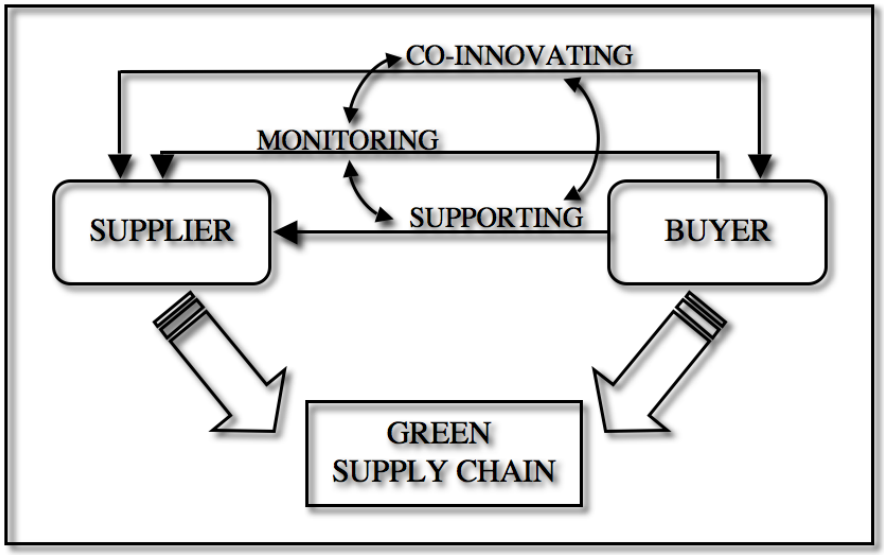
> "*The collaboration, the partnership we establish with suppliers is meant also to make them grow*". (Environmental manager, IKEA Italy)

Cooperation for the introduction of new products or processes does not reduce the need for controlling the activities of suppliers: the higher the novelty for the supplier's activities, the higher the need to control if it is in line with the buyers expectations. If this is valid for every innovation, it is even more important for those aiming at reducing impacts on the environment, other than targeting other economic goals. Being a frontier for the industry, in which suppliers have low knowledge and which is difficult to evaluate because of the credence feature, developing environmental innovations spurs, at the same time, the importance to work in harness for innovation and to monitor more intensely supplier's activities. Also supporting activities appear to be very linked with co-innovation and monitoring. The narrative suggests that co-innovation and monitoring are occasion for the firms to support suppliers. Working in harness with them on innovation is a deliberate strategy to support them, which results in transfers of knowledge and joint problem-solving. Giving suppliers detailed product's specifications and process' standards, other than being at the core of the monitoring effort, represents also a "roadmap for sustainability" for them. The implementation of each of the three practices opens up the space for the others and is a necessary complement for their effective implementation. IKEA's interactions to monitor and implement the Code of Conduct open up the space for the co-development and introduction of innovations,

especially as far as the production process is concerned, and the related continuous exchange of information and knowledge put the premises for the development of reciprocal knowledge and trust and ease the monitoring activity. Valcucine's employees, while visiting suppliers to work with them on innovations, verify also their production process' environmental performance, suggest improvements and increase their awareness on environmental problems. In the Valcucine case, it seems that it is more often co-innovation that ensure also supporting and monitoring, whereas for IKEA is rather the effort to monitor and control suppliers that extend info forms of cooperation on innovation and support. In other words, it seems that those "positive externalities" between the three constructs are often beginning mainly from the one which is more prevalent in the case, but further research should be perform to understand which factors affect the directions and the intensity of the interaction between the three. Figure 5.4 depicts the interactions between the three constructs identified through the empirical analysis.

Proposition 4 *To foster environmental improvements along the supply chains the firms engage in all the three following activities: i) cooperation on innovation, ii) monitoring and iii) supporting.*

Figure 5.4: A model to understand the nature of the buyer-supplier interaction to green supply chain. Source: author's elaboration.



5.3.5 On the importance of long-term, network relationships for the greening

Implicit in the analysis performed above is that, in order to effectively reduce the impact of the supply chain on the environment, lead firms engage in deep relationships with suppliers, rather than market-based ones. Also an economic justification support this evidence; to engage in monitoring, supporting and cooperating activities is not cost-free for lead firms. These "greening costs" represent additional costs with respect to the management of supply relations that not consider environmental

impacts, which may absorb many of the lead firms' resources. Employees at IKEA and Valcucine spent a considerable amount of time working together with suppliers to develop new products, monitoring their environmental performance, teaching them how to implement new processes or achieve standards and certifications. In IKEA, much of this effort is linked with the implementation of IWAY: many resources have been devoted to develop it and other are continuously employed both to effectuate it at suppliers and to improve it to further lower environmental impacts. In Valcucine, instead, the most substantial costs are linked with the time spent to interact with suppliers to develop innovations.

In both cases, the effort to contribute to suppliers' innovative activities, ensure about their environmental performance through monitoring, and supporting their development represents a powerful *switching cost* for lead firms. According to the literature, those costs are sunk costs arising with relation-specific investments that represent a strong incentive for a firm not to change its suppliers (Williamson, 1975; Katz and Shapiro, 1994). To minimize those costs, firms have the incentive to engage in long-term, complex relationships with suppliers as opposed to coordinate their supply chain through simple market-based coordination mechanisms.

> "*We work in long-term partnerships on a par with suppliers, which are based on shared standards and on collaboration. We do not go to the market to find the lower price with on-line auctions like many other companies do. We go to a supplier and tell "we have to produce this thing with these characteristics, you should be oriented this way" and we try to work together to gain the highest efficiency, have a good product and maybe we even develop it together in details to have even higher efficiency*". (Environmental manager, IKEA Italy)

> "*With suppliers we have a very deep partnership. Being them suppliers that have long-term collaboration with IKEA we can work together in a very integrated manner*". (Environmental manager, IKEA Italy)

> "*We know each other very well since a long time. [...] They are our partners, some of them we could say that are friends!*" (Purchasing Manager, Valcucine)

> "*We know everybody at Valcucine, it is like a family! [...] They do not act as they are superior to us: when they have a problem they rely on our competencies, there is trust, they know that we do not cheat*". (R&D manager, Eureka)

However, to engage in deep relationship with each and every supplier will be too costly, especially for lead firms that outsourced so many activities. For this reason, both lead firms concentrated their effort toward a sub-group of the overall suppliers, the strategic suppliers, with whom they develop long-term partnerships[7]. This is

[7]For an external confirmation of the differential attitude of IKEA toward some suppliers see also the paper by Baraldi (2008). He reports that with the majority of suppliers there are "deep and established relationships" based on mutual benefits but just with some of them, which represent important sources of innovation, there are more complex, long-term relations governed by trust.

true not only for co-innovation activities, as was already discussed in paragraph 5.3.1, but also for the monitoring and supporting. If the achievement of minimum levels of environmental performance is required to all suppliers, the development of more complex innovations and the implementation of more advanced environmental supporting projects regard just this sub-set of suppliers. In Valcucine, those strategic suppliers are also subjected to deeper control and monitoring activities with respect to commodity suppliers. In addition, IKEA reduced the number of suppliers it deals with, to keep low the "greening costs" to ensure the uniform achievement of a minimum threshold of environmental and social performance across all suppliers. In little more than 10 years it halved its suppliers while increasing of more than 20-times its turnover (recall the discussion in chapter 4.1.2). Andersen and Skjoett-Larsen (2009) named this move from arm's length to more complex and long-lasting relations a passage from "from trading to purchasing". Interviews with IKEA's personnel and documentary evidence (see Reichert and Larson, 1998, Andersen, 2005 and Andersen and Skjoett-Larsen, 2009) suggest that the decision to concentrate increasing volumes on a smaller number of suppliers – which began in the late 90s, contemporaneously to the development of IKEA's environmental strategy – was at least partly motivated by the willingness to implement better environmental performance at all suppliers.

Proposition 5 *In order to pursue the reduction of environmental impacts at suppliers, lead firms are likely to rely on deep and long-lasting rather than arm's length relationships.*

5.4 Conclusions

Academic and practitioner literatures are converging in moving their focus from the analysis of environmental impacts at the firm level toward the supply chain level. The literature so far has focused on the importance of i) collaboration between buyers and suppliers to achieve the successful implementation of new products or processes at the suppliers and more generally the reduction of their environmental impacts (Geffen and Rothenberg, 2000; Vachon, 2007), or of ii) monitoring and enforcing environmental specifications at suppliers by the mean of Code of Conducts or by imposing the use of specific certifications (Andersen and Skjoett-Larsen, 2009; Houe and Grabot, 2009; Yang, Lin, hui Chan, and Sheu, 2010). Investigating GSCM strategies at two very different firms, in this chapter I contribute to this discussion considering both these aspects of GSCM at a time. In particular, I specified a theoretical framework on how firms interact with suppliers to effectively foster a production model that reduce the impact on the environment. The results emerging from the comparison of the case studies suggest that firms engage in i) cooperation on innovation, especially as far as product development is concerned, ii) direct monitoring activities, or by the mean of standards and code of conducts that guarantee uniform yet basic environmental performance at suppliers, or by more informal mechanisms based on personal interactions, and iii) supporting activities, by disseminating knowledge or even offering financial support. Differently from the previous studies, which considered these constructs separately, my results show

that they co-exist within the strategies of firms. Furthermore, results point to the shift-away from governance structure based on arm's length relations to the advantage of network forms of relationship with suppliers.

The fact that results are consistent both for the case of a small producer of high-end kitchens embedded in an industrial district context and for a multinational managing relations with big suppliers all over the world to produce low-cost furnishings, enhances the power of the emerging framework and suggests the possibility to generalize results to other low-tech manufacturing industries in which buyers play a key role in leading the coordination of activities within supply chains. However, further research need to be performed in order to test these results on a broader context – e.g., testing them on more cases and verifying commonalities or differences with producer-driven industries or in other geographical contexts – also by the mean of other research methodologies such as quantitative analysis. Furthermore, there is the need to investigate the differences in the way firms coordinate the greening of their supply chains, and explain the conditions under which one strategy may be more effective than another, which will be the focus of next chapter.

Chapter 6

Which governance for the greening of value chains? Insights from the furniture industry

In the previous chapters, I analyzed the environmental innovative effort of IKEA and Valcucine and specified a framework for how they interact with suppliers to reduce environmental impacts. As discussed in paragraph 2.1.2, this chapter aims at contributing to the literature by considering the value-chain rather than just the buyers as the center of the analysis, and by analyzing the way activities are governed for the greening. Leveraging on the GVC framework, I will focus on each of the main object of the GVC analysis (see paragraph 2.3.3): i) the suppliers, understanding costs and incentives to pursue environmental innovative strategies and the impact of the buyer on their activities (section 6.2); ii) the lead firms, focusing on the tools they may use to ensure environmental improvements along the value chain, beyond first-tier suppliers (section 6.1) ; and iii) the governance structure for the greening, understanding which are the key determinants of green VC configuration patterns (section 6.3).

6.1 The tools for firms to lead the greening of their value chain

Which tools can firms employ to lead the desired reduction of environmental pollution along its value chain? The cross-case analysis suggests that there are three main mechanisms that firms use, at different degrees, to ensure the improvement of the environmental performance along the supply chain: supplier selection, standards and certifications and design. Many contributions in the GSCM has discussed these tools, mainly focusing on each at a time. Contributions on suppliers' selection have identified methodologies to consider environmental, economic and more recently also social factors in suppliers' selection criteria (see e.g., Bai and Sarkis, 2010), focusing implicitly mainly on how to select *new* suppliers: but what about the *existing* suppliers, suppliers the firm was already making business with when decided to implement its green supply chain strategies?

Similarly, also design has been already identify as a key function firms can leverage on to reduce the ecological footprint along the supply chain, through the application of LCA approaches or by enhancing product recovery and remanufacturing possibilities (see Srivastava, 2007, for a literature review). If those contributions has a focus mainly on the technical aspects of design with respect to the reduction of the impact on the environment, in my analysis I focus on its implications on inter-firms management.

Supplier selection (and development)

Supplier selection consists basically in including a minimum threshold the supplier has to fulfill before making business with a lead firm. The cross-case analysis displayed the existence of two different ways to enforce this threshold: the formal approach of IKEA (see paragraph 5.2.2) and the personal-based approach of Valcucine (see paragraph 5.1.2). The IKEA way to select new suppliers is embedded in its code of conduct, which identifies start-up requirements and is a pretty routinized process, as Figure 5.1 shows. To make business with IKEA is essential to achieve environmental certifications such as ISO14001 and put in place a system to control the provenience of the wood. When selecting new suppliers, the company looks not only for suppliers that already have those certifications but that in general have an organizational structure that can enable the achievement of those and more complex requirements. Conversely, Valcucine does not include formal environmental specifications in the supplier selection process but prefers suppliers that have higher environmental awareness, if any.

The more lead firms is willing to introduce new-to-market innovations, which may ensure a sustainable competitive advantage, the more it will be difficult to find suppliers that already deal with the needed low-polluting technologies, while having also the required quality, costs, flexibility and organizational capabilities. Therefore, to overcome this scarcity lead firms rather keep the existing suppliers and invest in the *development* of their environmental capabilities, *supporting* suppliers (see Paragraph 5.3.3).

> "*New suppliers are selected based on an expanded list of start-up requirements. This helps us to select suppliers that share our values and who want to grow and develop together with us. This in turn will further strengthen our long-term relationships with our suppliers.*". (IKEA Group 2009)

> "*We have some guidelines for purchasing. Sustainability is among them. But there is also quality, service, and price to be considered. [...] We look for green suppliers, if there are any [...] but not for all products it is so important.*" (Purchasing Manager, Valcucine)

As far as Valcucine is concerned, the only supplier that was selected because it already had environmental-friendly products was ELECTROLUX. The other suppliers were selected based on personal knowledge (BIESSE CREA) or for their quality and innovation capabilities (ABET LAMINATI and EUREKA) and their environmental performance was developed afterwards. As far as IKEA is concerned, MEDIA-PROFILI and ELECTROLUX had already achieved many of

the standards required by IKEA before making business with it, while ILCAM had just some, developed for other customers (FSC), but had to implement many organizational and process changes before becoming a full supplier of IKEA. Finally, FRIULINTAGLI, the "oldest" supplier among the interviewed ones, incrementally reduced its environmental impacts just thanks to the relation with IKEA. Overall, apart from ELECTROLUX that has already achieved the highest environmental standards, all the other suppliers had no the needed environmental performance when selected, but they developed with the buyers.

Standards and Certifications

Another tool for lead firms, just partly overlapping with the previous – suppliers selection – and the following – design – is that to rely on standards and certifications. Those standards can be internal to the firm, like in the case of IWAY, or can be managed by third parties, such as the FSC certification. They are useful to the lead firm both to leverage on final customers about environmental feature of the product and to ensure that all suppliers reach the same performance. Despite their doubtlessly usefulness, standards and certifications ensure just the achievement of "base" level of environmental performance. This is not to mean that firms does not have to put a great effort to achieve or maintain them but rather that, being standardized, they often cannot include nor stimulate "non-standards" improvements. This proved to be a key obstacle for their application by Valcucine, which complained their narrow way to "define" and "measure" environmental-friendliness (see paragraph 5.1.2). Being it highly innovative, in the majority of the cases it is beyond the threshold fixed by those certifications, therefore privileging innovative and quality capabilities at suppliers, rather than their ability to achieve those certifications.

Both Valcucine and IKEA rely on the FSC certification, guaranteeing about the provenience of wood. This commonality suggests firstly, that the traceability of wood is perceived as an important environmental issues within furniture value chains and secondly, that is one of the few raw material for which it exists a third-party managed auditing system that is considered reliable, as emerges also triangulating evidence from interviews with experts and documentary information.

It is interesting to notice that some of the standards and certifications, such as FSC, IWAY and partly the ISO14001 requires suppliers to be responsible for second-tier supplier' environmental performance, therefore expanding the scope of these tools beyond first-tier relationships. FSC, for example, requires the traceability of wood from the forest to the final product and that each actor in this chain is FSC certified, in order for the final product to be certified.

Product design and specifications

Design proved to be a powerful tool that lead firms explicitly use to influence environmental performance along their value chain. Through design, they can achieve the reduction of the environmental impact at the suppliers, even without the need for their direct contribution. The example of the dry-manufacturing process enabled at EUREKA by Valcucine's design, reported in paragraph 5.1.2, is emblematic in this sense. Lead firm's design allow to reduce material and energy

use along the value chain (e.g., the reduction up to 80% of materials used to produce Valcucine's doors and worktops), and to boost input environmental innovations (e.g., the substitution of PVC with less toxic materials as emerging in ILCAM and MEDIA PROFILI). Embedded in the product specifications, sustainability "travels" along the value chain, enabling first and second-tiers suppliers to reduce their impact on the environment. Especially IKEA's suppliers reported that specifications represented also a key source of (environmental) knowledge transfer from the lead firm. In fact, they summarize not only *which* are the levels to be achieved but also, very often, *how* to achieved them, being very detailed.

> "*Since we own our brand, we can decide what we want about environmental performance of products, regarding raw materials and the characteristics of suppliers so it is easier [to obtain that they meet your environmental requests]. Companies that buy on the market have to adapt to what suppliers impose them [...]* ". (Environmental manager, IKEA Italia)

6.1.1 On the importance of internal knowledge to enable the greening of the value chain

Valcucine and IKEA's internal knowledge emerged as a key enabling factor to ensure the effective development of each of the three tools. Sustainability issues are not easy to deal with and include often trade-offs, both in terms of different impacts on the environment, e.g. a raw material that use less energy to be produced vs. one that is recyclable, and in terms of environmental-economic trade-offs, e.g., an environmental friendly technology that yield lower quality or higher costs. In order to deal with the complexity of sustainability efficiently and efficacy, firms should have knowledge i) on the environmental impacts along its VC and ii) on the technology to manufacture their products. The first is essential for the firm to understand where to focus its effort, the second is key to develop a product design that enable the reduction of the impacts on the environment. Extensive knowledge on all the steps of the value chain enables the firms to set costs, quality and environmental goals that suppliers can achieve, to give them the needed support and even to effectively cooperate on innovation[1] The existence of a set of knowledge and competencies on this issues within the lead firms encourage also its ability to learn further from suppliers or any other external partners.

> "*We go to our supplier and we try to learn their technology, then we mix their technological knowledge with our creativity and our competencies, which are important too. Because we can see more than our supplier: we know the technology to work glass, aluminium, wood, and we can put them to work together to develop new technologies*". (R&D manager, Valcucine)

Not only technical but also managerial and organizational capabilities proved to be important to boost environmental innovation and reduction of pollution along

[1] On the importance of technical and organizational competencies in IKEA to enable cooperation on innovation with suppliers and the development of new products see also the analysis of Baraldi (2008).

the VC. Interviews revealed that the internal capabilities of Valcucine have been very important to enable the development and the well-functioning of networks of suppliers to develop innovations. Similarly, IKEA's internal structure proved to be key to manage suppliers for the purpose to achieve low costs and reasonable quality together with low environmental impacts. This results may be read as an evidence of the importance of the *absorptive capacity* – meaning the importance of the internal knowledge and the internal effort to leverage from external source of innovation (Cohen and Levinthal, 1990) – to explain the ability of lead firm to reduce environmental impacts along the VC. This evidence complement results emerging in chapter 1, in which internal R&D displayed a substitutive effect with R&D cooperation, by suggesting that cooperation suppliers may actually be complementary with the internal effort when it come to suppliers[2].

Environmental knowledge at the lead firms analyzed is not necessarily deputed to a specific department but is diffuse within different organization's units, confirming the theories asserting that, in order to successfully implement environmental strategies in supply chains, each and every aspect of the business activities have to be involved (see e.g., Andersen and Skjoett-Larsen, 2009). In Valcucine, environmental knowledge is held by R&D officers but also by the product development and the purchasing and marketing units. Similarly in IKEA environmental knowledge is diffused both within the design department (IoS) and within the trading departments (TSO), responsible for the implementation of the CoC at suppliers and for their support. Similarly, technical knowledge about environmental issues is present also within the industrial subsidiaries of the group, which held an expertise on wood products that is often shared with suppliers (at this regard see also Ivarsson and Alvstam, 2010a).

6.1.2 Beyond first-tier suppliers

Acknowledging the complexity to control and ensure compliance further the value chain, yet its strategic importance for their environmental strategies, both lead firms are extending their direct influence by directly engaging in the monitoring and influencing of second-tier suppliers. However, if it is difficult that suppliers control their sub-suppliers – also because they may not perceive the importance of environmental compliance the same way the lead firm, which has a brand to preserve, does – it is even more challenging for lead firms, which have less managerial levers to influence their activities. For them it is even difficult to know who second-tier suppliers are and. Their exponential number makes it difficult to influence each of them. The cross-case analysis suggest that to boost environmental improvements along the VC, lead firms i) involve first-tier suppliers in their effort and create incentives for them to influence their own suppliers, and ii) engage in direct interactions with "strategic" sub-suppliers.

First-tier suppliers are in charge to "guarantee" about the respect of minimum environmental standards of their suppliers, as codified in the product specifications.

[2]It is worth recalling that that analysis did not distinguished the typology of partner involved when considering the relation between cooperation and R&D, not to understand the depth of the relation not the depth of the green innovations involved.

IKEA specifies that their responsibility is that to "ensure that their sub-suppliers acknowledge, understand and accept the IWAY requirements" (IKEA Group, 2009), a responsibility to *inform* rather than *directly control* the production activities further the value chain. Suppliers usually deal with this duty easily, simply pretending the respect of product's specifications, requiring to their suppliers certifications of conformity and testing incoming products. In this sense, environmental requirements simply add to the business habit of requiring paperwork, by asking for additional certifications and tests, however just on the products and not on the processes of sub-suppliers.

> "*Everybody in the chain, also our suppliers, benefits from working according to the [environmental and quality] standards required. If you cheat, they'll catch you. The large-scale retailers like IKEA have an organization that is devoted just to control, so you won't get off scot-free*". (Environmental manager, Media Profili)

Overall, suppliers are in charge to perform the *product monitoring*, and, thanks to the incentives created by the lead firm, they may *cooperate on innovation* to create new products or improve their process, to reach lead firm's objects. However, it is the lead firm that takes on the responsibility to influence the *production processes* along the value chain, engaging on innovations, monitoring or supporting their change. Because of their high number, lead firms focus their direct effort just toward those sub-suppliers that are potentially most harmful to the environment or that are more important in terms of contribution to the final product. For example, IKEA heavily focused on wood, which was perceived as one of the most important environmental issues. The establishment of Swedwood was partly due to the willingness to secure the supply of FSC certified wood – which at that time was still very scarce – for its producers. Furthermore, the group engaged with NGO such as WWF and Rainforest alliance to increase the availability of certified wood, and developed a specific unit, the "wood supply function", "to support selected wood-suppliers in developing efficient and sustainable supply strategies" (IKEA Group, 2009).

Valcucine's way to influence environmental activities further the VC, is that to cooperate on innovation, finding sub-suppliers that suits its requests and working in harness with them and its first-tier supplier to develop new products (recall, for example, the water-borne varnish developed with BIESSE CREA, OECE and TECHNOSPRAY, described in paragraph 4.3.5). IKEA, instead, does mainly interact with them in terms of monitoring and controlling. IKEA considers two typologies of second tier suppliers: i) Original Equipment Manufacturers (OEM), which produce semi-finished products for the suppliers and ii) raw-material suppliers. IWAY standards are applied to the first typology of sub-suppliers, even if its enforcement differs from first-tier ones in terms of recurrence, since they are audited at a lower rate. Similarly to Valcucine, it does not affect or monitor the activities of the second type of suppliers other than requiring to its suppliers to purchase raw materials that comprise specific environmental characteristics (e.g. FSC wood). However, it directly involves in the sourcing activities, by proposing to suppliers to buy from a set of "preferential" sub-suppliers, which IKEA has agreements with, or

from IKEA itself[3]. In IKEA's eyes, this strategy not only enables a higher control on the environmental features of the supplied products, but consists also in a form of support for suppliers to achieve its environmental goals. If suppliers want to buy from their existing source, in fact, they have to ensure the compliance with the many standards requested by IKEA.

Despite the IKEA's environmental manager proudly described this effort on the Swedish group side, few of the suppliers interviewed did changed their suppliers with those suggested by IKEA. When they did, it was mainly for non-strategic products (e.g., pallets made of recycled plastic), partly because they had already identified suppliers willing to work accordingly to the standards and specifications of IKEA before it formally develop this procedure (e.g. FRIULINTAGLI) or because they had already access to "environmental" raw materials (e.g., FSC wood for ILCAM and MEDIA PROFILI). This evidence points to the limitations of the action of the lead firm: even if it puts great effort in directly influencing the entire value chain, its endeavor may be broken down if not complemented by the first-tier supplier's effort[4]. However, the majority of IKEA's suppliers asserted that IKEA action was very powerful in improving the attention toward environmental issues in the entire market, increasing the ease for them to find raw-materials and components that respected its basic requirements.

> "*Now is easier for us, because all the chain has moved [toward a more environmental-friendly production]*". (Entrepreneur, ILCAM)

To sum, both lead firms directly involved in direct activities with second-tier suppliers. For non-strategic activities, they rely on (first-tier) suppliers controls, leveraging on the "design" and the "standards and certifications" tools to indirectly influence second-tier markets. When it comes to strategic-activities, Valcucine's way to influence sub-suppliers' activities is mainly to cooperate on innovation, whereas IKEA monitor and control their performance by enforcing standards and certifications and by directly influencing the sourcing activities of its (first-tier) suppliers. Its influence on second-tier markets is broader and more intense than Valcucine's but the evidence suggest that even this approach is can be broken down.

[3]It is interesting to report in this setting an evidence emerging from visits to fairs and conferences. In fact, I found component-producers, which displayed the IWAY certification among the certifications they achieve, such as ISO14001 or ISO9001. When asked about the reason why they reached IWAY standards some of them reported that they actually were not yet IKEA's sub-suppliers but they passed through the IWAY certification process on the purpose to "enter that market". In my opinion this evidence well epitomize the ability of IKEA to influence its second-tier markets, thanks to its high volumes but also to its ability to crystallize environmental best practice into standards.

[4]Another possible evidence of the limitations in the influencing activity of second-tier suppliers emerged in the analysis of EUREKA. The interviewee reported that indirectly working for IKEA did not affected their routines. This evidence could also be interpreted as the fact that IKEA's environmental requirements, at least in non-core industries such as aluminium manufacturing, are not more stringent than what competitive suppliers in a developed country are already doing.

6.2 Supplier's costs and incentives to reduce environmental impact

6.2.1 The costs of greening the production process

If by now the analysis has focused mainly on the effort exerted by lead firms to influence the activities of their suppliers, also the effort at the suppliers to reduce their environmental impacts need to be taken into account to fully understand the dynamics of greening of supply chains. Often, they face high costs when accepting to work with buyers to develop less polluting products or processes. These costs consist in i) physical investments to change equipments and existing machinery, ii) costs for the implementation and maintenance of managerial systems and iii) cost to develop new products.

From the cross-case analysis it emerges that many IKEA's suppliers have been substituting the existing *equipments and machinery* in order to improve their eco-efficiency, even before they reached their end-of-life. IKEA did not impose suppliers to buy specific machineries but required eco-efficiency improvements that are better achieved through the acquisition of new equipments, and, in many cases, supported the selection of new machineries through its supporting activities. Interviewees reported that these investments were not idiosyncratic to IKEA: they allowed to reduce operational costs or to satisfy also other customers. Among the most recurring investments in equipment and machinery are:

- the substitutions of the existing boilers with more efficient ones, which enables to lower emissions and recycle chips – waste from the production process;
- the acquisition of photocell-equipped machineries that enable to reduce the energy consumption by ensuring that machinery works just when needed;
- the substitution of machineries' engines and of the existing lighting systems with more energy-efficient ones;
- the optimization of the internal logistic systems;
- the change or adaptation of the machinery in order to meet new product specifications, like the use of water varnishes (ILCAM), the substitutions of solvent-based glues with polyurethane-based ones or the substitution of PVC with polyethylene or similar materials, more expensive but less polluting and toxic (MEDIA PROFILI).

As far as Valcucine is concerned, just BIESSE CREA reported the necessity to invest in machineries in order to adapt to specific requests of the lead firm, which was very challenging because of the few resources of the firm and because, at that time, it faced pressures for environmental improvements just from Valcucine.

Suppliers often face high *administrative costs* to achieve new managerial systems and environmental certifications, including costs to set them up, to maintain them, to train the employees. To meet IWAY standards, IKEA suppliers have to adapt its organization accordingly, by implementing complex performance-measuring systems, enabling the traceability of raw materials and performing the audits required by IKEA. To be in business with IKEA, firms' have to have the ISO14001 certification: in some cases (FRIULINTAGLI and ILCAM) it has been achieved just to fulfill

IKEA's requests, in other cases (ELECTROLUX and MEDIA PROFILI) it has already been achieved before starting business with the green giant. Furthermore, both IKEA's and Valcucine's wood suppliers had to learn how to deal with Chain of Custody systems to get the FSC certification and maintain it, which is costlier the less volumes the firm has.

Last but not least, suppliers face *R&D costs*, namely the costs to develop new products or processes that meet buyer's requests. In the Valcucine case, those costs are particular important. Especially BIESSE CREA and EUREKA reported of a long trial-and-error process, which required R&D officers and technicians to spend a considerable amount of time to those projects.

> "*We are a tough company to work with. Many suppliers decided to gave up with us: they were fed up with all the continuous requests, modifications, disputes we had about new product development!*" (Purchasing Manager, Valcucine)

> "*It is not easy to work with us, yet it gives satisfaction*". (R&D manager, Valcucine)

In sum, it seems possible to affirm that costs suppliers face to adapt to environmental requests of IKEA are linked mainly to physical equipment and to the organization, whereas costs faced by Valcucine's suppliers are mostly linked with time to be spent for the development of new products, what I named R&D costs.

6.2.2 The importance of incentives

To adapt to the lead firms' requests, suppliers need to make costly investments, more or less idiosyncratic to that specific buyer. So, why do suppliers obey to these requests? In the GVC framework, the possibility for lead firms to achieve their goals is often explained in terms of power asymmetries, which could simplistically be explained as the result of the comparison between the dependency of the supplier from the buyer in terms of share of the overall sales, and the dependencies of the buyer on the supplier in terms of competencies (see Sturgeon, 2009). However, as far as this contribution is concerned, it seems more appropriate to refer to a costs-incentives structure. From interviews, it emerged that the possibility of a win-win situation for both the buyer and the supplier, rather than power, was a key motive for the alignment to buyers' requests. In other words, the ability of firms to make suppliers reduce their environmental impact it was not to impose it to them rather to make them understand the benefits that they could gain[5].

> "*[We convinced them to introduce environmental innovations because] we make our name weights upon them but also, what we ask can be useful for them too [...] they can see the utility that this would have for them*". (R&D manager, Valcucine)

[5]See also the analysis of Tarnovskaya, Ghauri, and Elg (2007a), in which emerges the importance of the motivation of IKEA's suppliers to enable a more proactive approach toward the improvements of environmental and social performances

> "*Our customers are part of large-scale retailers and are very sensitive as far as sustainability is concerned and they are used to involve also their major suppliers on those topics. So we have been trained and we understood that other than reducing the impact on the environment, that is very important, there was an economic advantage for us too*". (Environmental manager, Media Profili)

> "*We became sensitized to environmental topics since we got contacted by our customers: the willingness to work in a more eco-efficient way started also thanks to our customers, since they made us aware about it, they showed us how they were working, and we believed that this way of working was valuable. IKEA does not tell you "or you change or you are out". They give you suggestions, and they show your what are the advantages for you*". (Environmental manager, Media Profili)

Except for few cases (like the methacrylate products at MEDIA PROFILI), suppliers of both lead firms reported that working for them did not enabled higher margins than competitors, but suggested the importance of other incentives that I named *transaction-specific* or economic incentives, i.e., volumes and secure demand, replication or *replicational* or strategic ones, namely learning and reputation, and *supporting* incentives, i.e., market or legislative trends.

A first typology of *economic incentives* regards the high *volumes* that firms enables: except for ELECTROLUX and ABET LAMINATI, more than half of the overall production of the interviewed suppliers is devoted to IKEA or Valcucine (see Table 3.2). Those suppliers seems to be more prone to accept led firms' requests. The possibility to fill the production lines or to improve the production capacity proved to be a key benefit for the collaboration especially as far as IKEA suppliers are concerned. Not just the *size*, but also the *recurrence* of the transaction proved to be an important incentive. Both Valcucine and IKEA's suppliers declared that they were persuaded to make investments to satisfy the environmental requests of the lead firm because its demand was secure, i.e., not market-based but within a long-term relationship.

> "*IKEA is our partner, we grow together. [...] If you decide to invest in them [depending on them for a big share of your revenues] they invest in you too. You know you are in a relationship and you can make investment because you know they are going to buy from you for a long time*". (Environmental Manager, Friulintagli)

As far as what I named "replication" or "strategic" incentives are concerned, the possibility to *learn* how to deal with environmental concerns or other innovations was named as a key motivations for suppliers to engage in the development of environmental product or process innovations. For some companies, to cooperate with those lead firms was explicitly meant as a way to learn how to deal with environmental topics. IKEA and Valcucine are perceived by their suppliers as front-runners of trends that will soon become mainstream; some IKEA' suppliers reported even of an intended strategy of *environmental R&D's outsourcing* at the lead firm, suggesting the presence of a substitution effect between suppliers internal

Table 6.1: An overview of the typologies of costs and incentives for suppliers to reduce their impact on the environment accordingly to buyer requests. Source: author's elaboration.

Cost	Incentives	
Equipment and machinery	Transaction-specific	*High Volumes*
Administrative		*Secure demand*
R&D	Replicational	*Learning*
		Reputation
	Supporting	*Market trend*
		Legislative trend

environmental R&D and the collaboration with buyers. Having learnt, through their long-term relationship, the ability of IKEA to systematically anticipate new trends and acknowledging its superior knowledge as far environmental innovations are concerned, they decided to systematically follow IKEA's requests as they were coming from their internal R&D department.

Both IKEA and Valcucine are very well known, in their markets, for their commitment to the reduction of environmental impacts. Furthermore, IKEA is known for being very tough as far as organizational and production practices are concerned. Similarly, Valcucine is known for its innovative products and for the tough qualitative standards that its requires. By cooperating with those buyers, suppliers can gain also in terms of *reputation*. As far as IKEA is concerned, this reputation will regard mainly the possibility to achieve economies of scales and to deal with environmental certifications and the like, whereas for Valcucine it will regard mainly innovative capabilities, flexibility and quality inflected by the respect of the environment. Other than an "external" reputation, spent with other customers, as far as Valcucine was concerned it emerged also the existence of an "internal" reputation-effect, in that suppliers reported that to work with Valcucine constituted also a motivational factor for employees, since it is well-known to be a rather tough task. When reputation or learning incentives are high, the relation with the lead would be considered worthy also if the costs to introduce some innovations would be higher than the margins they allow. In fact, within the suppliers' portfolio of customers, the relation with IKEA or Valcucine contribute to enhance the probability to gain new costumers (both because of the increased competencies and reputation) rather than just to increase actual margin.

Also *supporting* incentives contributed to the decision of suppliers to undertake environmental investments. It was mainly the case in which suppliers perceived an impending stringency of policy pressure, so that to innovate according to the buyer was simply a way to anticipate the inevitable, or when other customers were making similar requests. Supportive incentives were powerful especially for IKEA suppliers. Being inserted in value chain leaded by mass retailers they were already exposed to some environmental requests, regarding mainly the achievement of certifications such as ISO14001 and FSC, which are becoming mainstream in the market. These incentives reduced the idiosyncrasy arising from the relation, because they enable to meet other objects than those arising from the lead firm. For this reason, those incentives could be considered a sub-category of the replication ones. The difference

between the two lies in the *timing* and the *probability*: supporting incentives are already present when the suppliers take the decision, whereas replicational ones embed a certain degree of uncertainty on the possibility to gain in other transactions.

6.2.3 The "power" of buyers to achieve their environmental goals

The interplay between the different costs and incentives faced by the suppliers (see Table 6.1 for an overview) will determine the willingness of the suppliers to align to the buyer's requests, the "power" of the buyer to achieve its goals. In this setting, the measure of the "power" of buyers is not a consequence of their direct control, the "power exerted directly by lead firms on suppliers, which is analogous to the direct administrative control that top management [...] might exert over subordinates in an offshore subsidiary" (Gereffi, Humphrey, and Sturgeon, 2005), but rather the ability to enable win-win solutions.

In the case of "transaction-specific incentives", the costs to buy new machinery, equip with managerial systems or to develop new innovations are offset by transactions within that specific relation, amortized by the high volumes and the repeated transactions. "Replicational incentives", instead, consist of future benefits: by investing in this relation today, suppliers hope to gain tomorrow, in terms of achievement of new customers or of the possibilities to use the knowledge developed to produce new products or processes. Similarly, "supporting incentives", linked to the alignment of the request from the lead firm with stimuli from actors external to the specific relationships, enable to spread the investments on more transactions.

All the three categories were present in both value chains, even if the typologies were specific to each, except for secure demand. In IKEA's VC, benefits where mainly high volumes, and to a lower degree, reputation and learning[6]. In the Valcucine case, reputation and learning where considered the most important incentives to engage in deep cooperation and volume was less important. However, it is not a black-and-white picture: benefits are often overlapping and change slightly on a case-to-case basis. What it seems interesting to notice, however, is that in each value chain a typology for each of the three categories seems to be needed to justify the harder work to include environmental concerns in the business activities.

> "*Valcucine is a top customer, it is a very good reference. But then also the numbers justify the work. They assure you orders for a long time, constant, that many other customers do not*". (R&D manager, Eureka)

Whatever typologies of costs of benefits involved, the benefits have to offset the costs, for a supplier to accept to green its activities, otherwise the buyer will face many difficulties in pursue its policy. The example in Box 6.1 may help in the understanding of the interplay between these two variables.

> "*Our supplier was not doing yet any recycled [aluminium] laminates. If there is no request they do not produce any [environmental-friendly*

[6] As far as the importance of volumes and reputation for IKEA's suppliers see also Andersen and Skjoett-Larsen (2009).

> *innovation], because it is costly, but if there is a demand, and object to be achieved together, they are more willing to do it then*". (R&D manager, Valcucine)

Box 6.1: Costs and Incentives in the introduction of FSC for Valcucine's wood applications

A couple of years ago Valcucine decided that, starting 2010, all of its wooded products would have been FSC certified. While FSC certifications is getting mainstream, Valcucine's decision was pretty unusual, since it consisted in the certification of the entire wooden door rather than just parts of it, which is the habit in the industry. The main supplier for wooden products, BIESSE CREA, opposed the request of Valcucine for long time, for the complexity and the costs it implied. Interestingly, in the words of the entrepreneur of Biesse Crea such opposition – which Valcucine did not face when it came to the introduction of other very complex and costly innovation, like the water-borne varnish technology – is motivated by the fact that this would have been an idiosyncratic investment for the firm. It was neither possible to be used for other customers (because of how the FSC certification is structured) nor to gain in terms of reputation. Finally, BIESSE CREA accepted to introduce this certification as "a way to guarantee a long term partnership" with Valcucine. By certifying according to the client's request, Biesse Crea is hoping to strengthen the relation with Valcucine and being rewarded by new orders and maybe a better mark up.

6.3 The governance to green supply chains

The cross-case analysis between Valcucine's and IKEA's GSCM practices suggested that lead firms that are willing to reduce the impact on the environment of their value chains shift away from market governance structure toward more complex forms of interactions with their suppliers (see paragraph 5.3.5). The contrast-oriented comparison, allowed by the methodology chosen, enables not only to strengthen the common evidence emerging, as in the previous chapter, but also to identifies two "stereotypes" of governance, endpoints of a continuum in which network structures developed by firms may mix at different degree aspects emerging from one or the other. In the following, I will first call attention to the difficulties to situate the case studies in the categories and constructs developed by Gereffi, Humphrey, and Sturgeon and, second, characterize the two governance structures for greening emerging from my analysis.

6.3.1 Does greening requires to identify different Value Chain's governance structures?

Leveraging on previous empirical evidence in the GVC literature, Gereffi, Humphrey, and Sturgeon identified 3 network structures spanning between the market and hierarchy – modular, relational and captive – emerging according to the values of *complexity* and *codificability* of transactions and *capabilities* of suppliers (see paragraph 2.3.2). These three network structures are classified in ascending order as far as the explicit coordination from the lead firm and its use of "hands-on mechanisms" are concerned. The application of these governance structures to the

analysis of the greening value chain, however, poses some challenges, especially as far as the definition of the governance of IKEA is concerned[7].

In *modular* value chains, the high codificability and capabilities of the supply-base enable suppliers to deal with very complex transactions. Technical standards enable to keep the effort to explicitly coordinate transactions very low, reducing the need for direct control and monitoring. IKEA strives to reduce idiosyncratic costs, when possible. Despite standards proved to be key for the coordination of VC activities at IKEA, it seems that they rather improved switching costs. The strategy to adopt, when possible, "market" certifications – like ISO14001 and FSC – or to exploit supporting incentives – by requiring suppliers to change incrementally in a way that could suits the requests of other customers – has not reduced the need for explicit coordination and direct monitoring (see "monitoring" in 5.2.2) as predicted in the modular governance typology, nor the need to interact, even if at a lower level than Valcucine, to complement its internal competencies with those of highly competent suppliers (see "coordination on innovative activities" in 5.2.1). The company needed, in fact, to complement those standards with its own standards, encapsulated in the IWAY, which increased the degree of explicit coordination with the lead firm rather than decreased it and reduced its incentives to change suppliers. This evidence may be explained by the fact that, differently from other domains, as far as the environmental impact of production activities are concerned there are no standards yet acknowledged by each actors in the market, which ensure the respect of the environment in all its aspects, requiring each lead firm to fill in this gap privately, through idiosyncratic standards. Moreover, since environmental are credence feature, they require an higher degree of control on lead firms' side than other product's characteristics (Reardon, Codron, Busch, Bingen, and Harris, 1999).

The recurrence to a great deal of intervention and control is a key characteristics of the way IKEA coordinates activities within its value chain to enable low environmental impacts, feature that usually characterizes captive VC. *Captive* Value chains are characterized by a high degree of monitoring and intervention from the lead firms (which recall the "monitoring" and "supporting" constructs defined in the previous chapter), which encourage lead firms to build-up transactional dependence and "lock-in suppliers in order to exclude others from reaping the benefits of their efforts" (Gereffi, Humphrey, and Sturgeon, 2005), to keep low what in paragraph 5.3.5 I named "greening costs". This is why in captive value chains buyers represent a big share of suppliers' turnover. Except for ELECTROLUX and ABET LAMINATI, all Valcucine's and IKEA's suppliers were transactional dependent from the buyer, selling more than 20% of their sales to their focal firm – the threshold set by Pietrobelli and Saliola (2008) in the only attempt, to the best of my knowledge, to quantitatively measure the governance within

[7]The only attempt so far, at the best of my knowledge, to classify IKEA within the GVC framework is that of Avdasheva, Budanov, Golikova, and Yakovlev (2005), which classify IKEA's as a modular governance, justifying this choice with the low margin that the company ensure and the very detailed specifications and the strong support it gives to suppliers. However, these authors explicitly identify the idiosyncrasy emerging from this strategy, as I do in my discussion, which is in contrast to the definition of modular VCs.

VCs. In the theoretical model of governance outlined by Gereffi, Humphrey, and Sturgeon, the necessity of buyer's intervention is explained by the low capabilities of suppliers in the face of complex products that cannot be easily codified, which seems the case of environmental innovations development at IKEA and Valcucine. The analysis, in fact, have outlined that suppliers have usually low knowledge as far as environmental and design issues are concerned, even if they have high manufacturing (for Valcucine's) and organizational (for IKEA's) skills.

If IKEA strategy resembles partly the modular, partly the captive governance structure, the way Valcucine coordinates environmental innovations within its value chain seems close to the *relational* governance structure. Mutuality between firm and its suppliers is the key characteristics of relational VC, in which complex transactions that cannot be easily codified creates the incentives for lead firms to "outsource to gain access to complementary competencies" (Gereffi, Humphrey, and Sturgeon, 2005). Valcucine's transactions are definitely complex: the company is continuously introducing innovations, many of which can be defined as new-to-market innovations, and pretends high quality performance from its suppliers. Despite the complexity of the transaction is definitely high, it could be codified: the point here seems rather that there is not the incentive to do it, because of the low number of products and the high number of changes (innovations). Differently from what identifies in Gereffi's model for relational governance, supplier's knowledge is not highly competent, as far as environmental knowledge and capabilities are concerned. The mutuality arising among them is then closely linked with environmental innovations developed together, and more often, to the investment in support that Valcucine did to increase their environmental capabilities, which once again, would call for a captive VC model. Notwithstanding the high emphasis on trust, and co-developing, explicit coordination exerted by Valcucine does also include high level of control.

6.3.2 Types of governance for the greening of the value chain

The above discussion suggests that to understand the dynamics of coordination within VC to achieve environmental goals, new typologies of governance structures should be identified. In particular, high idiosyncrasy and the implementation of "hand-on mechanisms" seems to characterize both the VCs analyzed, even if the coordination mechanism employed differ. In the following, I will try to generalize the evidence emerging from the empirical analysis to identify i) two governance structure for the greening, namely standard-driven, which resemble the IKEA way to green its value chain, and relational-driven, similar to Valcucine's, and ii) under which conditions they may arise, namely strategic approach and dimension of the VC.

Standard-driven

In the *standard-driven* governance structure, standards are the main coordination mechanisms that govern value chains. The lead firm identifies and defines which are the main environmental impacts to be reduced and how to deal with them and crystallizes them into standards, which suppliers have to respect. The standards,

which are not static but may change over time, may comprise standards already existing in the market – to reduce the idiosyncrasy of their application at suppliers – but will also include more conditions the more the lead firm is committed to the reduction of the impacts on the environment. Standards and certifications may regard the environmental features both of the product and of the process.

The ability to codify environmental goals and procedures impact the supplier's management, i.e., the suppliers' selection process – setting minimum thresholds – and the supplier development process – i.e., the support that lead firm bestows to suppliers so that they can raise from that initial level of environmental performance to an higher (and predetermined) one. The lead firm's support to suppliers take often the form of formal projects to transfer know-how to suppliers, of detailed specifications on product and process procedures, of formal visits and auditing systems.

Other than supporting, monitoring and controlling is the main interaction that take place with suppliers. The lead firm takes on the responsibility to control that the set standards are achieved by (all) suppliers. They are responsible for the manufacturing process and work accordingly to the detailed specifications given by the lead firm and just occasionally contribute to innovation activities. New products are in fact developed mainly internally to the lead firm, following routines, and then transformed into standards and specifications that have to be followed by suppliers. Suppliers in standard-driven VC may have to adapt to buyer's requests by adjusting their machinery and equipments' fleet with more eco-friendly ones and bear managerial costs to deal with certifications and standards. Upstream actors are incentivized to participate in these networks by the possibility to make secure and high volumes, even if unit margins are low, and to learn how to implement sustainability strategies.

Standard-driven governance structures enable the development of environmentally sound innovations along the supply chain – or support the environmental "upgrading" of suppliers, to use the GVC vocabulary – thanks to explicit knowledge transfers and to the existence of incentives for all the actors involved. The standard-driven governance structure seems to suit best environmental innovations regarding eco-efficiency and, more generally, the reduction of impacts linked with the production process. This business model enables both lead firm and suppliers to gain from the reduction in manufacturing costs rather than asking consumers a premium price for the environmental features. Furthermore, being bounded to stringent targets, innovations developed within a standard-driven VC are less likely to be new-to-market.

Relational-driven

In *relational-driven* VCs, the main coordination mechanisms are the personal interaction with supply chain partners. Interactions with suppliers are complex and are handled trough trust, reputation and face-to-face interactions. Environmental problems and their solutions are considered on a case-to-case basis and do not necessarily need to fit easily-to-measure metrics. The internal R&D office is responsible for the definition of new product concepts and to identify which are the most important environmental problems to tackle, but cooperates with suppliers to

identify the technical solutions. The main tools used by the lead firm to govern the value chain is the design and the product specifications, which enable suppliers to be environmental-friendly even if they have low environmental awareness. In this sense, design represents a "hand-off" mechanism to have an indirect yet effective impact along the entire value chain.

Cooperation on innovative activities is the prevalent interactions between buyers and first- (and second-) tier strategic suppliers. The actors are mutual dependent for knowledge and skills: the lead firm has the leadership on environmental knowledge, the suppliers on technical one. This does not mean that suppliers are not able to find solutions that lower the impact on the environment, but rather that it is the lead firm that sets the objects and the strategies to reach those goals, whereas the supplier more often is responsible to find the technical solution to reach those goals. Face-to-face interactions characterize cooperation, monitoring and supporting activities. Recurrent visits both at the suppliers and lead firms facilities, facilitate the flow of knowledge and information among the firms and is a key tool to enable the enhancing of suppliers' environmental capabilities. Also monitoring of the production processes is handled through personal interactions and trust-based mechanisms, rather than formal mechanisms. When it comes to product monitoring, instead, the control is more formal and exerted through tests on the features of the product but may be complemented by on-site visits. Very often the suppliers have to face high R&D costs, linked with the time spent to identify the best technical solutions to apply that design, but they participate in this VC because they can gain in terms of replication incentives. The mutual dependency arising between lead firms and suppliers is not necessarily higher than in the case of standard-driven VCs, since cooperation for innovation may be handled project-based, therefore changing suppliers.

Similarly to standard-driven governance, it enables the improvement of suppliers' environmental knowledge and ability to introduce environmental-friendly products. This governance structure suits best the development of complex and systemic innovations, which reduce the impact of the final product rather than the manufacturing process itself. The flexibility enabled by informal monitoring and innovating strategies fits breakthrough innovations or more in general innovations that interpret the reduction of environmental impacts in a non-traditional manner.

Table 6.2 summaries the key features of the standard-driven and the relational-driven governance structures, enabling a comparison on the dimensions presented in the previous paragraphs (in parenthesis features present in both governance structures).

6.3.3 Which variables affect the governance structure?

Under which conditions should we expect standard-driven or relational-driven networks to arise? Which variables affect the adoption of one or the other coordination mechanisms? Leveraging on the evidence emerging from the empirical analysis, I made a comparison between IKEA's and Valcucine's VC to identify the key determinants of the two network governances, along several dimensions regarding the characteristics of the lead firms, their value chain, strategy and the

Table 6.2: Emerging governance structures for the greening of the value chain. Source: author's elaboration

	Standard-driven	Relational-driven
Lead firm's main tools	Standards & certifications, supplier selection, (supplier development)	Design, (supplier development)
Prevalent interaction	Monitoring and controlling, (supporting)	Cooperating on innovative activities, (supporting)
Intensity of co-innovation	Low	High
Monitoring mode	Formal	Informal
Supporting mode	Formal	Informal
Suppliers' costs	(Machinery & equipments), managerial	(Machinery & equipments), R&D
Suppliers' incentives	High volumes, (learning), (secure demand)	Reputation, (learning), (secure demand)

business model, as in Table 6.3. According to the analysis it seems that the main determinants in shaping the governance structure are the strategic approach and dimension of the value chain.

Strategic approach

The strategic approach of the lead firms appear as a pivotal variable in explaining how they go for reducing the environmental impact along the value chain (see also the importance in determining the way firms cooperate with suppliers and support them, as encapsulated in corollaries 1 and 3 in section 5.3). The strategy comprises choices on the market to compete in, on the type of products, the innovation strategies and more in general the business model of the firm and entails also a focus on different environmental impacts and different strategies to address them.

The literature identifies two main competitive advantages firms can aim at: low cost or differentiation. Firms that aim at achieving cost-leadership in their markets offer low-cost, mass products, targeting a price-sensitive market. Key to ensure the profitability of this model is the possibility to produce high volumes, which enables to gain from economies of scale and of replication. In the case of an high fragmentation of production, a large organization would be important also to identify and enforce standards along the supply chain. Standards are important to ensure the low-cost leadership: by communicating to each producers the necessary information to produce a predetermined and run-of-the-mill product lead firms safeguards the homogeneity of products and production functions. Within this strategic approach, innovation introduced are more likely to affect the process, aiming at squeezing production costs rather than improving the product's range, and to be incremental rather than new-to-market. Tackling environmental issues is likely motivated by the willingness to reduce reputation or legislation risks or to improve production efficiency. Environmental problems addressed are likely those that can be easily measured and identified. Other then imposing the respect of minimum environmental standards along its value chain, the environmental strategy of firms

Table 6.3: Variables for the cross-case comparison. Source: author's elaboration.

	IKEA	Valcucine
Lead Firm's Characteristics		
Size (emply.)[a]	127,000	171
Size (turnover)[a]	23.1 billion	36 million
Subsidiaries	Yes	No
Export	>90%	>50%
Internal R&D deptartment	Yes	Yes
Continuous R&D activities	Yes	Yes
Internal manufacturing[b]	Yes	No
Internal marketing	Yes	Yes
Internal retail/distribution	Yes	No
Value Chain's Characteristics		
Dimension of the VC (geography)	Global	Local
Dimension of the VC (size)[a]	1,074	300
Suppliers type	Turn-key	Specialized
Suppliers' environmental capabilities	Low	Low
Suppliers' manufacturing capabilities	High	High
Suppliers' managerial capabilities	High	Low
Firm's strategy and business model		
Final product	Low-end	High-end
Volumes	High	Low
Main competitive advantage	Low-costs	Differentiation
Innovativeness[c]	Low	High
Main green Innovation type	Eco-efficiency	Final product

[a] Data for IKEA is as of 30 June 2010, of Valcucine as of 31 December 2009.
[b] IKEA manufacture around 10% of its overall wooden range and Valcucine performs in-house the final manufacturing steps of its VC (see paragraphs 4.1.2 and 4.2.2).
[c] See paragraph 4.4 for a more thorough discussion of the environmental innovations strategies of the two firms.

will be that to reduce costs, therefore implementing eco-efficiency innovations, like in the IKEA case (see also discussion in paragraph 4.4). Environmental innovation will therefore affect mainly the production process or the inputs rather than the final products.

On the contrary, firms competing for their ability to deal with quality, innovation and design are more likely to organize their Value Chain through a relational-driven governance. The frequency of innovations introduced is likely to be high and the content breakthrough and new-to-market. The more complex an innovation to be introduced, the more likely a firm will need to rely on the knowledge of external partners and to support suppliers' activities to implement it, supporting the need for a relational-driven governance. Face-to-face interactions allowed by this network type, enable to deal with more complex environmental problems and to identify more radical solutions, which may or may not be codified into specific standards. Its environmental-friendly attitude is knitted with the firm's brand and

its marketing effort, being the feature that allow it to differentiate from competitors. Firms following this strategic approach target a market niche valuing the respect for the environment and willing to pay a premium price for it. The firm may address more deeply environmental concerns with respect to the previous, aiming at reducing the impacts well below the threshold set by the law. In order to do so, the firms is likely to introduce very complex and systemic environmental innovations, which can heavily affect the product's architecture of the input used to produce it, like in the case of Valcucine. A standard-driven governance would not fit this strategic approach, now allowing the needed flexibility and creativity in identifying and tackling environmental impacts of the production activities. Environmental innovations to be introduced are more likely to affect the value chain *depthwise* than *widthwise*.

The size of the Value Chain

Also the size of the value chain proved to be a key determinant of the interactions among firms, in particular as far as monitoring strategies are concerned (see also Corollaries in section 5.3), partly explaining their recurrence to standards or personal interactions. The size of the Value Chain can be considered according to three, correlated, dimensions: i) the number of products, ii) the number of suppliers, and iii) the number of countries the company supplies from.

Firms which manufacture or brand a broad range of products are more likely to lead the reduction of environmental impacts along the value chain through standards. Each product entails different environmental challenges, innovation frontiers and production technologies. The higher the number of products, the more complex for a firm to handle environmental concerns and innovation informedly. The complexity increases the more these products are very different one from the other, like in the IKEA case, that sells not only furnishings for all the house, but also textile, accessories and the like. In these situations, standards may be the most effective way to ensure the reduction of impacts along its value chain: even if they not allow great environmental improvements, they represent easy-to-define metrics on which lead firms can evaluate suppliers – even suppliers of very different industries – and track their improvements. On the contrary, firms focusing on a smaller number of items, like Valcucine, may more easily be familiar with their production processes and understand not only the environmental problems of different steps of the value chains, but also how to tackle them. The lead firm may therefore address more deeply environmental concerns, by developing ad hoc innovative solutions together with suppliers.

Similarly, interacting with a big value chain, considering both the number of actors involved and their locations, poses peculiar opportunities and challenges with respect to a smaller one. The numerical dimension of the VC will affect not only the way a firm goes to monitor its suppliers but also the forms in which it will provide support and even the content and the recurrence of the interactions. In the case of smaller networks, the firm may rely on direct control and face-to-face interaction to monitor and influence the activities of suppliers on a case-to-case basis, without incurring in prohibiting costs, thanks also to the mediating effect of trust and reputation. On the contrary, the importance of standards as coordination

mechanisms will increase with the dimension of the VC. Costs of face-to-face interactions are increasing in the intensity and the number of supplier-specific interactions, whereas costs of producing and enforcing standards are decreasing in the number of suppliers.

Likewise, the broader the VC, i.e., the more countries the firm supply from, the greater deal of effort it has to exert to ensure the uniformity among all of them. This issues become very important especially when a firms manage suppliers located in developing countries, where regulations and the business practices are not as environmentally sound as in developed ones, like in Italy. Also the possibility to monitor directly the activities of each supplier increases in their geographical dispersion. Moreover, the firm cooperating with suppliers located all over the world may less likely take advantage of coordination mechanisms such as trust and reputation. The experience of Valcucine, however, suggests that these "economies of proximity" may be enjoyed not only within the districts – as the traditional district literature suggest – but within broader geographical and economical areas, like North Italy was for Valcucine.

Variables to green or not to green: that is the question?

Variables emerging in this analysis are just partially overlapping with those in Gereffi, Humphrey, and Sturgeon's paper. The variable strategic approach in a way encapsulate both the *complexity of transactions* and the *ability to codify* them, identified in that paper. However, no variable describing the suppliers seems to be a determinant in this model but rather the characteristics of the overall value chain (VC size) seem important. *Capabilities in the supply-base* did not proved to affect the governance mechanism differentially: in both cases suppliers had high manufacturing capabilities and low environmental ones and developed from that starting point thanks to the lead firm effort.

However, the identification of these variables does not necessarily challenge Gereffi, Humphrey, and Sturgeon's ones, rather helps in identifying which governance structure arise when it comes to greening a value chain, a sub-set of more general decisions made by the firms on how to shape and coordinate their activities.

6.3.4 A theory of environmental governance

In the following, I will described the standard-driven and relational-driven governance structures based on the determinants just identified, to "test" the power of these variables to describe the emerging structures and better specify them in the light of those variables. For the sake of creating a model, I simplified and abstracted the evidence, assigning to the variables just two values. The variable "strategic approach" will take on the values low costs or innovation-quality, summarizing in the first case the situation in which the main competitive advantage of the firms is low-cost, innovation strategy has a low profile and environmental innovations consists mainly in changes in the products or process that improves eco-efficiency; in the second, the cases in which differentiation is the main competitive advantage, innovativeness is high and environmental innovations are mainly improving the

Table 6.4: Key determinants in environmental VC governance. Source: author's elaboration.

	Standard-driven	Relational-driven
Strategic approach	Low costs	Innovation-quality
Competitive advantage	Low-cost	Differentiation
Innovativeness	Low	High
Environmental innovation	Eco-efficiency	Eco-product
Value Chain size	High	Low
Number of products	High	Low
Number of suppliers	High	Low
Number of supplying countries	High	Low

product. The variable "VC size" will take on the value high and low, considering for the three dimensions identified in the previous paragraph (see table 6.4)[8].

When the strategic approach is based on the low cost competitive advantage, and the size of the Value Chain is high, *standard-driven governance* structures can be expected, like in the IKEA case. In standard-driven VCs, innovation is bounded by stringent targets and is to be easily codified and therefore applied at suppliers and monitored. IKEA's standards includes many specifications regarding different aspects of the *greening*, but all ensuring a "basic level" of environmental performances, mainly requiring suppliers to comply to the laws of the strictest country IKEA sells its products in, to control inputs features and to ensure continuous improvements in eco-efficiency, a level that can be verified through identified and easy-to-collect metrics. The dimension of its Value Chain requires the company to use standards to ensure uniformity in the definitions of environmental problems and solutions and to enforce their respect. However, the existence of standards does not reduce the transactional dependence between suppliers and customers, since standards are specific to the lead firm and still require explicit coordination.

If the strategic approach is rather oriented to compete on innovation and quality and the size of the VC is relatively low, *relational-driven governance* can be expected. In order to develop more breakthrough environmental innovations, which completely change the way a product is done and used, firms rely on relational-driven value chains, which enable higher flexibility in identifying and tackling

[8]Definition of high and low levels, as far as the case studies analyzed are concerned, is a matter of shades, but necessary for model theory building purposes. For example, low innovativeness, associated with the model inspired by IKEA does not mean that the development of that innovation did not require an high effort at the lead firm or that its products are not valued on the market for their novel content, shape or design. However, as emerges in the narratives of the two environmental strategies, it seems reasonable to assign to it a lower value than Valcucine's. Similarly, the labels "high" or "low" for the variable VC size may be not univocal: the number of suppliers Valcucine makes business with, in fact, may actually be considered high if compared to the dimension of the firm. However, I labeled it "low" because of the explicit strategy of the firm to focus on few of them (one) as the main supplier for each product and to keep all the others on the bench, other than for their absolute value with respect to IKEA's.

environmental issues that the standard-driven ones. This was Valcucine's way, in which many new-to-market environmental innovations have been introduced thanks to the cooperation with suppliers. Those complex transactions can be handled through face-to-face interactions, deep collaboration and mediated by coordination mechanisms like reputation, trust and personal interactions. These mechanisms do not necessarily reduce the need for monitoring not the deal for intervention of the lead firm or the transactional dependence.

6.3.5 One, no one and one hundred thousand: the issue of multiple chains and governance structures

The analysis presented contributes to the understanding of how firms go for the greening of their value chains and under which conditions one way is more likely to be expected than another. However, it has also some limitations, partly shared with other analyses of governance performed in the GVC literature, as expounded by Sturgeon (2009). Actually, the same firm may be *contemporaneously* embedded in different value chains, as far as the industry and the governance structure is concerned, and that, *within the same value chain*, there may be different governance structures, even non-network ones.

Both lead firms and suppliers are embedded – at the same time – in multiple value chains. IKEA sells 9,500 different products within its product range. Even focusing just on one sub-industry, the wood-furniture, as I did in this analysis, it is evident a big heterogeneity as far as products are concerned. The same holds also for Valcucine that, even if is specialized in a sub-set of the furniture industry, kitchen, is indeed embedded in different value chains (e.g., the wood, aluminium, glass furniture), involving very different innovations frontiers, environmental problems and being differentially strategic for the firm. Similarly, the fact that many suppliers make business with more than one buyer proved to be anything but not important (see the discussion about *supporting incentives* in section 6.2.2). In a similar fashion, suppliers may do business with other buyers, which are not enforcing the same coordination mechanisms of the (focal) lead firm, and not even requiring the same environmental improvements and standards. Suppliers may be therefore embedded in different governance structures, which requires them the use of different coordination mechanisms with its own suppliers but also different costs and incentives for their participation in the greening. The choice to analyze suppliers working with both lead firms, namely ELECTROLUX and EUREKA, supported the evidence that different tools, costs and incentives and interaction mechanisms co-existed within the same supplier. Similarly, it is well possible that the same lead firm implement a different governance with different suppliers in the same step of the VC. It is interesting to notice that not with all suppliers IKEA and Valcucine were leading a standard-driven or relational-driven governance structure. With "commodity suppliers", in fact, they lead a governance structure that resembles *market* rather than a *network*. This applies mainly to Valcucine that, having less resources and having implemented a more flexible sourcing strategy to fit to its innovation model – which changes very often materials, design and production processes implemented – focuses its attention, as far as the greening is

concerned, mainly on few suppliers, but is consistent also with the IKEA's model, since it cooperates on innovation and supports the development just of a sub-group of suppliers (see also the discussion in section 5.3.5)[9].

> "*[Sustainability] does not really affects us. [...]*". (R&D manager, Eureka)

Notwithstanding the methodological choice to address both lead firms' and suppliers' points of view enables a better view of how the influence of the lead firms spread along the chain and which coordination mechanisms are used, this does not ensure a comprehension of the governance along the entire VC. Even in low-tech industries like the furniture, the Value Chain may be very long and complex. The tools used by firms – supplier selection and development, standards and certifications, and design – proved to extend their influence at least at second-tier suppliers but the evidence does not allow to verify to what extent they actually hold further the chain.

Furthermore, it may well be that the way buyers coordinate activities with first-tier suppliers does not reproduce itself along the entire chain. In other words, the governance structure may differ not only *within* the same tier (commodity vs. strategic suppliers) but also *between* different tiers, at different steps of the VC. The study by Gereffi, Lee, and Christian (2009) on two food and agricultural industries in the US, already pointed to the presence of different governance structures at different points of the VC. In my analysis, it emerges that hierarchy and market governance structures characterize IKEA's and Valcucine's strategies, other than the network forms discusses above IKEA vertically integrate to ensure sourcing of environmentally sound wood: Swedwood was established also on the purpose to counteract the scarcity of FSC certified wood in the market. A similar strategy was implemented also by one of its suppliers, ILCAM. Many years before starting business with IKEA, this Italian supplier decided to buy some forest in eastern Europe and certified them to secure the quantity of FSC certified wood that its customers were increasingly requesting. This evidence corroborate the hypothesis that the same firm may implement a different governance structure at different points of its VC. Furthermore, it hint that this choice is not necessarily contingent to the lead firm specificities, rather to the specificities of the transaction taking place (e.g., certified wood sourcing). Together with the evidence on the market governance with "commodity suppliers", it suggests that, to deal with the greening of the supply chain, there may be other governance structures than network. If this evidence call for further analysis to understand under which circumstances hierarchy occurs, it nevertheless reinforces the hypothesis that, to deal with environmental innovations along the VC, firms shift-away from arm's length relationships toward coordination mechanisms that ensure higher control but also higher transactional dependency with VC partners.

To use Sturgeon's words, "what we observe in the field is a mixing of GVC governance forms within industries, value chains, firms and even single establish-

[9] An external reference supporting this evidence is the analysis by Ivarsson and Alvstam, which report the differential role of Italian suppliers within IKEA's suppliers portfolio, with respect to Asian suppliers.

ments". However, this evidence should not lead to disregard the theory developed, but rather suggests to use it "consciously" when applying it to empirical setting for policy making or strategy development purposes. The existence of ideal types generated by the theory is nevertheless a useful guide to understand the much more complex reality.

6.4 Conclusions

In this chapter, the Global Value Chain framework developed by Gereffi and others (Gereffi, Korzeniewicz, and Korzeniewicz, 1994; Gereffi, 2005; Gereffi, Humphrey, and Sturgeon, 2005; Sturgeon, 2009) provided an entry point to the theoretical discussion on the impact of the governance structure on environmental improvements along the value chain. By the analysis of the value chains of two very different furniture firms, IKEA and Valcucine, this exploratory analysis attempted to understand of how lead firms drive the greening of their chains, why suppliers may participate in the greening and how governance structures implemented by firms affect the possibilities to implement green innovations in their VC. The empirical analysis underscores the important role of buyers in leading the greening of their suppliers and beyond. The empirical evidence suggests that lead firms have three main tools to implement the reduction of the environmental impact along their value chain: supplier selection (and development), standards and certifications, and product design. Even if at a different degree, these tools can influence VC activities beyond first-tier suppliers, even if lead firms should provide a strong effort to effectively achieve the reduction of the impact at actors of its chains over which it can use less managerial levers.

In this setting, the ability of a firm to influence its suppliers' activities – i.e., to enforce the introduction of product or process innovations that reduce the impact on the environment – is defined by the interplay of the costs they face to implement environmental innovations – to adapt the equipments, to administer environmental certifications or to develop new products and processes – and the incentives enabled by the lead firm. The traditional concept of "power" used in the GVC literature is revisited as a measure of the ability of the lead firm to create incentives for its suppliers to follow its guidelines, which may be specific to that transaction (high volumes and secure demand) or concerning other products and other customers (learning, reputation and market and legislative trends). Despite arising from the analysis of environmental innovations, this approach could be applied in all the settings in which VC relations are concerned and may contribute to a better comprehension of GVC dynamics.

As far as the governance structure is concerned, the emergent analysis challenges the use of the typologies identified by Gereffi, Humphrey, and Sturgeon (2005) to understand the greening of Value Chains. Two network structures emerged from the comparison of the IKEA and Valcucine cases: a standard-driven and a relational-driven governance structure, which differ in terms of main tools used by the lead firm, the relative importance of cooperation, monitoring or supporting, and the costs and incentives faced by suppliers. While there are many variables that affect how lead firms coordinate their activities, in this paper I developed a framework

that identifies two main variables as determinants of the above mentioned network structures: the strategic approach, comprising different environmental innovation strategies and competitive advantages, and the size of the Value Chain, consisting of the product range and the number of suppliers and of supplying countries.

Despite it needed to be modify to account for environmental innovations, my analysis suggests that the GVC framework can be effectively applied to understand environmental innovations dynamics for several reasons. First, it enables to consider (the environmental impacts of) all the activities a firms deals with, rather than focusing just on some of its products, like in the contributions using the LCA approach. Secondly, it allows understanding the coordination mechanisms implemented by lead firms for the greening of the value chain. Last but not least, it enables to focus on the geographical dimension of the network of partners working with the lead firm. The GVC framework has an explicit focus on activities spanning international borders yet acknowledge the importance of local and national institutions and of geographically rooted competitive advantages. The analysis presented in this paper explicitly highlights the importance to consider the geographical dimension of the network: geography does matter when considering greening possibilities and the coordination mechanisms that firms may implement to achieve their goals.

This analysis focused on the management of inter-firms relations to the implementation of environmental strategies. However, the decision to reduce the impact on the environment is never disconnected to other business considerations. The typologies of environmental innovations introduced are closely linked with the business model implemented by the firm. Furthermore, decisions about supplier selection and management are heavily affected also by considerations of their service, quality and cost levels, which in some cases are considered even more important than their environmental performance. Especially when there is not an environmental-friendly alternative to polluting technologies, firms may decide to favor costs, quality or aesthetic factors to environmental reasons.

The analysis provided represents just an exploratory study of how firms coordinate with Value Chain partners for environmental friendly-products or processes. Despite the many contributions, it remains still very close to the starting line. Other empirical studies should test the validity of the emerging framework also in other industries, especially to test if they hold just for "buyer-driven" value chains or also in the case of "producer-driven" value chains. Furthermore, the variables identified in the model need to be further developed, to operationalize them in metrics that could be used for testing these hypotheses through large-scale datasets.

Part III

Appendix

Appendix A

Supporting materials for Chapter 1

Table A.1: Simple correlations among the independent variables (n=5,801)

	1.	2.	3.	4.	5.	6.	7.	8.	9.	10.
1.cooperation	1.000									
p-value										
2.ext_r&d	0.165	1.000								
p-value	*0.000*									
3.r&d_intensity	0.172	0.056	1.000							
p-value	*0.000*	*0.000*								
4.cont_r&d	0.256	0.070	0.400	1.000						
p-value	*0.000*	*0.000*	*0.000*							
5.size	0.123	0.083	-0.237	0.214	1.000					
p-value	*0.000*	*0.000*	*0.000*	*0.000*						
6.export	0.076	0.084	0.043	0.232	0.253	1.000				
p-value	*0.000*	*0.000*	*0.001*	*0.000*	*0.000*					
7.subsidiary	0.083	0.085	-0.083	0.109	0.455	0.103	1.000			
p-value	*0.000*	*0.000*	*0.000*	*0.000*	*0.000*	*0.000*				
8.pub_funds	0.343	0.168	0.273	0.349	0.164	0.145	0.060	1.000		
p-value	*0.000*	*0.000*	*0.000*	*0.000*	*0.000*	*0.000*	*0.000*			
9.innovation05	0.082	0.065	0.136	0.273	0.046	0.148	0.003	0.150	1.000	
p-value	*0.000*	*0.000*	*0.000*	*0.000*	*0.001*	*0.000*	*0.842*	*0.000*		
10.prinnovation	0.165	0.105	0.106	0.399	0.453	0.278	0.221	0.266	0.228	1.000
p-value	*0.000*	*0.000*	*0.000*	*0.000*	*0.000*	*0.000*	*0.000*	*0.000*	*0.000*	

Table A.2: First Part Logit Regression, measuring innovation propensity across Spanish manufacturing firms

	ENV_INN	
	Coef.	S.E.
size	0.306***	(0.030)
group	0.063	(0.081)
biotech	0.932***	(0.271)
hamp_high_costs	-0.199***	(0.034)
hamp_domin_mkt	-0.184***	(0.035)
hamp_no_demand	0.478***	(0.034)
Constant	-0.783***	(0.185)
Observations	5801	
Pseudo R^2	0.0927	
Chi^2	515.9***	

Robust standard errors.
*** p<0.01, ** p<0.05, * p<0.1.

Table A.3: Fixed-effects second stage logit regression, explaining environmental innovation performance using data for 2003-2008.

	ENV_INN	
	Coef.	S.E
cooperation	0.448***	(0.131)
ext_r&d	-0.002	(0.003)
r&d_intensity	2.328***	(0.642)
cont_r&d	0.496***	(0.145)
size	0.644***	(0.243)
export	0.035	(0.139)
subsidiary	0.391*	(0.226)
pub_funds	0.102	(0.126)
innovation_3	0.203	(0.143)
prinnovation	1.809***	(0.520)
Industry dummies	included	
Observations	2911	
Number of ident_num	1055	
Pseudo R^2	0.0541	
Chi^2	114.3	

*** p<0.01, ** p<0.05, * p<0.1.

Table A.4: I.V. regression explaining environmental innovation propensity, considering location as instruments for the variable cooperation

	Second Step ENV_INN		First step COOPERATION	
	Coef.	S.E.	Coef.	S.E.
cooperation	0.240	(0.512)		
ext_r&d	-0.000	(0.002)	0.003***	(0.000)
r&d_intensity	0.017	(0.145)	0.276***	(0.050)
cont_r&d	0 .155**	(0.063)	0.119***	(0.014)
size	0.028**	(0.013)	0.024***	(0.006)
export	-0.064***	(0.016)	0.001	(0.013)
subsidiary	0.004	(0.025)	0.030*	(0.017)
pub_funds	0.011	(0.128)	0.231***	(0.016)
innovation05	0.108***	(0.031)	0.042**	(0.018)
prinnovation	0.320***	(0.094)	0.111*	(0.057)
Industry dummies	(included)		(included)	
location			0.021***	(0.006)
Constant	-0.041	(0.069)	-0.146***	(0.054)
Observations	4409		4409	
R^2	0.109		0.184	
Chi^2	750.6		977.0	
Wu-hausman test (p-value)	0.626			

*** p<0.01, ** p<0.05, * p<0.1

Appendix B

The furniture Global Value Chain

B.1 The furniture Value Chain

Furniture is a large sector, which in 2010 accounted for almost 373 million US$ (Csil, 2010). Among the biggest low-tech industry worldwide, it undergone deep transformations in recent years, mainly because of internationalization dynamics. Developing countries' producers entered the global market arena, boosting the increase of furniture trade but also a deep transformation in the geography of production and in the developed countries' firms strategies. In the followings, I will give an overview of the recent trends in the industry, including the increasing environmental awareness that the furniture firms are increasingly challenged to consider within their business activities. First I will describe the furniture Value Chain, using the different levels of analysis identified in the literature (see e.g., Gereffi, 1994): the geography of production (paragraph B.1.1), an input-output structure (paragraph B.1.2), and a governance structure (paragraph B.1.3). Later on, I will give an overview of the peculiarity of the furniture industry in Italy B.2, which is the setting of the analysis and finally analyze the environmental challenges in the industry B.3.

B.1.1 Internationalization and the changing geography of furniture production

The majority of furniture production, 58%, is manufactured in developed countries, even tough this share is fast shrinking to the advantage of transitional and developing countries. China accounts for the lion's share, being responsible for the production of almost a quarter of the overall world production, and is followed by United States (15%), Italy (8%) and other European countries such as Germany, France, UK and Poland (3% each) (Csil, 2010). China is also the major exporter to the world market: it toppled Italy in 2005 to gain the number one spot. In 2009 China's export, in US dollar, was 59 billion, versus the 14 and 7 billion of Italy and Germany, ranking second and third respectively (International Trade Center, 2011).

The application of ICT technologies in production and design, the usage of new materials, such as MDF, which reduced the amount of forestry resources needed, and

the introduction of the ready-to-assemble furniture, allowed an extended division of labor and the participation of new countries in this market, which resulted in a steep increase in furniture international trade that started to shrink just in 2009 (Csil, 2009). Between 1995 and 2000, trade in this industry grew 36%, much faster than in other highly globalized industries such as footwear (1%) or apparel (32%) (Kaplinsky, Memedovic, Morris, Readman, and Way, 2003). The openness of markets, measured as import/consumption ratio, grew from 24 to 30% between 2000 and 2008 (Csil, 2010).

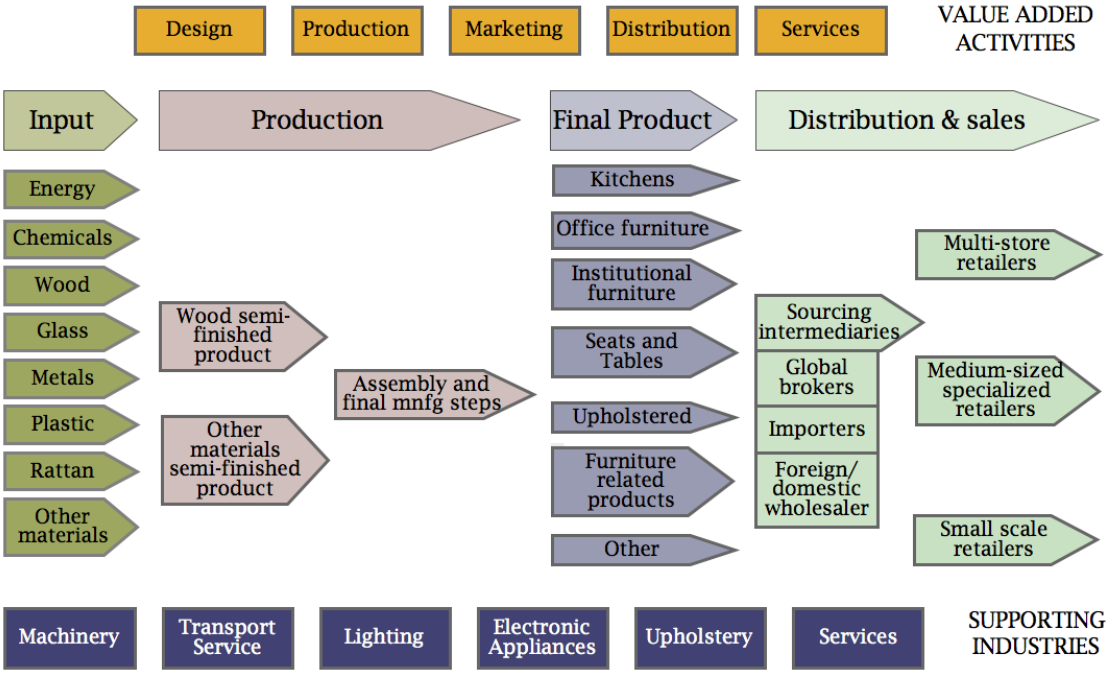
As consequence of internationalization dynamics the geography of production fast expanded. Despite still dominated by advanced economies, furniture production is increasing speaking the language of the transitional and developing countries: economies that have increased the most their production levels, considering the 5 years period 2003-2008, are Asian such as China (+30%) and Vietnam (+32%), serving mainly the US market, or eastern European such as Russia (+28%), Ukraine (+22%) and Turkey (+20%), serving mainly EU customers (Kaplinsky, Readman, and Memedovic, 2008; Csil, 2010). Other less developed countries, such as Thailand, Indonesia and Malaysia have strongly increased their presence in international markets, also thanks to their availability of resources, which is an important competitive advantage in this industry.

More recently, the industry was affected by the economic recession, that is exacerbating the competition between developed and developing countries, which are denting traditional producers' leadership in the global markets. In 2009, furniture global demand reduced by 20% with respect to the previous year (Csil, 2010). In particular, the reduction of the United States' demand, which represented the major market for world production for the last decade, has been particularly challenging for the industry.

B.1.2 The furniture Value Chain Input-Output structure

The furniture VC includes a wide range of activities, which vary mainly depending on the main raw materials used. Wood, which traditionally is the most used material, is in fact increasingly substituted by other materials such as metals, plastic and glass, both because of environmental and aesthetic reasons. The scholar contributions on the furniture value chain by now have been focusing mainly on the wood-furniture (see e.g., Kaplinsky, Memedovic, Morris, Readman, and Way, 2003), which in 2003 represented less than half of the overall trade in furniture. Based on those contributions, figure B.1 has been developed in the attempt to fill in the gap, considering all the activities involved in the production of wooden and non-wooded furnishings, including *input and raw materials*, *production* of components and semi-finished products (including production of moldings, panels, doors, frontal parts in various materials) and assembly, *final products* and finally *distributions and sales*. The figure reports also the *value added activities* and the *supporting industries* involved in furniture production.

Figure B.1: The furniture Value Chain. Source: author's elaboration.



B.1.3 Value chain governance and lead firms

As the majority of labor-intensive industries, the furniture value chain is a buyer-driven one (Kaplinsky, Memedovic, Morris, Readman, and Way, 2003; Kaplinsky, Readman, and Memedovic, 2008), that is a chain in which actors at the end of the chain play a key role in setting up and coordinating the activities of decentralized production networks (Gereffi, 1994, 1999). The majority of firms in the industry specialize just in few steps of their VC: buyers, i.e., retailers, branded marketers and branded manufacturers coordinate the activities along the chain and are very often responsible for the higher value-added activities in the chain: product design, marketing, customer support, retailing, and distribution. Therefore, they are able to capture the higher portion of the value-added created. Purnomo, Guizol, and Muhtaman (2007), by the mean of an analysis of the Indonesian teak furniture value chain, found that just the 35.9% of the value added stayed in the country: 64.1% was instead captured by importers, wholesalers and retailers, which were able to leverage on the proximity to the final markets and on the ownership of strong brands. Noticeable exceptions are high-wage producing countries, such as Italy and Denmark, where even small and medium-sized producers are able to gain a bigger slice of the pie thanks to their high specialization and their manufacturing and design capabilities.

B.2 Furniture in Italy

Italy is not only the major European exporter, which in 2009 was responsible for the 22.7% of the overall EU27 world export (International Trade Center, 2011). According to Eurostat's statistics, in 2006 Italy was the first furniture producer in Europe in terms of employment and value added, being responsible for the 15% of

the overall European furniture workforce and generating the 17.8% of the industry value added produced in Europe. As of 2009, the 73,000 wood-furniture firms in Italy employed almost 400,000 workers (Federlegno-Arredo, 2010). Also the market for home-furnishings products in Italy is very big: according to Euromonitor (2009a) it was worth 24.4 billion euros in 2008, representing the second largest market in EU after Germany.

B.2.1 The history of furniture production in Italy

Italy has long been a center for furniture production: already at the beginning of the 20th century many firms were specialized in wood manufacturing and furniture production, mainly small-sized artisans. However, it is just starting the 50s that furniture in Italy took the shape of an industrialized industry, coinciding with the broader industrial boom that characterized many sectors in Italy in those years. The increase of the internal demand for furniture, the low entry barriers and the technological progress supported the development of furniture as an industrialized industry (Chiarvesio and Lojacono, 2002).

The third phase of development of the industry, as described by Gargiulo, Onida, and Traù (2005), started during the 70s, with the emergence of a new industrial model that would have represented the basis for the competitiveness of the Italian industries in the following decade: the industrial district (Beccatini, 1979, 1991; Sengenberger and Pyke, 1991). Starting those years, time series on the variations of firms' size showed null or negative figures, for the first time after 20 years of continuous increase. Instead of growing vertically, to exploit economies of scale, Italian furniture firms' grew horizontally, though a division of work in geographically-bounded and sector-based districts that guaranteed even higher competitiveness levels than vertically integrated firms (see e.g., Priore and Sabel, 1994). Exploiting economies of specialization, the availability of a skilled work force and a flexible division of labor characterized by trust and informal cooperation, the so called "Third Italy" has been able to succeed in global markets despite the average dimension of firms was much lower than in other countries. Gargiulo, Onida, and Traù (2005) report that when in Italy the majority of furniture firms had less than 20 employees, the average dimension of German, French and USA's firms was 5 times bigger. As a consequence of districts competitiveness, starting the same period furniture production increasing polarized within restricted geographic areas, in particular in the North-east and the Central-east (Gargiulo, Onida, and Traù, 2005). The main districts are Brianza (in Lombardia region), Quartier del Piave (Veneto), Livenza (Friuli-Venezia Giulia), Manzano (Friuli-Venezia Giulia), Pesaro-Urbino (Marche), Murgia (Basilicata and Puglia). In 2009, just those six districts where responsible for 60% of the Italian furniture export.

B.2.2 Recent challenges to the Italian furniture producers

Starting the mid 80s and the 90s other transformations affected the industry. First, there has been a decreasing specialization in the upper phases of the wood-furniture value chain to the advantage of furniture and semi-finished products (Gargiulo, Onida, and Traù, 2005): the resulting shortage of Italian wood is a big challenge for

the industry nowadays, which has been partly filled in by an increasing cooperation with Eastern European producers, rich of forest and wood manufacturer since long time. An analysis that I performed on the database AIDA, which provides the balance sheet of all Italian firms with a turnover bigger than 850.000 euros, confirms the consistent validity of this analysis: the majority of the top-10 furniture firms, considering both employment and turnover, are firms that preside over the final market, and just a minority is specialized in production steps of the value chain, mainly panels producers.

Second, the industry was affected, even if to a lower degree than other industries, by offshoring trends to fill the shortage of wood and to take advantage of new opportunities created by the modularization of production. In fact, new technologies have enabled, on the one hand, a more extensive division of labor, on the other hand, an increased flexibility in responding to customization needs of final consumers, with the emergence of a new mass customization model, as described by Grandinetti (2002).

Finally, a transformation that has heavily affected the industry in recent years regards distribution and, in particular, the rising importance of large retailers. Home-furnishings distribution in Italy is very fragmented, being among the very few European countries in which small scale retailers still represent the largest channel for sales Euromonitor (2009a). However, the picture is fast changing: due to the impact of the economic recession, to the decline in the disposable income and to a deeper transformation in the concept of home-furnishing, big distribution groups are increasing their market share to the disadvantage of local distributors. Similarly, an increasing number of producers are understanding the importance of the proximity to the final markets and of the relations with customers and are opening franchising stores or other proprietary distribution channels. According to Euromonitor's data, in 2008 the first brand in the Italian home-furnishing market, was IKEA, with a 5.3% share, followed by Mercatone Uno (3.4%) and Divani & Divani and Frau (2.6% each).

For long time Italy has been the first exporter in the world market, its competitive advantages being high quality, innovation, design and flexibility. Design, in particular, has been a key competitive advantage, developed especially by "pioneering companies" which have been able to mix art, technology and tradition to create successful products (Lojacono, 2001; Di Maria, 2007) thanks also to the collaboration with consulting industrial design firms (Capaldo, 2007). The creativity and design skills of Italian firms have strongly contributed to their success in international markets. Lead firms have recently emerged as engines of the most competitive local systems, leveraging on traditional local competencies and on (global) value chains spanning outside the traditional boundaries of districts, remaining competitive despite the general crisis of the industry in the early 2000s (Lojacono, 2001; Di Maria, 2007). However, the entrance of new competitors in the global arena and the more recent recession have been challenging the leadership of Italian districts, questioning the ability of the district model to face the challenges of the new millennium. The recent economic recession has been worsening the competitive pressure on Italian producers: in 2009 production shrunk by 18.2%

with respect to the previous year, as reaction to a 21.9% decrease in export and 16.8% in internal demand. The first month of 2010 shows signs of a recovery, with export increasing by 3.3% in values and 14.9% in quantities, which may suggest a downgrading in terms of products exported, with the strongest increase especially in extra-EU countries such as China, Slovenia and Libya (Federlegno-Arredo, 2010).

B.2.3 The Livenza furniture district

The Livenza furniture district straddles the Livenza river, a natural border between Treviso province (in the Veneto region) and Pordenone province (in Friuli-Venezia Giulia), in the North-East part of Italy. The Livenza district is one of the biggest furniture district and is specialized traditionally in home-furniture production, even if more recently also the office and the bath furnishings are increasing their importance. In these two provinces, this industry outnumbers all other production: 61% of manufacturing employees are specialized in wood and furniture production or related industries. In the district there are about 1,500 firms (800 in the Pordenone province, 600 in the Treviso one) producing a turnover of 1.7 billion euros (as of 2009). Firms in the Livenza district are characterized by being slightly bigger with respect to the national average and are well-known all over the world for their innovative and manufacturing capabilities.

Differently from many other furniture Italian districts, the Livenza is pretty young: it developed starting the 50s thanks, other than the enabling factors named before that are common to all districts, to the existence of a local flexible and relatively low-cost workforce and to specific incentives provided by local authorities (Chiarvesio and Lojacono, 2002). At the very beginning, firms were responsible for the overall steps of the Value Chain but starting the 70s many of the local firms outsourced parts of the production to leverage on economies of specialization enabled by the presence of many firms in the area, born as spin-off from the parent firms. Starting the same period, district firms started to sell in foreign markets, which then it will become a leitmotiv in the following decades. Livenza district's firms are among the more competitive in Italy: in 2008 the province of Treviso alone was responsible for 14% of the Italian furniture export (Federlegno-Arredo, 2009). However, the district has been hit by the recent economic recession even harder than the overall industry: in 2009 turnover reduced by 20% and export by 23% with respect to the previous year.

Many of the district's firms grew through acquisition rather than internally: according to the survey conducted on the TeDIS dataset by Chiarvesio and Lojacono (2002), 47.9% of those districts were part of a group. The same survey revealed that, similarly to many district firms, the majority of Livenza firms (91.8%) outsources at least part of its production, mainly to local sub-contractor (50%). The furniture district benefitted from the presence of other manufacturing specialization in the area, such as the mechanical, which provided advanced and customized equipments and contributed to ability of furniture producers to work with other materials than wood, especially metals. If the traditional competitive advantages of firms were innovation, quality, flexibility, the ability to manufacture environmental-friendly products is increasingly becoming an important asset for district firms, especially

in the Pordenone province, in which the district body is very supportive.

B.3 Environmental challenges and environmental innovations in the furniture industry in Italy

According to the report realized by the (European Commission, 2008), the most relevant environmental problems to be taken into account in the furniture industry regard:

- Loss of biodiversity, soil erosion and degradation as a result of unsustainable forest management and illegal logging;
- Landscape impact from mining activities;
- Use of non-renewable resources such as; metals and oil/natural gas for plastics;
- High water and energy consumption in the production of several materials;
- Use of hazardous substances that can be released during production, use or disposal;
- Use of organic solvents and generation of VOC emissions
- High amount of packaging;
- Early replacement of furniture due to a lack of reparability options, low durability, ergonomics or furniture not fit for purpose.

In Italy, according to a survey administered in 2010 by the industry association to 84 firms, the environmental aspects more often addressed by firm's environmental innovations regard the raw materials used (19.9%), waste management (16.9%), energy-efficiency (15.7%) and the use of chemicals (13.9%). Each of these aspects, affect different phases of the value chain, which can be summarized in input, the processing and the final product and its use.

As far as the *inputs* are concerned, main environmental challenges regard the resource consumption and reduction of biodiversity, generated by the inconsiderate use of forests, which is addressed through the use of i) certified wood, ii) recycled raw materials and iii) new materials. An increasing number of firms is using FSC or PEFC certified wood, which is wood coming from responsibly managed forests. In 2009, the number of Italian furniture firms using PEFC-certified wood almost doubled with respect to the previous year and FSC-certified even tripled (Federlegno-Arredo, 2010). Veneto and Friuli's firms are among the more sensitive, representing alone the 27% of Italian PEFC certifications and the 32.3% of FSC ones. Furthermore, other than MDF and particleboard – made by second-hand materials – an increasing number of firms are using components and semi-finished products made, thanks to a newer technology, by 100% recycled wood. In additions, firms are substituting wood with other materials, mainly glass (60%), steel (17%) and aluminium (8%). According to Federlegno-Arredo, in 2009 7.97% of raw materials used in Italy by wood-furniture firms was of any of the above described typologies, a 80% increase in 5 years time.

Regarding the *production processes*, main environmental concerns are the emissions and hazardous substances, mainly associated with the varnishing process, which is responsible of the emission of formaldehyde, a carcinogen substance. Firms

are increasingly testing new varnishing methods, which enable the uses of less solvents and hazardous substances and lower emissions in the atmosphere. Data from the Federlegno-Arredo's survey suggest than in 2009 the consumption of varnishes, glues, thinners or similar chemical products reduced with respect to previous years. In 2009 the emissions of Volatile Organic Compounds (VOC) for the furniture industry was 48% lower than in 2005. Furthermore, many firms are implementing eco-efficiency measures, to reduce their use of energy and reduce wastes. According to the Federlegno-Arredo', energy consumption per cubic meter decreased from 0.051TEP/m^3 in 2005 to 0.038 in 2009 and the percentage of wastes not going to dumps moved from 86.9% to 93.6%. The number of firms which achieved a ISO14001 certification – the voluntary international certification schemes assuring on the environmental performance of the production processes of firms – strongly increased. In 2009, 44 new firms achieved the certification, 22.7% more than in the previous year, suggesting an increasing interest in environmental concerns and effort to reduce the ecological footprint.

Finally firms are increasingly designing products so to allow sustainability also at their use and at the end of life. Through eco-design solutions, firms works to increase the increase their life expectancy, to increase the eco-efficiency in their usage and finally the recyclability of the products. For examples of environmental innovations introduced by firms in the furnishings and in other industries see also the publication by Italian ministry of the environment (2010).

Appendix C

The questionnaire

C.1 Innovation and environmental sustainability

- What does environmental sustainability means for your firm?
- Did your firm introduced any product or process environmental innovations? Could you describe them? Why were they introduced?
- If you introduced product innovations, what is the share of environmental products on the overall products?
- What have been the impacts of the introduction of environmental innovations on firm's activities? What the impacts on the existing product range?
- What trends do you envision for the future? Are your firms going to introduce other environmental innovations?

C.2 The implementation of environmental innovations

- What information sources have been important to your firm innovation activities if any (e.g., suppliers, clients, competitors, consultants, universities or other research centers, trade fairs, industry associations,....)? Were they different from those used for other innovation activities?
- How did your firm develop environmental innovations? Did it implement internal R&D activities, buy patents or buy special equipments or machineries? Did it collaborate with external entities such as universities, suppliers, customers, NGO, industry associations or any other? Why? How did you selected them?
- In which phase of the innovation process were external partners involved, if any (e.g., they have been a useful information source, they have cooperated to develop the technology, the supported the firm's design and R&D effort,...)?
- How and how much have your enterprise invested to develop the environmental innovations?
- Does your firm have an internal R&D department, how many persons are devoted to those activities and how much of the overall effort is devoted to develop environmental innovations?

- Did your firm patent innovations? If yes, how many and why? Are there any differences between environmental innovations and other innovations?

C.3 Sustainability and supply chain management

- Have environmental innovations introduced by your firm been stimulated by a buyer? If yes, how?
- Were the innovation suitable just for that company or were you firm able to use them also for other customers?
- Which have been your incentive to change? Did the buyer offer any support (e.g., financial, knowledge,....) ? Did any other actor support or stimulate your environmental innovations?
- Following to introduction of environmental innovations in your company or to develop them, did your firm need to change its suppliers or its relationship with them, asking the introduction of innovations in their production process or new products? Did your firm needed to supply from new firms?
- Did the technical capabilities or the attitude of the suppliers impacted on your firm innovation capabilities or on its green strategies?
- Is sustainability among your criteria to select suppliers? If yes, does it concern all suppliers, i.e., suppliers of each input and components and all suppliers for each input and component?
- Does your firm control the environmental performance of your suppliers? Who, how and how much? Does your firm requires suppliers to obtain specific environmental certifications?
- Does your firm monitor or influence the environmental performances of your second-tier suppliers? If yes, how and what differences are there with respect to the management of first-tier suppliers?
- How do your firm deal with suppliers that do not satisfy the environmental performance it requires? Do you move to new suppliers or do you support its change? Which factors affect this choice?
- Did your firm support the change of your suppliers toward a more environmental friendly production process? If yes, how and why?

C.4 The company

- What is the main activity of your company? Which is your business model?
- What is your main competitive advantage?
- What is your turnover and the number of employees?
- Which production phases you deal with in-house and which have been outsourced?
- How many suppliers do you make business with? Where are they located? Which competences do they have and why you choose them?
- How would you describe the relations with you suppliers? How long have you making business with them?
- Who are your main customers and where are they located?

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