THESIS FOR THE DEGREE DOCTOR OF PHILOSOPHY

Capturing Value from Green Offers

An Examination of Environmental Differentiation and Economic Performance

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ABSTRACT

This thesis examines how a number of Swedish firms try to create and appropriate economic value from offers that are differentiated by low environmental impact. It presents empirical, methodological and theoretical contributions to the environmental strategy literature, focusing on the appropriation of economic value by profit-seeking firms.

Based on accounting and survey data and a novel methodological approach the thesis shows that, in small Swedish firms, environmental differentiation is negatively associated with economic performance. It shows also that for environmentally differentiated offers, a resource efficient design leading to low total cost of ownership for customers is positively associated with economic performance. Other hypothesized benefits related to environmental differentiation, such as increased sales from communicating environmental superiority, associated regulatory support and improved product quality, are not significantly related to economic performance.

Based on a multi-level qualitative study of an established firm, the thesis explains how corporate visions and top managers' explicit commitment to increased sustainability facilitate the commercialization of environmentally differentiated offers. This study shows that cleverly formulated environmental goals may enable a firm to accelerate and achieve wider diffusion of already developed, originally customized solutions to specific customer problems.

A longitudinal study of a small manufacturing firm developing and launching a service-based, circular business model built on remanufacturing, provides a rare examination of the challenges and opportunities encountered during the development of such a business model. An important conclusion of this study is that service-based circular business models, by design, imply a larger business risk during their implementation than more traditional, so-called linear business models.

The thesis proposes a theoretical framework of appropriation strategies specifically related to environmental differentiation. The framework draws on the problem-solving perspective of the firm and the social dilemma literature to derive four generic appropriation strategies in which many of the drivers of environmental differentiation reported in prior literature can be understood as special cases. The four appropriation strategies exploit the advantages from resource efficiency, reputational gains, regulatory fit and closer inter-firm value chain integration.

Keywords: Value appropriation, environmental strategy, circular business model, business model, circular economy, business case for sustainability, environmental innovation.

List of appended papers

The thesis is based on the work contained in the following papers, referred to by Roman numerals in the text:

Paper I

Linder, M. (2012) 'A problem-solving perspective on strategies for appropriating environmental value – some implications from considering institutional solutions to social dilemmas'. *International Journal of Innovation and Sustainable Development*, Vol 6, No. 2, p. 164-183. DOI: 10.1504/IJISD.2012.046946

Paper II

Björkdahl, J. and Linder, M. 'Formulating Problems for Commercializing New Technologies: The Case of Greening'. Presented at *DRUID summer conference 2010*, Imperial college: London, June 16-18. Revised and resubmitted to an international journal.

Paper III

Linder, M., Björkdahl, J. Ljungberg, D. (forthcoming) 'Environmental Orientation and Economic Performance: A quasi-experimental study of small Swedish firms'. Published as early view in *Business Strategy and the Environment*. DOI: 10.1002/bse.1788

Paper IV

Linder, M. 'Determinants of economic performance for environmental technology-based offers – A cross sectional study of small Swedish firms'. Submitted to an international journal.

Paper V

Linder, M. and Williander, M. 'Examining the challenges of implementing closed-loop service-based business models from an entrepreneurial perspective'. Revised and resubmitted to an international journal.

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/Marcus Linder

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1 Introduction

Imagine a society of rapidly increasing material wealth, configured in a way that does not jeopardize humanity's long-term prosperity. A major issue jeopardizing long-term prosperity is that today's economy is most likely not sustainable from an environmental point of view (Stern et al., 2006; IPCC, 2007; Rockström et al., 2009). However, more and more firms are seeking to develop new offers with reduced environmental impact. The topic of this thesis is development, commercialization and economic performance of environmentally differentiated offers by profit-seeking firms.

The profit motive of firms is arguably a cause of many unsustainable practices. However, the profit motive is also a driving force behind much innovative problem solving in society. Since firms are among the most potent problem-solving organizations, it is highly desirable to better understand the current extent to which and the potentially favourable conditions for firms' efforts to profit can be aligned with reduced environmental impact from their businesses. The research objective[1] of the work presented in this thesis is to increase society's rate of change towards a state of sustainable development by providing knowledge of the business opportunities and challenges related to the development and commercialization of contemporary environmentally differentiated offers.

To achieve this research objective the thesis examines two cases of development and commercialization of environmentally differentiated offers; it also examines, for a larger sample, the extent to which and conditions under which environmental differentiation is associated with economic performance. While the topic of environmental differentiation has been studied for decades (e.g. Ashford et al., 1979; Runge, 1987; Hart, 1995; Horbach, 2008), there is arguably still much uncertainty among both scholars and managers regarding the extent of and conditions for economic success from such practices. The research aim of the thesis is to contribute to the environmental strategy literature by providing new theoretical viewpoints on, methodological approaches to and empirical data on the development, commercialization and economic performance of environmentally differentiated offers.

In this thesis an environmentally differentiated offer is defined as an offer that is justifiably claimed to be superior on the environmental impact performance dimension, to the typical alternatives that the customer is choosing between. However, thorough assessment of the environmental sustainability of the considered offers is beyond the scope of this thesis.[2] The offer attribute of interest here is environmental differentiation as a social

[1] The term research objective here refers to the underlying goal of the study. The term research aim (see next paragraph) refers to the abstract summary of the academic contributions the thesis attempts to make.

[2] This is related to issues of epistemological uncertainty (cf. Rockström et al., 2009 versus Brook et al., 2013), operationalizational demands (cf. Guinee, 2002) and predictive uncertainty related to path dependency. For further details, see section 2.1.1.

construct,[3] that is: a justifiable claim of superior environmental performance. The term justifiable here implies that for the casual sceptic this claim is would be considered reinforced by supporting evidence upon closer inspection.[4]

Research on environmental differentiation and its relation to economic performance is conflicting in terms of theoretical basis and empirical findings. A common theoretical argument is that environmental differentiation creates common goods but private costs and, hence, is harmful to economic performance (McGuire et al., 1988; Friedman, 1970). However, there are also several schools of thought that argue that firms can improve environmental differentiation and economic performance simultaneously. The natural resource-based view (Hart, 1995; Sharma and Vredenburg, 1998) argues that a proactive environmental strategy allows firms to reduce risk and develop valuable capabilities, among other benefits. The pollution-as-waste perspective (e.g. Porter and Van der Linde, 1995a) argues that environmental differentiation leads to efficiency savings (Florida, 1996) and increased economic performance. A variant of this argument, which acknowledges the importance of inter-firm relations and cooperation, is presented in the literature on product-service systems (e.g. Mont, 2004). The institutional perspective (e.g. Pacheco et al., 2010) argues that firms can benefit by leveraging and influencing the social norms, regulations and subsidies related to environmental differentiation. There is also the reversed causality argument (e.g. Waddock and Graves, 1997), which claims that while there is a positive relation between environmental differentiation and economic performance, causality runs from increased economic performance to increased environmental differentiation. A possible explanation for this is that economically successful firms have slack resources that managers invest in proactive environmental efforts.

Among the empirical findings, there is no consensus in prior research regarding the relation between environmental differentiation and economic performance. On the one hand, there is quantitative evidence (e.g. Orlitzky et al., 2003; Cornell and Shapiro, 1987; Pava and Krausz; 1996; Waddock and Graves, 1997; Preston and O'Bannon; 1997) and numerous success stories (e.g. Porter and Van der Linde, 1995b; Holliday et al., 2002; Willard, 2002; Esty and Winston, 2006) showing a positive association between environmental differentiation and economic performance. On the other hand, there are some inconclusive findings (e.g. Fogler and Nutt, 1975; Anderson

[3] The description of environmental differentiation as a social construct refers to acknowledgement in this thesis that the meaning of the concept is negotiated within social interaction and, accordingly, may change over time. It is *not* meant to imply that the thesis employs a social constructivism meta-theoretical perspective overall. See section 2.1.1 for further details on the reasoning behind the concept definition. For the meta-theoretical stance employed in this thesis, see section 3.1.

[4] In terms of operationalization, the environmentally differentiated offers discussed in this thesis are either 1) more closely aligned than alternatives to the four system conditions of a sustainable society (Robèrt et al., 2002) or 2) match the European Union Environmental Technologies Action Plan (European Commission, 2004) definition of environmental technologies.[8] In most instances, these two criteria overlap.

and Frankle, 1980; Aupperle et al., 1985; Keele and DeHart, 2011) and findings showing a negative association between environmental differentiation and economic performance (e.g. Simpson et al., 2004; Revell et al., 2010).

There are several possible explanations for these contrasting findings. One complication is that that many of the activities of the studied firms are fully or partially unrelated to environmental differentiation. It is, therefore, difficult correctly to delimit the activities and the revenue and cost components relevant for inclusion in measures of both environmental differentiation and economic performance driven by this differentiation. Another complication is the role of contingency factors, such as differences in firms' business models and industry and institutional differences (Steger, 2004). These methodological issues, together with the sometimes conflicting theoretical explanations for environmental differentiation, have led to calls for further research on the link between environmental differentiation and economic performance (e.g. Aragón-Correa and Sharma, 2003; McWilliams and Siegel, 2001; Rowley and Berman, 2000; Schaltegger and Synnestvedt, 2002), and on the market conditions and strategic decision making affecting this link (Ullman, 1985; Lankoski, 2008).

In response to these calls for further research, this thesis attempts to contribute to three research domains. They are identified below in the form of research questions. Each pertains to various aspects of the development, commercialization and economic performance of environmentally differentiated offers. The first question focuses on the economic performance of environmentally differentiated offers, their attributes and the market conditions associated with profitability of these offers. The second question focuses on managerial behaviour facilitating the development and commercialization of environmentally differentiated offers in established firms. The third question focuses on the opportunities and challenges for firms trying to commercialize offers based on closed material flows. The three research questions are:

Research question 1: To what extent are firms appropriating economic value from environmentally differentiated offers, and what situations facilitate value appropriation?

Research question 2: How can the development of environmentally differentiated offers be managed effectively?

Research question 3: What are the risks and opportunities associated with service-based offers designed for closed-loop material flows?

The research involves the development of a theoretical framework for the strategies for appropriating environmental value, and three empirical investigations. The first investigation is based on a cross sectional survey and accounting data for small environmental technology firms. The second is an in-depth multilevel retrospective case study of a manufacturing firm extending its product portfolio with environmentally differentiated offers. The third is a longitudinal interventionist case study of a manufacturing firm attempting to launch a circular business model. In this thesis, I draw on and

combine the perspectives of institutional solutions to social dilemmas (e.g. Ostrom, 1990), the problem-solving perspective of the firm (e.g. Nickerson and Zenger, 2004), product-service systems (e.g. Mont, 2002), and the environmental strategy literature more generally (e.g. Hart, 1995), in order to examine and explain the management of environmentally differentiated offers and its implications for economic performance.

The thesis consists of five appended papers along with this cover paper. This first chapter defines the topic and focus of the thesis; the second chapter presents a frame of reference and a review of the prior literature on environmental differentiation. It provides justification for the three research questions in relation to the prior literature. Chapter 3 describes the choice of research design, data collection and analysis, and the meta-theoretical perspective employed in the thesis. Chapter 4 provides a summary of the appended papers. Chapter five reviews the findings in light of previous theory and seeks to develop the existing theory on environmental strategy. Suggestions for further research and managerial implications are presented in Chapters 6 and 7.

2 Theoretical framework and prior research

This chapter has two aims. First, it defines certain key concepts used in the thesis; second, it reviews prior research related to this thesis research. Whereas the first part focuses on concepts and draws on the more general business strategy literature, the second part discusses the findings from research focused specifically on environmental differentiation and related phenomena. This is followed by a justification of the research questions. The chapter is divided into three parts:

The first part defines the key concepts used in this thesis and conceptualizes the underlying problem of appropriating value from environmentally differentiated offers. This constitutes the theoretical framework of the thesis. This framework was developed to highlight the challenges related to a business strategy of environmental differentiation.

The second part positions the thesis in relation to prior research, and provides the background to support the research questions. It begins with an overview of how the environmental strategy literature has evolved, and contrasts the various perspectives employed in the field with the one chosen for this thesis. This is followed by descriptions and discussions of the literature related to each of the three research questions.

The chapter concludes with a section that provides explicit justifications for the three research questions in relation to the reviewed literature.

2.1 Theoretical framework

Three concepts are of particular importance in this thesis: environmental differentiation, value appropriation, and service-based circular business models. Environmental differentiation defines the general phenomenon studied in the thesis. The value creation and appropriation concepts provide a framework for discussing the challenges and opportunities of environmental differentiation from a general business strategy perspective, including also the notions of social dilemmas and their relation to economic institutions. The third concept, service-based circular business models, refers to a specific part of the phenomenon, studied in *Research question 3*.

2.1.1 Environmental differentiation

The concept of environmental differentiation is used to define the phenomenon studied in this thesis. In a review of the literature on the association between environmental differentiation [5] and economic performance, Peloza and Yachnin (2008) found 39 different measures for

[5] Different papers use different labels. Alongside environmental differentiation, the most common are environmental performance (e.g. Tyteca, 1996), environmental technology (e.g. Klassen and Whybark, 1999), corporate environmental performance (e.g. Orlitzky et al., 2003), environmental orientation (e.g. Menguc and Ozanne, 2005), eco-environmental performance (e.g. Williander, 2006) and environmental sustainability (e.g. Pullman et al., 2009). I take these to refer to approximately the same construct, as has been commonly done in many prior publications (e.g. Orlitzky et al., 2003; Peloza and Yachnin, 2008).

this construct. These range from objective measures, such as pollution reporting or word counts in annual reports, to subjective measures such as survey responses and external rankings. Thus, there is little consensus on how to operationalize the construct.

One reason for this may be that many definitions of environmental sustainability or environmental impact are inherently problematic. A fundamental problem in trying to pin down an objective and general definition of environmental sustainability is that there is epistemic uncertainty about what will be sustainable in the long run. For example, the paper by Rockström et al. (2009) quickly became influential, suggesting it met a latent need for a good definition. Rockström et al. described a number of environmental indicators and thresholds beyond which the provision of eco-system services will decrease rapidly. However, only three years later, the papers by Nordhaus et al. (2012) and Brook et al. (2013) rejected these indicators and demonstrated the uncertainty in the predictions about thresholds. Some years earlier, Robèrt et al. (1997) outlined four system conditions for a sustainable society which have also been criticized as being ambiguous (Upham, 2000). The most common definition is perhaps that provided by the Brundtland commission[6] (United Nations, 1987), but this has been criticized repeatedly for vagueness, and because it is difficult to operationalize for specific instances (Kemp and Martens, 2007).

Even if one were to adopt one of the suggested definitions as accurate, several practical issues arise. A proper assessment of the environmental impact of an offer over its life cycle takes many years (e.g. Eide, 2002; Heikkilä, 2007). Were the research on the profitability of environmental differentiation to be limited to studies including such ambitious evaluations, the scientific community would end up with a lot of knowledge about the environmental impact of offers, but very little knowledge about the profitability of the firms attempting to move in that direction. If the only interest for a business strategy researcher were the phenomenon of true environmental sustainability of firms' offers, then such a slow lumber forward might be the only viable option. However, if the limited extent of our current knowledge regarding environmental sustainability is acknowledged, there arguably remains a worthwhile phenomenon to study. Although the validity of claims to environmental sustainability must often remain in doubt, be it for epistemic reasons or because of practical limitations,, the fact remains that firms are still doing *something*.

One way to deal with these issues is to define and treat environmental differentiation as a social construct, acknowledging that the specific meaning of the construct evolves and changes over time through interaction and negotiation among society's actors. This means that the phenomenon, the object of study, in this thesis is not environmentally sustainable offers according to some objective perspective, but offers for which a justified

[6] "Sustainable development is development that meets the needs of the present without compromising the ability of future generations to meet their own needs" (United Nations, 1987, Chapter 2, page 1).

claim of lower environmental impact than typical alternatives has been made. In this thesis, such offers are referred to as environmentally differentiated.[7]

There are several reasons for environmental differentiation thus defined as the choice of phenomenon. First, while it may not be the objective phenomenon often implicitly assumed in the environmental strategy literature, it captures something of interest to society and the study of environmental strategy. I will be able to present valid claims regarding the economic performance of offers that are *considered* environmentally superior, at least by some relevant actors, such as the firm and independent third parties. Second, the findings regarding environmental strategy presented in this thesis should by this choice stand a better chance of remaining valid as the perceptions and knowledge about environmental sustainability changes over time. In other words, the findings will not be limited to some, in the future possibly out-dated or unfashionable, measure of environmental sustainability. Third, given the cost in terms of the time and resources required to thoroughly evaluate the environmental impact of an offer's over its life-cycle, this choice of phenomenon is warranted also on pragmatic grounds. Fourth, lack of environmental sustainability is often considered a societal *problem* (e.g. United Nations, 1987). By definition, a problem needs a subject, an actor that formulates the preferred state of affairs (Pounds, 1969; Simon, 1978). It then follows that a view of the phenomenon as a social construct captures something essential about the phenomenon (Landry, 1995).

There of course remain operational challenges related to the concept of environmental differentiation as defined in this thesis. For example, as previously mentioned, the term justifiable in this thesis implies that the claim to the casual sceptic would be considered reinforced by supporting evidence upon closer inspection. The response to these challenges in terms of data collection is described in the method chapter. In summary, Papers III and IV use a claim by a third party based on interviews with the firm in relation to the EU definition of environmental technologies[8] (European Commission, 2004), combined with a direct claim by the firm. Papers II and V use an assessment by the researchers themselves based on the four system

[7] Environmental differentiation should not be confused with offers *positioned* in the marketplace as environmentally superior. I use the term environmental differentiation to denote that there is a justified claim being made that the offer has lower environmental impact than typical alternatives the customer is choosing between. This is distinct from offers that are simply marketed as environmentally superior towards customers. Communicating the claimed environmental strengths of the offer to customers is one way to increase the appropriability of the offer. However, an offer can be environmentally differentiated without being positioned as such on the marketplace.

[8] "Technologies whose use is less environmentally harmful than relevant alternatives […] They encompass technologies and processes to manage pollution (e.g. air pollution control, waste management), less polluting and less resource-intensive products and services and ways to manage resources more efficiently (e.g. water supply, energy-saving technologies)" (European Commission, 2004, p. 2).

conditions[9] of a sustainable society (Robèrt et al., 2002) combined with the firm's claim of environmental differentiation. Paper I is a conceptual paper and therefore the construct is not operationalized there.

2.1.2 Value creation and appropriation

In order to survive in a competitive market, the firm must appropriate economic value. Apart from rent-seeking behaviour (cf. Krueger, 1974), firms create profits through a two-stage process (Brandenburger and Stuart, 1996; cf. Lepak et al., 2007). The first stage is to create value – typically for customers. The second stage is to capture a part of that value – typically via revenues. For a firm to profit, the captured value needs to be larger than the firm's costs of creating the value in the first place. The logic of how a firm creates and appropriates economic value by taking advantage of an opportunity is typically referred to as the firm's business model (Björkdahl, 2007; Osterwalder and Pigneur, 2009). A business model is considered economically sustainable if it allows the firm to capture more value than it consumes in creating that value. Thus, the two prerequisites for designing an economically sustainable business model are viable strategies for how the firm can 1) create value and 2) appropriate a large enough share of that value to attract and keep the required resources to provide that value plus profit.

Taking a problem-solving perspective of the firm (Nickerson and Zenger, 2004), means taking the view that firms create value by solving problems. Value *appropriation* thus refers to the act of capturing the value generated by a solution or by addressing a problem. A problem is defined as the difference between the perceived current state of affairs and an imagined preferred future state of affairs (Simon, 1978) as experienced by the subject (Landry, 1995), here referred to as the problem-owner. In addition, the problem must be perceived as significant for the involved stakeholders, solvable by some agent, but not trivially so by the beneficiary of the problem's solution (Agre, 1982). A problem formulation consists of an explicit statement of the: 1) problem owner, 2) perceived current state of affairs, and 3) preferred state of affairs. The activity of problem formulation is the generation of a problem formulation. Arguably, the single most important aspect in the problem solving process is formulating the problem because this, in large part, determines the subsequent course of action (Lyles, 1981). Although the task of problem formulation is critical to managers' decision-making responsibilities, in reality managers rarely fully understand the problems they are trying to solve (Pounds, 1969).

A problem is solved if the current state of affairs changes and equates with the preferred state of affairs from the perspective of the subject (i.e. problem-owner). In most situations, what constitutes a full solution to a problem is contingent on how the subject or problem owner chooses to formulate the problem. Thus, in many practical situations, the distinction

[9] These are: "In the sustainable society, nature is not subject to systematically increasing... 1. Concentrations of substances extracted from the Earth's crust. 2. Concentrations of substances produced by society. 3. Degradation by physical means. 4. And, in that society human needs are met worldwide" (Robèrt et al., 2002, pp. 198-199).

between a solved problem and a problem that is merely addressed is irrelevant. However, in some situations it is important to acknowledge that the problem has been only partly solved. For example, when considering environmental problems on a global scale, it would be unusual for a single firm to be able to resolve the problem. In such situations, the concept of problem addressation is used to denote the partial solving of a problem. A problem is considered addressed when the problem is fully or partially solved. In other words, it is addressed if the current state of affairs is moved closer to the preferred state of affairs such that the state is considered by the problem-owner as preferable to the previous state of affairs.

A problem-solution combination is considered valuable if the cost of the solution is lower than the cost of the problem (cf. Hsieh et al., 2007). A problem is considered valuable if it can be used to construct a valuable problem-solution pair. If a valuable problem-solution pair is addressed, value is created. Thus, by definition, the prerequisite for a profitable business model is the existence of a valuable problem–solution pair. In fact, the concept of valuable problem-solution pairs has been constructed to match common definitions of entrepreneurial opportunities (Hsieh et al., 2007). If there are environmental problems that are likely to have considerably larger negative effects over time than the cost of their solutions, there should be significant potential opportunities for firms that can solve these environmental problems.

In this thesis, environmental problems are defined as the set of problems in which the preferred state of affairs involves preservation of the suitability of the natural environment for future human needs (cf. Johnson et al., 1997). Thus the perspective adopted here is anthropocentric in the same sense as for example the Brundtland Commission's definition of sustainable development (United Nations, 1987). The preferred state of affairs of an environmental problem are the necessary conditions for an environmentally sustainable society. The term environmental problem, in contrast to environmental differentiation, is used here as an abstract tool of analysis – not as a construct used for empirical investigation. In this terminology, an environmentally differentiated offer is the solution to a problem for which there is a justified claim that at least part of the problem is an environmental problem.

There exist valuable problems in the set of environmental problems if there exists several environmental situations that are costly and that could be solved at a lower cost than provided by the status quo, but not trivially so by their beneficiaries. Such problems do arguably exist (Linder, 2012), since the total economic costs of neglected environmental problems can be quite high (e.g. Stern et al., 2006). This means that the first prerequisite for economically sustainable business models to allow firms to address environmental problems is in place: i.e. firms can *create value* by addressing at least some environmental problems.

The second prerequisite for an economically sustainable business model is that there exists a way for the firm to appropriate a large enough share of the

created value. A major challenge to achieving this is that many environmental problems can be represented as social dilemmas, or social dilemma problems. A social dilemma occurs when "individuals in interdependent situations face choices in which the maximization of short-term self-interest yields outcomes leaving all participants worse off than feasible alternatives" (Ostrom, 1998, p. 1). Because the problem-owner of a social dilemma problem is the 'collective', that is, the sum of the involved actors, there is no individual actor with an incentive to solve the problem as long as the situation shares the pay-off structure of a social dilemma – *even when* the environmental problem *is* a valuable problem (cf. Dawes, 1980). Hence, in social dilemma situations, valuable environmental problems, even if properly formulated, may not be perceived as opportunities by individual firms.

When a valuable environmental problem can be represented as a social dilemma problem, appropriation of the created value can be difficult for the firm addressing the problem. Thus, a firm might create more value by changing its offer or operations in order to address an environmental problem, but may still capture less value because the created value is diffused among problem-owners the firm captures no revenues form, such as the general public or future generations. This is illustrated in figure 1, which is adapted from the description of value appropriation in a value chain by Brandenburger and Stuart (1996). The first column is taken from Brandenburger and Stuart's paper. The second column includes an additional level on top of their model. It is added to illustrate the potential appropriation issue when addressing social dilemma problems. In a situation where the customer is the only problem owner of the problem addressed by the selling firm, the total value created corresponds to the highest amount of exchange value (typically measured as money) that the buyer would be willing to pay. When there is a consumer surplus in the exchange, the price is lower than the willingness-to-pay, as indicated in figure 1. The cost corresponds to what the firm has to pay its suppliers (including employees) in order to realize the addressation of the customers' problem. In the right hand column, some of the created value is captured by actors external to the transaction between the firm and its customers, denoted as value captured by the collective. Note that the value created by the firm is higher in the right hand column, but the value captured by the firm is lower.

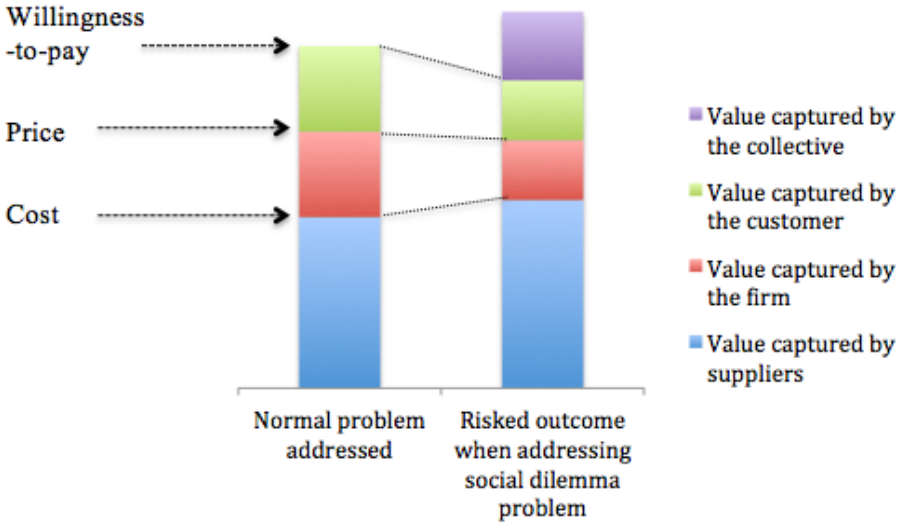

Figure 1 – The problem of value appropriation related to environmental problems in the form of social dilemmas. (Adapted from Brandenburger and Stuart, 1996, p. 10).

Viewed from the perspective depicted in figure 1, the issue that is core to environmental strategy is less one of how to increase the value the firm creates and more one of how to increase the value that the firm appropriates. The value appropriated is affected by the ratio of the value created that is captured by the collective; in other words, the amount of spillovers.

The concept of spillovers is used in the literature on the private appropriation of economic value, typically in relation to intellectual property strategy (e.g. Teece, 1986; Audretsch and Feldman, 1996). This is because (shared) knowledge has the properties of a public good, implying that the collective (including competitors) capture most of the value. In the case of knowledge, spillovers thus imply a social dilemma. The dilemma is that if knowledge can be used by anyone, it becomes difficult to appropriate its economic value because of competition. Hence individual actors are not incentivized to create new knowledge. This is to the detriment of everyone (assuming that knowledge creation is desirable). Because the intellectual property strategy literature deals with issues of spillovers, which is tightly connected to social dilemmas, it is of some relevance to this thesis.

One of the most cited papers on intellectual property strategy was written by Teece (1986). In this paper, he introduces the notion of appropriability regimes, defined as: "A regime of appropriability refers to the environmental factors, excluding firm and market structure, that govern an innovator's ability to capture the profits generated by an innovation. The most important dimensions of such a regime are the nature of the technology, and the efficacy of legal mechanisms of protection" (Teece, 1986, p. 287). Teece wrote this paper in the eighties, a handful of years before the field of new institutional economics really took off in the academic discourse on economics and firm strategy. It is therefore not surprising that Teece considers the firm's strategies for minimizing spillovers primarily in terms of complementary assets, to the exclusion of other institutions except the

patent system. The concept of complementary assets is also the topic of Christmann's (2000) highly cited *Academy of Management Journal* paper. She finds that firm capabilities for process innovation and implementations act as complementary assets that moderate the relationship between environmental best practice and achieving a cost advantage. However, in addition to the present regulatory framework (intellectual property regime), and the resource allocation configuration corresponding to 'complementary assets',[10] there are other types of institutions that can help resolve social dilemmas, for example, by reducing spillovers, in an economic system (Ostrom, 1990).

The term institutions refers to "the rules of the game" (North, 1990, p. 3). More formally, North (1990, p. 3) defines institutions as the "humanly devised constraints that shape human interaction. [...] they structure incentives in human exchange". In this thesis, only institutions that affect the incentives of *economic* production and exchange are considered. Such institutions can be categorized into embedded institutions such as customs and norms; formal rules of economic behaviour such as government regulation; and governance structures such as contract standards (Williamson, 2000). It has been shown that many of these types of institutions can serve as solutions to social dilemmas in that they change economic incentives, the so-called pay-offs in social dilemma games (Ostrom, 1990). Because social dilemmas explain much of the appropriation difficulties for firms that address environmental problems, the notion of institutions as meta-solutions to social dilemma problems is quite useful for discussing value appropriation in relation to environmentally differentiated offers. In particular, the levels proposed by Williamson (2000) are the basis for the derivation of appropriation strategies for environmentally differentiated offers proposed in this thesis.

2.1.3 Service-based circular business models

The concept of business models as a conceptual description of firms' value creation and value appropriation was introduced in the preceding section. This section introduces the concept of service-based circular business models; the prior findings regarding their economic efficacy are presented in section 2.2.5.

A generic type of business model that may be able to combine environmental differentiation with successful value appropriation is a business model based on service provision and circular material flows (Stahel, 2010). The term service-based circular business models is not well-defined in the literature, but refers here to a specific set of business models that meet two conditions. First, the appropriation logic is based on retained ownership of the physical product and sale of a subscription service that includes access to the product. Second, the value creation logic is based

[10] I draw here on Williamson's (2000) framework of economic institutions in which he defines one institutional level as the current resource allocation and resource employment in an economic system. An appropriation strategy relying on complementary assets (Teece, 1986) relies on leveraging these resource allocations to achieve bargaining power.

partly on remanufacturing. The retained ownership and subscription revenue model are together referred to as the renting model. The renting model and remanufacturing in combination constitute the distinction between a service-based circular business model and a corresponding linear business model based on the same physical product.

In a linear business model virgin material enters the value chain upstream, value is added through manufacturing and services, the material is sold to the consumer as part of the offer, and eventually is discarded to landfill. In a business model with a closed material flow, the material re-enters the value chain upstream after use by the consumer. It can enter in the form of newly recycled material, or of used product components suitable for remanufacturing or reuse. When feasible, reuse or remanufacturing is often preferable for economic reasons since much of the value added remains within the components (Nasr and Thurston, 2006). The extent of these benefits in the case of remanufacturing are referred to as remanufacturing cost effectiveness, which is the degree to which remanufacturing reduces the total value chain cost of maintaining an operational and non-obsolete fleet of products over time. By using used but still salvageable products and components as inputs to a remanufacturing process, a significant share of the value added in the original manufacturing process becomes cost savings in the remanufacturing process. A major challenge related to implementing remanufacturing is the reverse flow of products (Östlin et al., 2008; Willis, 2010). One solution to this issue is for the producer to retain ownership of the physical products and offering a service that includes access to or use of the product (Östlin et al., 2008; Sundin and Bras, 2005). Hence service-based and business models with closed material flows can be expected often to be combined into service-based circular business models.

An important task when implementing a new business model is to reduce uncertainty before committing capital to the new business model (Sarasvathy, 2001; Blank, 2005). One way to approach this task is to describe the business model as a set of hypotheses, with the purpose to test these hypotheses as cheaply and quickly as possible, primarily via customer interactions, before committing significant resources (Blank and Dorf, 2012; Ries, 2011). Such risk reduction is an important issue for firms considering a shift to a new type of business model. However, how much the risks inherent in service-based circular business models can be reduced by applying the above approach is unknown.

2.2 Prior research and empirical findings

The environmental strategy literature is fairly young; it emerged as a distinct field in the late 1990s and is still growing. This section begins with an overview of the evolution of the field, and positions the thesis in relation to major research streams within the field. This is followed by a summary of oft-mentioned drivers of firm investment in environmental differentiation. Successive sections provide more specific reviews of prior research related to the contributions put forth in this thesis. Section 2.2.3 presents a review of the research on what arguably is the question that most engages the

environmental strategy community (Berchicci and King, 2007): the association between environmental differentiation and economic performance. Prior research on managerial practices for developing economically successful environmentally differentiated offers is described in section 2.2.4. Finally, prior findings regarding the economic advantages and disadvantages of service-based circular business models are presented in section 2.2.5.

2.2.1 Evolution of the literature on environmental strategy

According to a bibliometric review by Linnenluecke and Griffiths (2013), the first highly cited papers on firms' relations with the natural environment are Bowen (1953) and Friedman (1962; 1970). Both authors discuss the moral imperatives of firms in relation to shareholders and society at large. They reignited an old academic debate that arguably originated in ancient civilizations (Donald, 1975). This re-ignition of the topic occurred during what Hoffman and Bansal (2012) refer to as the first wave of corporate environmentalism, concurrent with increased social awareness of environmental issues. Other highly influential publications concurrent with this wave were Hardin's (1968) famous treatment of the tragedy of the commons, Carson's (1962) treatment of the impact of pesticides on wildlife, and the Club of Rome's (1972) dystopian prognosis of overpopulation. Environmental management started to be integrated into the organizational structure of firms during this period (Hoffman and Bansal, 2012), but with little organizational power and focused strictly on legal requirements (Hoffman, 2001). Perhaps as a result of the small importance ascribed to the organizational role, there was little related theory development by academic business departments (Hoffman and Bansal, 2012).

In 1976, Hoffmann-LaRoche's Icmesa plant accidentally released a cloud of toxic dioxin in the affluent town of Seveso in Italy. In 1984 Union Carbide in Bhopal, India, accidentally released 45 tons of methyl isocyanate which killed 3,500 people. These events resulted in major changes to the institutional environment of many firms, such as the Seveso Directive issued by the European Community; massive civil penalties imposed on by Union Carbide; and increases in the insurance costs for many firms. In the 1980s, the Artic ozone hole was discovered, the Chernobyl reactor disaster released radioactive pollution which affected large parts of Europe, and the Exxon Valdez oil spill resulted in severe eco-system damage in Alaska. In response, many international initiatives emerged, such as the Montreal Protocol (1987), the Intergovernmental Panel on Climate Change (IPCC) (1988), and the Rio conference (1992) and achieved widespread media coverage. The highly cited Brundtland Commission report *Our common future* was published in 1987. Over the course of these events, firms began treating environmental crises as a strategic concern. Simultaneously, environmental strategy began to emerge as a research field in business schools.

Much of the early literature deals with the association between environmental differentiation and economic performance (Berchicci and King, 2007). Prominent environmental strategy scholars (Hoffman and

Georg, 2013) have argued that the sub-topic emerged as the a result of influential papers by Porter and Van der Linde (1995b) and Walley and Whitehead (1994). These papers argued for the existence of so-called win-win situations, and stressed the revenue and market opportunities inherent in environmental differentiation as complements to risk minimization and legitimization oriented environmental strategy. However, it should be acknowledged that earlier publications on the association between environmental differentiation and economic performance predate these two by almost a decade (e.g. Aupperle, 1985; Ullman, 1985; Cornell and Shapiro, 1987; McGuire et al., 1988).

Two highly influential[11] journal Special Issues on the topic appeared at the end of the century. In 1995 the *Academy of Management Review* (AMR) published a Special Issue on "Ecologically Sustainable Organizations". In 2000 the *Academy of Management Journal* (AMJ) published a Special Issue on the "Management of Organizations in the Natural Environment". The *AMR* issue included the much-cited extension of the resource-based view (Barney, 1991) to encompass also environmental resources, authored by Stuart Hart (1995).[12]

In mid 2000, this literature exploded. The number of publications grew exponentially from around 100 per year in 2003 to around 500 per year in 2010 (Linnenluecke and Griffiths, 2013). By analysing the citation links among 3,117 papers on "firms and sustainability", Linnenluecke and Griffiths (2013) concluded that there were now five major literature streams. They labelled these: corporate social performance theory (e.g. Carroll, 1999), marketing (e.g. Drumwright, 1994), stakeholder theory (e.g. Henriques and Sadorsky, 1999), corporate social performance vs financial performance (e.g. Orlitzky et al., 2003), and the greening debate (e.g. Hart, 1995). This thesis speaks to the greening debate (Papers I and II) and the corporate social performance vs financial performance literature (Papers III and IV) literature streams.

Hoffman and Georg (2013) proposed a categorization of the literature based on their understanding of the conceptual models used in the literature on "business and the natural environment". These categories are competitive strategy (e.g. Shrivastava, 1995; Christmann, 2000), the resource-based view (e.g. Hart, 1995; Sharma and Vredenburg, 1998), institutional theory (e.g. Delmas, 2002; Hoffman, 1999), stakeholder theory (Buysse and Verbeke, 2003; Delmas, 2001), incorporating the natural environment into management (e.g. Williander, 2006) and critical theory (e.g. Gladwin, 2012; Bergström and Dobers, 2000). Given the economic performance and appropriation focus of this thesis, the competitive strategy approach and to some extent the resource-based view are the most closely related

[11] Bansal and Gao (2006), who reviewed the prevalence of articles on the topic of "organizations and the natural environment" between 1995 and 2006 conclude that 19% of the most influential articles occurred in these two Special Issues.

[12] This paper is of particular relevance for *Research question 2* in this thesis due to its emphasis on the importance of corporate sustainability visions for successful environmental differentiation.

conceptually. While the thesis draws heavily on the notion of economic institutions, because of the appropriation focus it does so in a manner more akin to the approach in the entrepreneurship literature (e.g. Pacheco et al, 2010) than the self-regulatory and standards focus in much of the environmental strategy literature (e.g. Delmas, 2002; King and Lenox, 2000). The economic performance focus of the thesis does not invite a critical approach to management theory, nor a focus on how concerns for the natural environment are incorporated into management. A stakeholder approach might have added some interesting perspectives, but is not used in this thesis. The choice not to include a stakeholder perspective was driven primarily by the focus on economic performance as the outcome of interest in this research, which is an outcome variable that the stakeholder approach is compatible with, but not dedicated to.

The topic of Paper V, circular business models, is not covered in either literature categorizations; it is related to the work on product-service systems (e.g. Mont, 2004; Tukker, 2004), and to the business case for remanufacturing (e.g. Mont et al., 2006). The product service-systems literature emphasizes the complex interrelations between actors and objects in many cases of environmental differentiation, and often focuses on the opportunities inherent in the 'servicization' of product offers. This is closely related to the phenomenon of service-based circular business models and, therefore, is a literature stream drawn on in this thesis.

2.2.2 Drivers of environmental differentiation

The drivers for companies to become greener and develop environmental or green offerings comprise a range of factors. Below are a variety of drivers commonly reported in the environmental strategy literature. There are unquestionably many other ways to categorize the drivers, and some less common drivers may even have been partially left out. The point of this list is to present the fairly wide spectrum of reported drivers, and thereby implicitly illustrate the lack of a coherent framework that captures them all in a comprehensive and distinct manner.

First, as population and economic growth increase the pressure on for example waste management and supplies of fresh water, fossil fuels and raw materials, the economics of scarce resources are calling for new effective solutions with respect to the environment and energy. Thus, green initiatives often are directly related to the opportunity to decrease costs and increase efficiency (Florida, 1996; Lehni, 2000). Such efficiency improvements can result in a cost-advantage or a differentiation advantage, for example via lower product costs or a lower total cost of ownership of highly resource efficient offers.

Second, employee morale, a socially responsible image and legitimacy/license to operate for the firm are important drivers of corporate sustainability initiatives (Keeble et al., 2005; Davies, 1960). The introduction of one or several environmentally differentiated offers in the firm's product portfolio may be viewed as a means to enhance these benefits for the firm.

Third, regulation is an important factor in some corporate initiatives for environmental differentiation (Porter and van der Linde, 1995b). This includes regulation aimed at internalizing negative externalities but also subsidies for certain technologies, and deregulation of certain markets. In addition, political pressure for sustainable development implies the possibility of stricter regulation in the future.

Fourth, and related to governmental regulation, industry associations might push individual firms in the industry towards environmental differentiation (Barnett and King, 2008). This type of industry self-regulation may occur for benign reasons, or possibly as a way to collectively pre-empt stricter governmental regulation.

Fifth, there is arguably increased demand from both consumers (World Values Survey Association, 2008) and firms (Keeble et al., 2005) for environmentally friendly products, services and production processes.

Sixth, and related to increased demand from customers, an environmentally differentiated offer can provide access to new markets (Esty and Winston, 2006). This might occur because of national or industry standards require it, or because certain types of customers consider environmental differentiation an order winner attribute (Cohen, 2007).

Seventh, a move towards more control over the environmental impact of offers and related operations may be viewed as a way to reduce market, operational and legal risks, and thereby reduce insurance costs (Alberti et al., 2000; Dunphy et al, 2002).

Eighth, and partly as a result of the above drivers, many firms see major opportunities for differentiation (Porter and Van der Linde, 1995a), organizational learning (Sharma and Vredenburg, 1998) and other types of competitive advantage from involvement in environmentally friendly innovations.

2.2.3 The association between environmental differentiation and economic performance

Empirical studies of the association between environmental differentiation and economic performance have been inconclusive so far, with a slight tendency towards findings of a positive association. Most research on this relation considers large firms (Bos-Brouwers, 2010; Martín-Tapia et al., 2010; Aragón-Correa et al., 2008). It should be noted that it has been argued that firm size is generally not a confounding factor in the relation (Orlitzky, 2001). However, Clemens et al.'s (2008) study of the steel industry suggests that firm size influences the tendency to adopt proactive environmental strategies. In addition, there have been repeated calls for research that better accounts for contingent issues, such as industry, size and age of firms (e.g. Lankoski, 2000; 2008; Steger, 2004).

For large firms, a literature review by Griffin and Mahon (1997) provides conflicting findings. A meta-analysis of the literature conducted by Orlitzky et al. (2003) would seem to indicate a statistically significant positive

relation. However, the correlation identified becomes quite weak when non-environmental social performance measures are removed from the analysis. Molina-Azorín et al. (2009) concluded in a literature review that results are still mixed, but that a positive relation is the most common finding. Elsayed and Paton (2009) found a positive relation for mature firms, but that the relation disappears for firms in the growth phase; Keele and DeHart (2011), who used an event-study method, found no relation; and Al-Najjar and Anfimiadou (2012) found a positive correlation over a five-year period.

The number of relevant publications on relation between environmental differentiation and economic performance for small firms is still limited (Bos-Brouwers, 2010; Martín-Tapia et al., 2010; Aragón-Correa et al., 2008). Most of these studies have reported a positive link, using subjective measures (such as survey items) to measure both environmental differentiation and economic performance. For example: Aragón-Correa et al. (2008) found a positive relation studying small auto-repair shops in southern Spain,; Rao et al. (2009) found a positive relation studying small and medium sized enterprises (SMEs) in the Philippines; and Torugsa et al.'s (2012) results, based on a survey of small equipment manufacturers in Australia, showed a positive relation between corporate social responsibility (CSR) activities (including but not limited to environmentally differentiation) and economic performance. However, Simpson et al. (2004), found that most managers perceive the relation for their firms to be negative, studying SMEs in South Yorkshire (UK). And Revell et al. (2010) found that two-thirds of the managers surveyed among SMEs in the London area (UK) believe that there is no or a negative relation.

Among the few small firm studies that use objective measures of economic performance, Martín-Tapia et al.'s (2010) analysis of the Spanish food industry showed a positive correlation between proactive environmental strategies and export intensity. Also, Zeng et al. (2011) found a positive correlation between contamination control and prevention activities and economic performance, in their study of SMEs in Northern China.

It should be noted that several case studies show that there are clear business opportunities for some firms (e.g. Porter and Van der Linde, 1995b; Hoffman, 2000; Dunphy et al., 2002; Esty and Winston, 2006; Carrillo-Hermosilla et al., 2009), a finding supported by the responses to a recent executive survey on sustainability, conducted by MIT Sloan Management Review (Haanaes et al., 2011): 54 percent of respondents believed that their sustainability related actions had increased the profitability of their firm.

One possible source of the conflicting findings is that the diversity of measures. It turns out that the diversity of measures for environmental differentiation mentioned in section 2.1.1 is mirrored for measures of economic performance. Besides the 39 unique measures of environmental differentiation, Peloza and Yachnin (2008) also identified 36 unique measures of economic performance in the reviewed literature. There are also contingency factors to consider. Steger (2004), Steger et al. (2007) and Salzmann et al. (2005) have stressed the importance of taking into account

industry differences when evaluating the business case for sustainability. Further, there is no consensus on the theoretically predicted shape of the relation. Most studies have assumed linear associations, but it has been suggested that the relation might be best described by an inverted U-shape (Lankoski, 2008). In other words, that there is an optimal level of environmental performance that each firm should find, and that excess environmental performance hurts economic performance. On the other hand, an argument can also be made for a regular (non-inverted) U-shape relation.[13] Figure 2 below illustrates the multitude of approaches employed in the research on the relation between economic and environmental performance of firms.

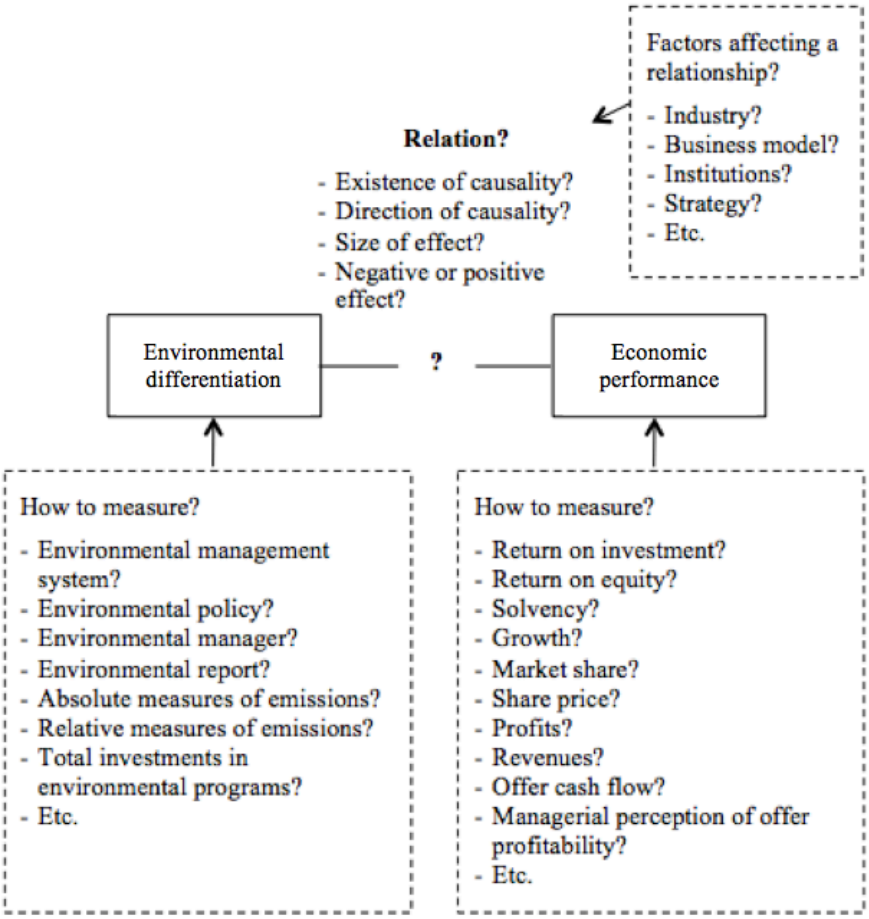

Figure 2 - Illustration of methodological issues to consider when researching the relation between environmental differentiation and economic performance.

[13] Assume that environmental differentiation costs resources but provide some competitive advantages (e.g. increased sales), but only if high *compared* to competitors. Then firms investing little in environmental differentiation would gain a cost advantage. Firms investing the most in environmental differentiation would gain the special advantages associated with a *comparatively* high environmental differentiation. Firms stuck in the middle then would be worst off, facing both a degree of additional costs as well as none of the advantages of a comparatively high degree of environmental differentiation.

2.2.4 Managerial practices for environmental differentiation

Several authors studying how to facilitate development of environmentally differentiated offers in established firms have argued that sustainability must be incorporated into the core strategy of the firm (e.g. Hoffman, 2000; Epstein, 2008; Hutchinson, 1996; Stead, 1995; Roome, 1992). Of particular note is the suggested use of firm vision statements to achieve successful environmental differentiation (Hart, 1995 and 1997; Larsson, 2000; Figge, 2002). Related to environmental visions, it has also been suggested that firms should utilize so-called big hairy audacious goals to implement such an integration of sustainability into corporate strategy (e.g. Hutchinson, 1996; Werbach, 2009). The importance of integrating sustainability into the firm's strategy is empirically supported by Larson (2000), who describes a case where having clear environmental visions and goals facilitated the development of environmental innovations. Figge et al. (2002) emphasize the role of explicit environmental goals, a so-called sustainability balanced scorecard, to facilitate the development of environmental solutions. Related research argues that 'what gets measured gets improved' (e.g. Preston, 2001). Several researchers have suggested implementation of environmental management systems, and the use of total quality management and lean production philosophies to achieve successful environmental differentiation (e.g. Florida, 1996; Melnyk et al., 2003; Simons and Mason, 2003). Williander (2006) convincingly argues that there is a need to recognize that firms may have difficulty seeing and acting even on comparatively obvious green opportunities.

Although these authors have studied environmental differentiation from quite disparate disciplines, ranging from strategic management (Hart, 1995) to entrepreneurship (Larson, 2000) and strategy implementation (Figge et al., 2002), they share an emphasis on the importance of environmental visions. As an instance of theoretical and empirical triangulation, this suggests that the finding that environmental visions support successful environmental differentiation is robust. There is, however, still a lack of empirical research that carefully investigates how the practice of using a corporate environmental vision and explicit environmental goals really relate to the development and commercialization of novel environmentally differentiated offers by the business units in established firms. The capabilities and market environments of different firms differ, and visions and goals can be formulated and integrated in the organization in many different ways. It is quite possible that many such combinations will *not* lead to successful development and commercialization of new offers. If an increased rate of commercialization and development of environmentally differentiated offers is desired, it is therefore important to better understand how environmental visions relate to this process.

2.2.5 Product-service systems and remanufacturing

Hitherto, the environmental strategy literature studying a move towards service-based circular business models has primarily been the literature on product-service systems (e.g. Goedkoop et al, 1999; Mont, 2004; Tukker,

2004; Tukker and Tischner, 2006a; 2006b; Morelli, 2006; Aurich et al 2006). The product-service systems literature in turn relates to and builds on a number of related fields such as functional sales (Sundin and Bras, 2005), functional products (Alonso-Rasgado and Thompson, 2006; Alonso-Rasgado et al, 2004), service/product engineering (Sakao and Shimomura, 2007) and closed-loop systems/the circular economy (Stahel, 2010). Other research streams essentially describing the same or very closely related phenomena include the literature on demand side management (e.g. Strbac, 2008), chemical management services (e.g. Reiskin et al., 1999), servicizing for sustainability (e.g. Rothenberg, 2007) and business systems (Dobers and Wolf, 1999).

The product-service systems literature focuses on how value creation can be achieved by environmentally differentiated offers that combine both products and services (Mont, 2004). The introduction of a product-service system means that the firm switches from selling a product (or, sometimes, selling only a service) to selling a product-service combination (Tukker, 2004) in a way that implies lower environmental impact the before (Mont, 2004). The introduction of a product-service system to an industry corresponds to an (business model) innovation in the sense that when it is successful, it is a valuable, realized and novel configuration of production factors (Schumpeter, 1934/2008).

Because the product-service systems literature emphasizes dematerialization there is a natural connection between product-service systems and remanufacturing. In addition, both product-service systems and remanufacturing are often most potent when ownership remains with a producer (Tukker, 2004; Östlin et al., 2008). In line with this, Mont (2004) describes how the product-service systems literature partly emerged from earlier literature on closed-loop business systems. More recently, the two phenomena are often examined in conjunction (e.g. Mont et al., 2006; Stahel, 2010).

In terms of predictive statements regarding service-based circular business models, service-based business models for physical products are argued to be able to improve customer value and thereby margins, reduce costs as well as reducing environmental impact (Baines et al., 2007). This is believed to be possible because the incentives for the actors of the value chain may be better aligned to increase the ratio of customer utility over the total cost of provision of the offer, compared to a product-only-based business model.

Overall, much of the literature describing service-based circular business models has been quite optimistic about the advantages of such a business model (Vezzoli et al., 2012). There are numerous suggested advantages: First, the use of remanufacturing should enable cost savings in manufacturing due to decreased procurement needs (Walsh, 2010, Stahel, 2010). Eighty per cent or more of the original raw materials, labour and energy embedded in products can be saved during remanufacturing for many firms (Nasr, 2011; Nasr & Thurston 2006). Second, this cost advantage will arguably lead to improved margins (Pearce, 2009; Gray & Charter, 2007).

Third, the servitization of the transaction should in theory lead to enhanced customer relations (Walsh, 2010) and, fourth, increased brand protection (Seitz, 2007). Fifth, this should in turn create differentiation potential to meet low cost competition (Besch, 2005; Heese et al, 2005). Sixth, dematerialisation opportunities related to both servitization and remanufacturing should create opportunities for reduced environmental impact (Mont, 2004; Stahel, 2010).

There are, however, a number of challenges identified with service-based circular business models as well. First, efficient product retrieval is often difficult but critical to get the cost benefits of remanufacturing (e.g. Pearce, 2009; Seitz, 2007; Besch, 2005; Ravi and Shankar, 2005; King et al,. 2006; Östlin et al., 2008). However, by keeping ownership of the product and sell its function, the return flow is secured and ownership and remanufacturing can be taken into full account in product design (Östlin et al, 2009). Second, reduced ability to respond to fashion changes is another potential issue with introducing remanufacturing (Mont et al, 2006). Third, if the offer is to be rented out, rather than sold, a financial risk transfers from the customer to the producer (Mont et al 2006; Besch, 2005). Fourth, as the selling firm takes over some of what was previously the business of the customer, this increases the liability and operational risk of the firm (Kuo et al, 2010). Sixth, there might be considerable challenges associated with creating the required understanding and incentives for key partners, such as retailers or service partners, as the move to a service-based circular business model influences and must be compatible with the business models of these firms as well as the initiating firm (Mont et al., 2006).

2.3 Synthesis and justification of research questions

This chapter began with framework defining the key terms of environmental differentiation, value appropriation and service-based circular business models. A special emphasis was put on the challenges of value appropriation from environmental differentiation by drawing on the notion of social dilemmas (e.g. Ostrom, 1990) and the problem-solving perspective of the firm (e.g. Nickerson and Zenger, 2004). The importance for both business and society of finding ways around this appropriation dilemma was noted.

The review of the prior research on the association between environmental differentiation and economic performance revealed that: 1) there is not a strong convergence in the findings, although the most common finding is a positive relation between environmental differentiation and economic performance, especially for large firms, and 2) there are still comparatively few empirical studies analysing the relation for small firms, especially based on objective measures of economic performance.

The review of prior research on drivers of environmental differentiation showed that there is a multitude of suggested ways that firms can capture net economic value in the short and long term. Different sets of these drivers are often presented in a non-comprehensive, ad hoc manner in the literature. There is a lack of a theoretical framework that comprehensively defines and

describes the strategic mechanisms through which firms can appropriative economic value from environmental differentiation.

Taken together, there seems to be a need for research on the extent to which environmentally differentiated offers are economically successful, and what characterizes the cases that are more or less so. Together, this justifies *Research question 1*: *To what extent are firms appropriating economic value from environmentally differentiated offers and what situations facilitate value appropriation?*

When it comes to organizing for environmental differentiation, it is clear that the topic is considered important by many researchers. The importance of a vocal leadership and a shared vision is consistently highlighted (e.g. Hart, 1995; Larsson, 2000; Porter and Kramer, 2011). However, there often is little or no supporting explanation for exactly how top management support – such as an explicit sustainability vision statement – facilitates the development of environmentally differentiated offers. If we do not know how or why certain proclaimed beneficial managerial practices facilitate the development of environmentally differentiated offers, we cannot be certain about when or for what types of firms they will work. This justifies *Research question 2*: *How can development of environmentally differentiated offers be managed effectively?*

Finally, the review of product-service systems and remanufacturing highlighted the claims that service-based circular business models promise substantial benefits to a firm that implements such a business model. These included drastically decreased costs, enhanced customer relations, better brand protection, radically reduced environmental impact and overall improved margins. A number of possible disadvantages of service-based circular business models were noted, but are seemingly of a smaller magnitude than the suggested benefits. This begs the question, why are firms not implementing circular business models at a higher rate? Indeed, Vezzoli et al. (2012) posed precisely this question. Thus, there seems to be a gap in the literature in terms of an explanation for the lack of action. Such an explanation must provide a sober look at the risks and opportunities associated with service-based circular business models. This gap justifies *Research question 3: What are the risks and opportunities associated with service-based offers designed for closed-loop material flows?*

3 Method

This chapter has five parts. A description of the type of scientific contributions I attempt to make sets the stage for the chapter. This is followed by some comments on the choice to use both quantitative and qualitative methods to address the research questions. The main part of the chapter consists of descriptions of how I have approached the three studies underlying the papers[14], in terms of research design, data collection and data analysis. The chapter is concluded by Table 1, which summarizes the methodological approach used for each paper.

3.1 Epistemological perspective

I attempt to produce knowledge that is useful in controlling the empirical world. To me[15], this means that the overarching goal of science is to facilitate predictions of important future observations based on current observations. In this sense, I subscribe to what is sometimes referred to as methodological instrumentalism, often attributed to Ernst Mach (1910) but diffused in the social sciences by Milton Friedman (1953).

Friedman argued that accurate predictions of observations are more important than that the concepts used to make these correspond to so-called 'real' objects. In line with this, when I refer to the 'empirical world' above, I refer to observations made by people; I do not strive to produce knowledge about some 'real' world independent of observers. Nor do I wish to take a stance of the existence of such an observer-independent world. I consider only observations important, and the nature of phenomena independent of observations as irrelevant to the degree that it does not affect said observations. Therefore, in terms of ontological positions I take neither a realist nor an antirealist stance. Humbly, I consider positing the existence of some real, structural or deep aspects of a phenomenon (e.g. Bhaskar, 1989) a convenient analytical tool to create useful statements or concepts. Formulations regarding various concepts or observations made in such a way to imply that they correspond to some real object are also an efficient method of communication, since it is intuitive. In none of these cases am I intending an implicit metaphysical claim about some potentially unobservable real nature of any phenomenon. One important implication of this is that while concepts may be intuitively thought of as corresponding to ontologically real objects, strictly speaking all concepts refer to constructs

[14] Paper I is different from the other papers in that it is a purely conceptual paper. Since there is no empirical study underlying the paper, it is only mentioned in relation to the other papers in this chapter. Consequently, to the extent that issues of validity and reliability are relevant for Paper I, it must be judged by parsimony with prior research (Pfeffer, 1982) and the soundness of the presented reasoning.

[15] To me, the approach of methodological instrumentalism is a pragmatic choice. I state it here to clarify what types of contributes I attempt to make, in the hope that they may be judged accordingly. I do not base my choice on the belief that there are irrefutable philosophical arguments for whether or not prediction is a more *valuable goal* than those provided by many other epistemological perspectives, for example the goal of creating knowledge interpreted as a justified true belief (cf. Plato, c.a. 369 BC).

for discussing observations and regularities between these. For example, in the previous chapter the concept 'opportunities' were defined as valuable problem-solution pairs. Problems in turn, were defined not as independently existing objects, but as perceptions of subjects; the problem-owners. They are observable, either imperfectly by interviewing the problem-owners, or directly by the problem-owners themselves. The ontological status of opportunities beyond this, a much-debated subject (Shane and Venkataraman, 2000; Klein, 2008; Shane, 2012; Alvarez and Barney, 2013), is considered essentially irrelevant for the purpose of this thesis. Another example is that if I say that environmental differentiation is negatively associated with economic performance, I am saying that if you observe more of environmental differentiation you are likely to observe less of economic performance within the range of the prediction. It is important that environmental differentiation and economic performance are observable, but not whether they exist in some sense beyond being observed.

The use of the term social construct in defining environmental differentiation warrants some elaboration in light of the instrumentalist position, as it may produce associations to a social constructivism position. My position is in fact ontologically consistent with what the Stanford Encyclopaedia of Philosophy (Chakravartty, 2006, Scientific realism entry, section 4.3) describe as the process of 'social construction': "any knowledge-generating process in which what counts as a fact is substantively determined by social factors, and in which different social factors would likely generate facts that are inconsistent with what is actually produced." Environmental differentiation viewed as a social construct here refers to the outcome of such a process (se section 2.1.1). For the concept definition to be compatible with the epistemological values of methodological instrumentalism, the concept must refer to (a combination of) observable phenomena (Friedman, 1953). I provide illustrations of how the environmental differentiation can be observed later in this chapter (see also the summary in footnote 4 in the introduction).

Although the overarching goal is to facilitate prediction, the magnitude of the research challenge sometimes implies that this must be achieved in steps (Friedman, 1953). To predict a relationship between various types of observations, first the typology of observations must be established. In other words, development of concepts and language to facilitate observation can be an important contribution towards a predictive model (Friedman, 1953). And before that, in order to enable proper conceptualization, an important initial contribution may be to provide detailed descriptions of observations (Christensen, 2006), using available but less refined concepts as a first step before developing more useful concepts.

From the above perspective, I believe that I can meaningfully attempt to make three types of contributions of knowledge to the literature on environmental strategy. I label these 1) predictive statements, 2) terminology and 3) observations. For each, I consider the degree of contribution to be determined by three aspects, the novelty of the claim, the validity of the claim and the usefulness of the claim. I defined these types of contributions

during the early stages of the research process and they have guided me throughout the research.[16]

The first type of contributions, predictive statements, are of the following nature: I provide two or more concepts, explain how another can observe these, and make a claim about what the observation of one is likely to be given a particular observation of another. The scientific value of a prediction is determined by the degree to which the prediction is a) novel/not settled in the scientific field, b) corresponds to observations and c) may help the scientific field gain relevance in society (if successfully disseminated). A historical and stellar example of a contribution of prediction type is Galileo's claim that the attribute acceleration of a ball rolling down a smooth lane is independent of the attribute weight of the ball. An example of a contribution of prediction type in my thesis is the predictive statement that there is a negative association between the attribute environmental differentiation and economic performance for small Swedish firms.

The second type of contribution, terminology, is of the following nature: I provide a set of concepts, according to which an observation can be described, remembered or communicated. The scientific value of the contribution is determined by the degree to which the concept a) facilitates description, memorization or communication of the observation and b) facilitates communication or discovery of predictive statements. A historical and stellar example of a contribution of terminology type is the introduction of the modern concept of energy ('vis viva') by Newton and Leibniz. Like for example environmental differentiation, energy is only indirectly observable. An example of a contribution of terminology type in my thesis is the introduction of the appropriation strategies for capturing environmental value (i.e. eco-lean, eco-branding, eco-lobbyism, eco-transaction design). Arguably, also the concept of environmental differentiation is such a contribution, as it integrates the changing but sceptical nature of perceptions of what environmental sustainability in a way suitable for business strategy research.

The third type, observations, is of the following nature: I provide detailed descriptions of my observations. The scientific value of the contribution is determined by the degree to which the descriptions of the observations are useful in helping generating contributions of the two previous types: predictive statements or terminology. I consider such usefulness to be determined by the degree to which the described observations are a) novel, i.e. made of a phenomenon where there is a lack of reliable data; b) reliable, i.e. if another observer interested in the same question would describe the observed phenomenon similarly and c) important, i.e. if there is reason to believe that the phenomenon either has or is associated with something which has intrinsic value to observers. A historical and stellar example of a

[16] For the reader familiar with Christensen's (2006), it may be helpful to note that the three types of contributions fairly closely correspond to the three steps of theory building outlined there. These are 1) statements of association, 2) categorization based upon attributes of the phenomenon and 3) observe, describe and measure the phenomenon. I only recently became aware of this paper.

contribution of type observations are the astronomical observations made by Tycho Brahe and later used by Johannes Kepler to derive the laws of planetary motion. Examples of a contribution of observation type in my thesis are the two case study descriptions. First, the manufacturing firm that discovered new customer uses for an originally customized technical solution as an eco-branding marketing campaign was to be launched. Second, the bicycle firm that struggled to develop and implement a circular business model.

3.2 Research approach – Mixed methods

Because the research questions are quite different in nature, I have employed a mixed methods approach in this thesis. In the end, I wish to contribute towards general statements about the commercialization, development and economic performance of environmentally differentiated offers. The topic is of course large and cannot be conclusively settled in any single study. I therefore chose to divide the areas to which I wish to make specific contributions into three research questions. These differ in both their nature and in the level of prior findings. The differences prompted different methodological approaches in each.

Research question 1, beginning with the words "to what extent…", can be paraphrased as essentially a "how much?" type of question. The latter part specifies the question with "how much… for different situations?" When the extent of value appropriation is approximated as economic performance, the question also directly relates to a wealth of prior studies. Including related fields, such as studies of corporate social responsibility and of environmental differentiation in larger firms, there are hundreds of published papers available on the topic (Orlitzky et al., 2003; Peloza and Yachnin, 2008). Together, the quantitative nature of the question combined with the availability of theoretical predictions suggested that statistical techniques were suitable tools to empirically contribute to the literature within the question area. However, there are fewer obvious candidates available for a theoretical model on the expected differences in ability to appropriate value dependent on the institutional and market environment of the offer. While there are many publications on various aspects of the issue, many of them mentioned in chapter 2, there is a lack of a summarizing framework of value appropriation for environmentally differentiated offers. I chose to address this in a two-step process. Paper I presents such a framework, derived conceptually using examples only for illustration. When this was in place, I chose to examine part of this framework empirically using statistical analysis. The main benefit of choosing a statistical approach is that it strengthens external validity. The model resulting from this is presented in Paper IV.

Research questions 2 and 3 are similar in that both were addressed by in-depth case studies with a high focus on contextual understanding. They are also similar in that any resulting generalizable claims I make are fundamentally based on conceptual reasoning, rather than generalization by the principle of induction from a sample of one. In other words, the approach

taken in both instances was to gain a deep understanding of the case and then use that understanding to better apply theoretical models and predictions from more general literature to explain the phenomenon (i.e. development and commercialization of environmentally differentiated offers).

Research question 2 is a "how?" type of question. While research question 1 examines the economic performance of offers on the market, research question 2 focuses on the organizational aspects of development and commercialization of such offers. I decided to pursue this as a qualitative case study for two reasons. First, the nature of the question implies a need for a contextual understanding of the development and commercialization process. Such data can be difficult to both collect and analyse in a quantitative fashion, and attempting to do so may even induce a spurious sense of accuracy (Bryman and Bell, 2007). Second, the management of development and commercialization processes of environmentally differentiated offers in established firms is not a well-studied phenomenon. Consequently, at the outset of the study there were no obvious well-established theoretical predictions to evaluate. This implied a need for further theory building. A qualitative, inductive approach is often considered suitable to achieve this (e.g. Ragin, 2008; Eisenhardt, 1989).

It is not so much the phrasing of research question 3 as the phenomenon being studied that prompted a qualitative research approach. I made the judgment that opportunities and challenges were likely to be more apparent during a search for a new business model, as compared to in a state of having already established a business model. Because there are currently not many firms making the transition, a case study provided the best available opportunity to gain a rich understanding of the reasoning of entrepreneurs attempting to implement a service-based business model.

3.3 Papers III & IV

To investigate *Research question 1: To what extent are firms appropriating economic value from environmentally differentiated offers and what situations facilitate value appropriation?* a cross-sectional study of small Swedish environmental technology firms were carried out. A cross sectional design typically makes causal inference difficult. However, it enables statistical inference about associations between variables from a small sample to a larger population. In this case about small environmental technology firms in Sweden.

By focusing on small firms, I attempt to avoid the issue that environmental differentiation often applies only to parts or divisions of larger firms, making effect sizes difficult to estimate. This can be compared to the efforts of other researchers who tried to overcome this problem by studying only the affected parts of corporations – such as specific plants (e.g. Lankoski, 2000). However, the focus on small firms also avoids potentially dubious calculations of return on investment and future cash-flows from a limited, possibly arbitrarily, selected part of firms' activities. Another advantage of focusing on small firms rather than specific plants or offers, is that it allows

me to obtain a larger number of observations, improving the power of the statistical tests.

3.3.1 Data collection

The data consisted of publicly available accounting data and a survey based on an early version of the conceptual framework in Paper I, which was sent to the Chief Executive Officers (CEO) of small environmental technology firms.

The sampling frame of environmental technology firms was generated from the register of Swentec – "the Swedish Environmental Technology Council". Swentec was a Swedish government project from 2007 to 2010 which, in response to the EU Environmental Technology Action Plan (ETAP), built a database of Swedish environmental technology firms. Swentec identified a total of 901 environmental technology firms. The firms were selected based on ETAP's (European Commission, 2004) definition of environmental technologies.[17] Swentec began its search by examining a subset of the firms in Statistics Sweden's [18] environmental and economic accounts and subsequently extended the search.[19] Swentec chose to include producers of energy-technologies from the environmental accounts but to exclude power producers.[20] Each firm was evaluated via interviews and an application form, to check whether it matched ETAP's definition of environmental technologies.[21] In the end, there were 21 different technology fields.[22]

To narrow the sampling frame to only include small firms, accounting data retrieved from Bolagsinfo, a Nordic provider of business accounting records, was used to exclude firms that did not meet the below criteria.

- only limited companies (Swedish "Aktiebolag")
- 1 (2) to 49 employees
- no holding companies or firms that reported dividends from shares in other firms
- profit margin between -100% and +100%

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[17] "Technologies whose use is less environmentally harmful than relevant alternatives […] They encompass technologies and processes to manage pollution (e.g. air pollution control, waste management), less polluting and less resource-intensive products and services and ways to manage resources more efficiently (e.g. water supply, energy-saving technologies)." (European Commission, 2004, p. 2)

[18] Statistics Sweden is a Swedish government agency.

[19] Although Statistics Sweden's environmental and economic accounts are based in part on NACE codes, Swentec's inclusion criteria and implementation are not based on NACE codes.

[20] According to an interview with Statistics Sweden's Swentec liaison Mats Eberhardson, 2012-06-25.

[21] According to an interview with the former Swentec project leader Catarina Hedar, 2012-06-20.

[22] These technology fields are: Air pollution control, Bioenergy and biofuels, Cooling technology, District heating, Energy efficiency, Energy storage and hybrid systems, Environmental- consultants- training and information, Heat pumps, Hydro power, Marine technologies, Material technology, Noise protection, Soil remediation, Solar energy technology, Sustainable building, Systems- engineering- control- engineering and monitoring, Transportation, Waste management and recycling, Water and wastewater treatment, Wave power, and Wind energy technology.

The first criterion was used to focus on firms for which good accounting data were available. The second was used to focus on small firms. The third was used to avoid misleading financial data related to complicated ownership arrangements designed for tax evasion et cetera. The fourth was used to capture firms that were operating normally during the studied time period. That is, to exclude firms that were extremely investment oriented during the period or that for various unusual reasons were reporting profits larger than revenues. The criteria above constitute an outer boundary for the type of firms that the results presented herein can be considered externally valid for.

Of the respondents in the effective sample, about 80 % were the CEO of the firm. The remaining held various influential positions ranging from "Founder" and "Owner" to "Marketing manager". To reduce the tendency of receiving biased answers for marketing purposes, it was emphasized in the survey that no individual answers would be published.

The sample differed for Paper III and Paper IV in this study, due to differences in purpose and the data analysis techniques chosen. For Paper III, the economic performance of environmental technology firms was compared to other firms similar to each of the environmental technology firms. Therefore the sample consisted of accounting data for all small (2-49 employees) Swedish limited firms. There was also some use of survey data for all identified environmental technology firms of suitable size. For Paper IV, the size criteria was loosened somewhat, to include firms with one employee. This was done because of the small available sample size, in order to increase the power of the tests. Further, for Paper IV the study focused on firms selling physical products (manufacturers and resellers) at the exclusion of firms providing only a service (e.g. architects with a environmental positioning) or a license (e.g. research and development labs). This delimitation was a trade-off: The analysis for Paper IV was a comparison of firms within the environmental technology sample and the sample size did not allow for a good control for industry classifications. Therefore I judged it preferable to compare only firms with physical products with each other. There are likely too large differences in market conditions between manufacturing firms and pure service/license firms to make meaningful generalizations. Their inclusion would likely add unjustified noise or bias to the data, making inferences more difficult.

3.3.2 Data analysis

For Paper III, which examines the extent to which environmental differentiation is associated with economic performance, a nearest neighbour matching procedure was used. Directly applying a standard t-test or regression with a dummy variable to compare the economic performance of environmental technology firms and other firms is problematic, since there might be confounding variables that co-vary with the economic performance of the firms (Heckman, 1979, 1990). The key issue is to estimate the counterfactual economic performance of the environmentally differentiated firms, had they not been environmentally differentiated. This is a type of quasi-experimental design, as it has non-random selection of cases

(Campbell and Stanley, 1963; Shadish et al., 2002). In a controlled experiment, one produces the counterfactual outcome in the control group that receives no treatment. In the quasi-experimental design, my co-authors and I attempt to achieve this from observational data via statistical means. This is done by matching each environmentally differentiated firm with other firms that are as similar as possible on number of observable characteristics. The matching can be based on so-called propensity scores (e.g. Dehejia and Wahba, 2002; Rosenbaum and Rubin, 1983) from which a weighted average is often calculated from all other firms based on their similarity to the environmentally differentiated firm. In this thesis, the matching was instead based on nearest neighbor matching (Abadie et al., 2004; Abadie and Imbens, 2006), since that allowed exact matching on one of the observable characteristics: industry classification.

There are several ways to calculate the similarity of firms (see e.g. Imbens, 2004; Morgan and Harding, 2006; Smith and Todd, 2005). In this study, a Euclidian distance was calculated between standardized values for firm age, turnover and number of employees; and exact matching for industry classification. From the three firms with the shortest distance to each environmentally differentiated firm, a counterfactual profit margin (economic performance) was estimated as the weighted average profit margin by distance. The mean profit margin of the environmentally differentiated firms was then compared to the mean of the estimated counterfactual firms.

For Paper IV, which examines the association between economic performance and the characteristics of environmentally differentiated offers, an ordinary least squares (OLS) regressions were used to analyze the data. OLS regressions are useful to estimate the linear[23] association between one variable (in this case: economic performance operationalized as profit margin and a subjective measure) and several other variables (in this case: characteristics of the offer captured in the survey). To ensure robustness of the findings, several steps were taken. First, the models were run with the addition of several control variables. Second, diagnostic tests were performed to ensure that the assumptions of OLS regression were met. Third, alternative models, such an ordered logistic regression and robust regression using M-estimators (Huber, 1964) were investigated. See the method section of Paper IV for more details on this analysis.

3.4 Paper II

To investigate organizational aspects of *Research question 2: How can development of environmentally differentiated offers be managed effectively?* an explorative retrospective multilevel case study (Ragin, 2008; Dul and

[23] OLS regression can of course handle non-linear associations to some degree as well. In fact, in the models presented in Paper IV, I controlled for an inverted-U association between economic performance and regulatory support after some of the diagnostics tests indicated this as a likely possibility. However, strictly speaking the final results neither corroborate nor falsify such a relationship. There is not enough data to say whether this depends on the non-existence of such a relationship or if the effect is too small to show up in a sample of this size.

Hak, 2007; Eisenhardt, 1989) was carried out at a manufacturing firm that had recently launched a number of energy-efficient products. The original purpose of the study was to investigate the organizational pre-conditions that facilitate the development of environmentally differentiated offers in established firms. After a few interviews, focus was narrowed down to the interaction between a recent environmental vision promoted by top-management and the practical development and commercialization activities in the business units.

3.4.1 Data collection

Data were collected from interviews, marketing information such as product brochures and the corporate website, trade press, and legal documents. The first set of interviews were unstructured and were followed by subsequent semi-structured interviews. Interviewees were managers, both at or close to executive level (e.g. chief technical officer, business development director, and vice presidents) and in business units (e.g. product development manager, sales manager, business development manager). This allowed us to study the implementation of the environmental vision both from the executive and the product development level. To avoid receiving 'espoused theories' of how things should happen, but may not necessarily really happen (Argyris, 1994), we systematically asked for examples and occasionally followed up with partially overlapping questions.

Fifteen interviews were conducted at the firm with fourteen different individuals. Most lasted for about 1.5 hours. The study initially extended over three months in 2009, with a follow up interview four months later in order to clarify certain points, and four additional follow up interviews in 2013. The last were conducted to see how the environmentally differentiated product line had developed and clarify some issues regarding the firm's sustainability vision. The cases studied in detail were identified from the initial interviews and involved semi-structured follow up interviews with people directly involved in the problem formulation, problem solving and development and commercialization processes of these offers.

3.4.2 Data analysis

Data analysis consisted of case write-up and sequence mapping (Miles and Huberman, 1994). To increase the robustness of the results the different data sources were triangulated (Jick, 1979). The interview parts relating to the case were transcribed and summarized but not formally coded according to any pre-set coding scheme. Since the data were used for illustrative and explorative reasons, the data analysis procedure did not revolve around any formal coding scheme. However, the analysis can be summarized as consisting of three steps. In the first step case histories according to the various interviews were produced, summarizing how the customer and environmental problems were iteratively formulated for each product. In the next step, these descriptions were combined into a single case for each product, relying on triangulation and follow-up interviews. In the third step, a complete case history was synthesized, combining all data sources and

including interview data from executives only indirectly involved in the development processes. Generalization was analytical (Yin, 2009) in the sense that it relied on the external validity of prior literature on firms as problem solvers (e.g. Nickerson and Zenger, 2004; Cohen et al., 1972).

3.5 Paper V

To investigate *Research question 3: What are the risks and opportunities associated with service-based offers designed for closed-loop material flows?* a longitudinal interventionist study of a small Swedish bike manufacturer implementing a circular business model was carried out. For reasons explored in Paper V, a move towards circular business models is not occurring frequently in industry today. To overcome this, the study was design around an initial intervention (Lukka, 2006), as this was deemed necessary to study an implementation of a circular business model. The design, in terms of case selection and the intervention created a rare opportunity to study an unusual phenomenon of interest. The intervention consisted of a local bicycle manufacturer being contacted to present the concept of remanufacturing. The owners of the firm became interested in the concept and a one year long project with the aim to implement a circular business model at the firm was launched.

An in-depth case study, especially with longitudinal data, makes causal interpretations more feasible than a traditional cross sectional snapshot based on more shallow data. The repeated interviews regarding reasons for moving forward or pausing development taken together with complete access to the market research available to the managers at every period, makes it feasible to describe events that caused hesitation or renewed initiative. It is not as good as a controlled experimental design for establishing causality, but at least the expressed reasons for managerial hesitation in relation to the available data can be presented and analysed. However, generalizations cannot be made on empirical grounds, but need to rely on previous theory or deduction of a priori statements.

3.5.1 Data collection

Data collection was based on an insider/outsider approach (Bartunek and Louis, 1996). The insider/outsider approach meant that one of the co-authors (and another researcher) worked closely with the owners to help develop and implement the new business model along the principles of customer development (Blank and Dorf, 2012). Meanwhile, the author of this thesis followed as an observer, systematically collecting data about the developments and perceived challenges in the project.

Data were collected with the aim of understanding how the managers of the firm reasoned about the design and implementation of the new offer with a circular business model. Because of the insider/outsider approach, two types of qualitative data ware collected. On the one hand, there was the systematic data collection of the detached outsider: me. On the other hand, there was the rich insight gained by the insider and partially communication to me via semi-structured interviews and co-authorship.

The most important data that I collected in this study consisted of six "snapshots" of the owner managers' visions of the business model throughout one year, as well as the main challenges and opportunities they perceived at each stage. These were collected via 1.5-2 hour semi-structured interviews, according to a predefined script consisting of both open and closed questions about perceived benefits and risks of the new offer. To describe the envisioned business model of the new offer, the business model canvas of Osterwalder and Pigneur (2009) was used. In parallel, ten shorter interviews were conducted with the insider, focusing on the encountered challenges and opportunities with the circular business model at various times throughout the year, as he perceived them. I also attended and took notes in four important decision making meetings over the year. In addition, there was one interview conducted before the project started and one towards the end of the project, to capture change in the perception of the circular business model of the owners. Recordings of all meetings and interviews were used to validate the field notes and transcribe significant passages. All of these data collection activities together resulted in a timeline of how the perceived risks and opportunities changed during the project.

3.5.2 Data analysis

Paper V focuses on the distinguishing attributes of a circular business models that creates well-founded hesitation for managers. Therefore, little would be gained by conducting a formal content or text analysis of the interviews.[24] Instead, the case was used in the study to help us to discover potential challenges with implementing a service-based circular business model from an entrepreneurial viewpoint. The case description is used in Paper V primarily to illustrate the arguments. I do not propose to make general claims based only on empirical data from a single case study. This would truly be as trying to generalize from a sample of one, as there are too many contextual factors for which one cannot control.

As a consequence, the general claims that came out of this study are by necessity based on theoretical arguments, so-called analytical generalizations (Yin, 2009; Gibbert et al., 2008). Because of the in-depth and qualitative nature of the data and the longitudinal design, causes of the challenges can to a limited degree be meaningfully interpreted from the data. But the claim that these challenges are generic to all circular business models, as compared to the corresponding linear business models, are by necessity deduced from concept definitions and previous theory. For these reasons, the data from this study was not so much analysed as synthesized in order to create a concise description of the causes for hesitation in implementing the circular business model. For example, before writing the case description, the changes between the snapshots of the envisioned business model and perceived challenges at different points in time was summarized as bullets in a table by the outsider, and then validated by the insider.

[24] But it might have been useful to describe and analyse the *perceptions* of managers. Indeed, a tentative analysis of changing perceptions has been conducted, but it is not part of this thesis.

Table 1 – Summary of methods used for the research questions

	Paper III & IV	**Paper II**	**Paper V**
Research objective	Examine association between economic performance and environmental differentiation	Explore managerial practices for development of environmentally differentiated offers	Explore managerial perceptions of risks and opportunities when implementing a circular business model
Research design	Cross sectional study, quasi-experimental design	Retrospective single case study	Longitudinal interventionist single case study
Sample	60 (Paper IV) to 84237 (Paper III) small Swedish firms	1 manufacturing multinational corporation	1 small manufacturing firm
Data collection	Primary sources: Swentec webpage, CEO survey, public accounting data Complementary sources: interviews with former Swentec personnel, interview with Statistics Sweden liaison, firm websites	Primary sources: 15 semi-structured interviews (face-to-face and over Skype). Complementary sources: internal presentation materials, articles in trade press, annual reports, marketing material, company website	Primary sources: 6 semi-structured interviews with owner-managers 10 semi-structured interviews with practicing interventionist 4 meetings with development team in which research related questions were asked
Data analysis	Nearest neighbour matching for average treatment effect for the treated Regression analysis	Pre-structuring of case after 8 interviews and subsequent abductive refinement of case description	Synthesis of case description created by combining thematic coding by me combined with experiences from active project participant and co-author.

4 Summary of appended papers

This chapter provides a brief description of the appended papers.

4.1 Paper I

Title: A Problem-Solving Perspective on Strategies for Appropriating Environmental Value – Some Implications from Considering Institutional Solutions to Social Dilemmas

Paper I proposes a framework for the appropriation strategies available to firms that address environmental problems. It is also a precursor to the theoretical framework utilized in this cover paper, but with a slightly different focus. The paper starts from the idea that any viable business model must enable both value creation and value appropriation. Environmental problems are analysed from the problem-solving perspective of the firm, and specifically that valuable problem-solution pairs correspond to entrepreneurial opportunities (Hsieh et al., 2007). The paper shows that many environmental problems are valuable problems, in the sense that net economic value will likely be created by proactively addressing them. Such as for example estimated in the so-called Stern review (Stern et al., 2006). Paper I argues also that many firms have some of the capabilities required to address these valuable problems. Drawing on the notion of social dilemmas (e.g. Ostrom, 1990), the paper shows that it is often difficult to appropriate the value created, suggesting that it is the absence of a suitable appropriation strategy for value appropriation that holds many firms back. The paper derives four ways in which firms proactively can overcome these appropriation difficulties, drawing on work in new institutional economics (e.g. Williamson, 2000) and political science (e.g. Ostrom, 1990). The appropriation strategies are labelled eco-lean, eco-branding, eco-lobbyism and eco-transaction design.

4.2 Paper II

Title: Formulating Problems for Commercializing New Technologies: The Case of Greening

Paper II takes problems as the unit of analysis and investigates how firms identify and solve environmental problems, and how this work is translated into new environmentally differentiated offers. It shows that the problem formulation and the problem solving processes involved in commercializing an environmental technology may be performed in different parts of the firm. It discusses the importance of a sustainability vision for the development of environmentally differentiated offers, illustrating this empirically by analysing a multinational mechanical engineering corporation that developed and launched what it internally referred to as its green product line to help customers reduce their CO_2 emissions. This paper contributes to the environmental strategy literature by providing an empirical study of how firms formulate and solve environmental problems and how the reformulation into an environmental problem based on the firm's

sustainability vision can transform the initial value proposition into a more generic proposition, thereby increasing the profit potential though the generation of new applications and increased usage.

4.3 Paper III

Title: Environmental Orientation and Economic Performance: A quasi-experimental study of small Swedish firms

This paper examines the relationship between the environmental differentiation and economic performance of small firms. It is based on a sample of 299 environmental technology firms (European Commission, 2004) and the remaining small firm (2-49 employees) population in Sweden. The paper estimates the effect of environmental differentiation on economic performance by examining how environmentally differentiated firms perform relative to non-environmentally differentiated firms. The estimate is based on a quasi-experimental design, that allows construction of a counterfactual control group of non-environmentally differentiated firms that are very similar to their environmentally differentiated counterparts. The paper uses two measures of environmental differentiation: 1) a third party classification according to the ETAP definition of environmental technologies, and 2) self-assessed environmental differentiation. The findings show a negative effect of environmental differentiation on economic performance. The paper contributes to the environmental strategy literature by using a novel and rigorous way to estimate the relationship between environmental differentiation and economic performance. Combined with the findings from other published studies, the paper also provides implicit support for the existence of a positive causal effect by economic performance on environmental differentiation.

4.4 Paper IV

Title: Determinants of Economic Performance for Environmental Technology-Based Offers – A Cross Sectional Study of Small Swedish Firms

This paper investigates the association between economic performance of environmental technology-based offers and various ways the offers can be marketed towards customers based on their environmental differentiation. The sample consists of a set of small Swedish environmental technology firms. Data were collected from small Swedish environmental technology firms, using a survey based on Paper I, and from Bolagsinfo which collects accounting data. Economic performance is estimated in two ways: as the profit margins of the firms, and based on the subjective judgments of the firms' CEOs. The analysis employs ordinary least squares regression, complemented by robust regression based on Huber's (1965) M-estimators and an ordered logistic regression for the survey-based dependent variable. The results indicate that eco-efficiency related to decreased total cost of ownership is significantly positively associated with the economic performance of the offer. This finding is robust to both the choice of economic performance measure and the choice of regression models

examined. The models investigated provide mixed results for other types of offer differentiation, suggesting the need for further research.

4.5 Paper V

Title: Examining the challenges of implementing closed-loop service-based business models from an entrepreneurial perspective

This paper investigates the implementation of a service-based circular business model – a product-service system based on remanufacturing. The paper investigates the reasons why firms operating traditional linear business models are reluctant to shift to service-based circular business models. The paper is grounded in a longitudinal interventionist project involving a small Swedish bicycle manufacturer developing a new remanufacturing-based service offer for a new product category. The paper reviews the disadvantages of service-based circular business models relative to linear business models discussed in prior research papers. Paper V suggests that many of these potential disadvantages can be mitigated in various ways, as illustrated in the studied case. However, there is an important challenge that persists. Proactive testing of certain key business model assumptions requires more time and more capital within a service-based circular business model context compared to a linear business model context. Since a service-based circular business model involves significantly more tied up capital during stages of high uncertainty, the shift carries significant risk. The identification and conceptualization of this challenge constitutes the main contribution of Paper V. Some possible solutions to this problem are discussed, but are ultimately left as an interesting topic for future research.

5 Discussion

This chapter has five thematic parts in which the papers and their findings are discussed in light of the research questions, the prior literature and the range of the findings' applicability. Each section provides a summary of the findings, a discussion of the type of scientific contribution I seek to make, a comparison with earlier studies, and a discussion of the respective study's limitations. The remaining parts of the chapter are two sections that provide a summary of the results in relation to the research aim, and how the three research questions have been addressed.

5.1 The extent to which environmental differentiation is associated with economic performance

Paper III focuses on the empirical relation between environmental differentiation and economic performance. The results are not encouraging in the sense that the data indicate a negative relation between these concepts for small Swedish firms. As noted in Chapter 2, numerous publications examine the relation between economic and environmental performance, but much less is known about this relationship in the case of small firms. There has been much critique of the methodological approaches in prior work for not taking account of the non-environmental differences among firms, such as industry contingencies (Steger et al., 2004; Salzmann et al., 2005). In this thesis, a novel and arguably more rigorous method (Abadie et al., 2004; Abadie and Imbens, 2006) was applied. This method enabled the construction of a counter-factual control group of firms with non-environmentally differentiated offers, which was compared with a group of firms with environmentally differentiated offers.

In terms of the types of scientific contributions outlined in section 3.1, Paper III makes a contribution of the predictive statement type. The predictive statement in this case is that on average, for small firms, environmental differentiation will be negatively associated with economic performance. Thus, it addresses the first part of *Research question 1*: *To what extent are firms appropriating economic value from environmentally differentiated offers and what situations facilitate value appropriation?*

That environmental differentiation is negatively associated with economic performance is valid for Swedish small firms. While there is no reason to believe that this finding would not hold also for other similar economic settings, the nature of the statistical inference and the chosen sampling frame do not allow such a generalization based only on the data. Therefore, applying this prediction outside the Swedish context should be done with caution and with full awareness that any such generalization must rely on the (theoretical) judgment that the conditions are similar enough in another setting – whether some future time period, or a different country – for the same underlying causal mechanisms to operate.

Although a conclusive statement regarding the causality involved would be ideal, it would be naïve to believe that a single observational study could

conclusively identify and resolve the causality issues related to such a complex phenomenon as economic performance. To do this would require a more developed theory of the micro foundations of economic performance than currently exists, and a substantial number of corroborating replication studies. However, we *can* identify those causal theories on the relation between environmental differentiation and economic performance that are supported respectively cast into doubt by the findings from this study.

Many prior empirical studies found a positive relation between the concepts of environmental differentiation and economic performance (e.g. Aragon-Correa et al., 2008; Armas-Cruz, 2011; Zeng et al., 2011; Torugsa et al., 2012; Orlitzky et al., 2003). Those findings can be explained by any of the four causal theories predicting a positive relation, outlined in section 2.2.3. However, to reconcile the positive association found in prior research with the results presented in this thesis, consider that only three of these theories predict a positive relation for the small firms studied here. These are the natural resource-based view (e.g. Hart, 1995; Aragon-Correa et al., 2008), the institutional perspective (e.g. Pacheco et al., 2010), and the pollution-as-waste perspective (e.g. Porter and Van der Linde, 1995b). Clearly, these theories cannot explain both the previous positive findings and my negative findings. To explain the empirical discrepancy, we may turn to the fourth theorized explanation for a positive relation: a reversed causal link (Waddock and Graves, 1998; McGuire et al., 1988; Kraft and Hage, 1990; Moore, 2001). Since the reverse-causality argument does *not* apply to the data in this thesis, the results lend some support – by argument of exclusion – for a reversed-causal link as the best available explanation of the observations to date. A reversed causal link would explain why some studies show a positive relation where this thesis shows a negative relation. A possible extension of this interpretation is that environmentally differentiated offers from larger firms are also to be unprofitable on average. Although more research would be needed to corroborate this proposition, it is possible that projects to develop such offers may sometimes be driven more by slack resources available in successful organizations than by the internal profitability of these projects. Clearly, this implication is limited by the extent to which there is a common causal link between environmental differentiation and economic performance in both small and large firms' environmental differentiation projects. Further, this somewhat discouraging conclusion is valid only for the average situation; there are numerous case studies indicating the opposite causality (e.g. Porter and Van der Linde, 1995b; Pacheco et al., 2010).

The main reason why the statement regarding a reverse causal relationship cannot be considered conclusive without further studies is that there may be some confounding variables. There are several firm attributes that are not controlled for in this or previous studies, which might account for the differences while not necessarily implying reverse causality. For example, neither my study nor any other study I am aware of controls for entrepreneurs' level of ambition and level of education, or the quality of hired human resources in the firm. All of these variables might affect the

economic performance of the firms studied. When conducting a statistical analysis of this type, the aim is to design the study so that these differences average out between the two groups due to the law of large numbers. However, there is no way to rule out that the distribution of some potentially important variables are skewed towards environmentally differentiated firms, and that this skewness might be a more generally applicable causal explanation for the differences in economic performance.

The above limitations notwithstanding, the predictive statement regarding the negative association between the two variables can be considered the most robust finding for small Swedish firms to date. This should, by itself, be of relevance to investors, managers and policy makers interested in the development of environmentally differentiated offers. Further, among the received theories on the business case for environmental differentiation, the findings provide support for a reverse causal effect. That is a positive effect by high economic performance on environmental differentiation in larger firms. While this thesis provides *support* for a certain causal theory, we need further studies and, arguably, also further theoretical developments in order to consider any theories of a causal relation conclusive.

5.2 A typology of appropriation strategies for environmentally differentiated offers

Paper I shows that many of the strategies described in the environmental strategyliterature on profiting from environmentally differentiated offers can be categorized according to a typology based on the institutional levels suggested by Williamson (2000). The four categorizes are labelled eco-lean, eco-branding, eco-lobbyism and eco-transaction design. This typology corresponds to a terminology type contribution (Friedman, 1953) or categorization or framework type contribution in the terms of Christensen (2006). In providing a typology of appropriation strategies for environmentally differentiated offers, Paper I provides a conceptual answer to the second part of *Research question 1:* concerning *what situations facilitate value appropriation.* The typology thereby contributes to the literature on the association between environmental differentiation and economic performance. Repeated conflicting findings in this literature have provoked calls for further theoretical developments to explain the conditions that promote economically successful environmental differentiation (e.g. Ullman, 1985; Lankoski, 2008). As described in section 2.1.2, there are reasons to believe that value appropriation is the largest challenge in building the business case for environmental differentiation. Paper I proposes a coherent framework for describing value appropriation from environmental differentiation. Thus, it contributes to the environmental strategy literature by emphasizing value appropriation, and showing that much of the prior environmental strategy literature (e.g. on the drivers of environmental differentiation, product-service systems and environmental branding) can be understood and integrated from this value appropriation perspective.

The framework is built on the idea that many environmental problems relate to social dilemmas, and that social dilemmas can often be resolved via appropriate economic institutions (Ostrom, 1990). Drawing on this idea, the prior environmental strategy literature is reviewed in light of its relation to different types of economic institutions (Williamson, 2000). The result is a comprehensive list of distinct aspects of appropriation strategies relevant to environmentally differentiated offers, each of which is discussed below in the context of the literature. This is followed by an explicit description of the type of scientific contribution I claim to make.

First, eco-lean covers situations when there is little economic impact of any social dilemmas often associated with environmentally differentiated offers. Much of the early literature on environmental strategy, especially during the 1990s, discusses such situations, including efficiency-based arguments for environmental differentiation such as Florida (1996) and Porter and Van der Linde (1995a), and studies that argue that environmental differentiation is often associated with increased product quality (e.g. Porter and Van der Linde, 1995b). Eco-lean thus describes the logic of value appropriation in situations where there is no social dilemma associated with the environmental problem addressed by the offer. In Paper I, the label 'eco-lean' was inspired by the idea that the environmental aspect of these offers is often based on reducing waste. The suffix 'efficiency' rather than 'lean' might arguably seem closer at hand for the phenomenon, the suffix is unfortunately often used in a way that includes almost all possible appropriation strategies related to environmentally differentiated offers (cf. WBCSD, 1992; 2001).

In the perhaps more theoretically interesting situation, when social dilemma type incentives make appropriation of part of the value created by environmental differentiation more challenging, firms can still attempt to exploit or even influence economic institutions to their advantage. There are three types of appropriation strategies available in these situations, based on Williamson's (2000) different levels of economic institutions.

The second category, eco-branding, refers to when firms capture economic value from their low environmental impact by leveraging first level environmental institutions: the norms and values of the society in which they operate. The term 'branding', while in hindsight perhaps a misnomer, is supposed to communicate that the appropriation strategy is based on signalling the relevant low environmental impact to stakeholders. Because the firm's stakeholders may embody certain values regarding so-called pro-social behaviour, environmental differentiation might in some cases be considered an additional and relevant performance dimension on which to compete. For example, some consumers might choose a brand of soap that is less toxic if other performance dimensions are equivalent – but only if they are aware of its superior environmental performance. If the customer is unaware of the superior environmental performance, but still prefers the soap, this, by definition, is a case not of eco-branding, but of eco-lean. Leveraging first level institutions is frequently referred to in the green marketing literature (e.g., Hartmann et al., 2005; Ottman, 1998; Grant,

2007), but it is not limited to consumer branding. Eco-branding can equally well describe reputational benefits of environmental differentiation related to human resource management (Wagner, 2012) and legitimacy among other key stakeholders, sometimes referred to as 'licence to operate' (Steger et al, 2004). In this sense, an equally appropriate label for this category might be eco-reputation.

The third category, eco-lobbyism, refers to when firms capture economic value from their environmental differentiation by leveraging or influencing second level economic institutions, such as formal regulations and laws. The benefits of successful eco-lobbyism include that it can be used to increase margins or market share, and to create a cost advantage for environmentally differentiated offers vis-a-vis competitors (cf. Salop and Scheffman, 1983). The suffix lobbyism perhaps suggests too narrow associations for this concept. In hindsight, perhaps a better suffix might be the more extended 'strategic fit with public policy and the regulatory environment'. The definition of this concept also includes effective *leveraging* of environmental regulation and government support, which often relies on successful prediction and adaptation (Dechant et al., 1994). Prediction, of course, is important also for influencing future regulation. An interesting, and possibly unexpected, implication here is that eco-lobbyism is therefore closely related to the concepts of proactive environmental strategy and over-compliance, commonly applied in the literature (e.g. Sharma and Vredenburg, 1998; Aragón-Correa et al, 2008; Porter and Van der Linde, 1995). In this context, eco-lobbyism could reduce time and money investments, and uncertainty related to both expansion siting procedures as well as potential litigation (Lankoski, 2000). Eco-lobbyism can also reduce the risk or magnitude of liability costs related to environmental problems, indirectly resulting in lower insurance costs. That proactive environmental strategy and over-compliance can be usefully viewed as aspects of a larger concept which includes also lobbyism as an expected component has not been highlighted in prior literature. That it becomes clear in the presented framework can be considered a contribution of the framework to the environmental strategy literature.

The last category is eco-transaction design and applies to situations where firms capture economic value from the low environmental impact created by both sides of the transaction by designing third level economic institutions. Eco-transaction design allows firms to appropriate environmental value by allowing them to resolve social-dilemmas through the creation of a mechanism for aligning incentives and making credible commitments through the design of third level environmental institutions. Economic value is created through eco-transaction design because certain contractual relations favour solutions that are eco-lean when viewed *across* organizational boundaries. Thus, a prerequisite for an eco-transaction design appropriation strategy is the opportunity to increase the total value created in two or more firms in a way that reduces environmental impact. Research on product-service systems indicates that firms that move downstream in the value chain by taking over parts of their customers' activities can increase

value chain value creation, and, more importantly, appropriate a significant part of the value created through increased margins (Mont, 2004; Roy, 2000; Roy and Cheruvu, 2009; Bates et al., 2003). By building on the theory of institutional solutions to social dilemmas (Ostrom, 1990), Paper I discusses the close relations among several separate literature streams based on their descriptions of instances of the same phenomenon: eco-transaction design. These areas include the product-service systems literature dealing with the manufacturing industry (e.g. Mont et al., 2006; Tukker and Tischner, 2006a); aspects of the literature on green supply chain management dealing with the opportunities for supply chain cost reductions (Sarkis, 2003); the literature on chemical management services (e.g. Stoughton and Votta, 2003); work on demand side management for energy provision services (Roy, 2000); and studies of sustainability through servicizing (Rothenberg, 2007).

In terms of the types of scientific contributions outlined in section 3.1, Paper I makes a contribution of the type terminology. It provides a typology of ways that firms can increase the value appropriated from environmentally differentiated offers. The typology is useful in providing an accessible checklist to consult when considering the appropriation aspects of the business model for an environmentally differentiated offer. Thus, it has both practical and theoretical uses. The type of contribution can be compared to, for example, the business model ontology in Osterwalder (2004), which is essentially a list of concepts that taken together describe a business model. Osterwalder's (2004) scientific and practical contribution consists of a checklist of aspects that need to be described to formulate a business model, whether for research purposes or to facilitate development of a new business model in practice. Similarly, Paper I provides a list of the relevant aspects of an appropriation model for environmentally differentiated offers. Researchers can use this typology to ensure that they capture a comprehensive description of how a firm appropriates economic value from environmentally differentiated offers. It can be used as a checklist for business, to ensure all relevant aspects are accounted for developing an appropriation model for an environmentally differentiated offer.

The limitations of this typology are that, although it is derived from fundamental economic theories of social dilemmas, its connection to work on environmental strategy is based on an snowball sampling of the environmental strategy literature. Beyond the validity of Williamson's (2000) proposed institutional levels, I cannot ensure that all the relevant appropriation strategies are considered. Indeed, it can be argued that the typology lacks an organizational learning perspective because it considers only direct appropriability and excludes generative appropriability (Ahuja et al., 2013).[25] Further, the typology has not been empirically validated.

[25] The paper describing generative appropriability (Ahuja et al., 2013) was published a year after the publication of Paper I (2012). An early draft of Paper I included an appropriation strategy labelled 'eco-learning', which to some extent captured the notion of generative appropriability. However, in the absence of a well-developed theoretical framework for generative appropriability at the time of writing, this strategy was excluded during the revision process.

Because of the scope of the typology, validating the typology as a whole might prove challenging in practice. Therefore, there is also no validated instrument for measuring the frequency of the proposed appropriation strategies among firms, although the survey in Paper IV could be considered to constitute a first attempt to capture certain aspects of the typology.

5.3 Determinants of economic performance for environmentally differentiated offers

Paper IV is an empirical study grounded in the theoretical framework for the appropriation strategies relevant to environmentally differentiated offers presented in Paper I. Paper IV conceptualizes the studied aspects of the appropriation strategies as sources of differentiation relevant to environmentally differentiated offers. It examines the statistical associations between these sources of differentiation and economic performance. The paper hypothesizes that the presence of each of these sources of offer differentiation will be positively associated with economic performance. However, the findings show that only low total cost of ownership, an aspect of eco-lean, is robustly associated with economic performance. While the data do not provide solid grounds for ruling out a positive association between economic performance and the other sources of differentiation, the findings indicate that their effect size is likely smaller than the size of the effect of low total cost of ownership – at least for small Swedish environmental technology firms.

Paper IV makes a predictive statement type contribution, and provides some new observations (represented by the unbiased coefficient estimates of the model). The predictive statement is that offers that score high for low total cost of ownership (eco-lean) are more economically successful on average than those that do not. Paper IV therefore responds to the second part of *Research question 1* about *what situations facilitate value appropriation.*

While this predictive statement might seem unsurprising at first glance, it should be noted that it is established controlling for several other sources of offer differentiation, such as regulatory support (an aspect of eco-lobbyism), superior quality (an aspect of eco-lean), provision of environmental information (related to generative appropriability), and eco-branding aimed at customers. Controlling for these variables constitutes an important contribution, since there was reason to believe that they might be correlated and might act as confounding variables. Not controlling for these variables might have led to overestimation of the effect-size of any one of them, to the degree that one variable co-varied with both economic performance and the included variable. For example, studying the effectiveness of eco-branding without controlling for the degree of regulatory support aimed at buyers or users of the offer could severely overestimate the association between eco-branding and economic performance.

While eco-lean can result in both enhanced quality and greater cost effectiveness, only the latter seems to be positively associated with the economic performance of the offers. This finding adds some nuances to

previous, more general arguments about the profitability associated with eco-lean (Florida, 1996; Porter and Van der Linde, 1995a).

Generalization of these findings is limited in three ways. First, the sample size is comparatively small, which reduces the power of the statistical significance tests. Thus, lack of a statistically significant association between a particular variable and economic performance, cannot be interpreted as evidence of the complete lack of such an association in the larger firm population. However, the findings do imply that the association with economic performance is likely stronger for low total cost of ownership (eco-lean) than for the other variables. Second, the results are based on a study of environmental technology-based offers from small firms in Sweden. Any generalization beyond that population should be made with caution. It cannot rely on the statistical methods used, but rather on theoretical reasons for why another population might be sufficiently similar. Third, the degrees of offer differentiation on the predictor variables were operationalized as reported perceptions of firm CEOs. To the extent that other stakeholders' answers would be correlated with the CEOs responses, the predictive statement should remain reliable.

5.4 Managerial practices for the development and commercialization of environmentally differentiated offers

The literature on the managerial practices facilitating the development and commercialization of environmentally differentiated offers stresses the importance of top management commitment (e.g. Hart, 1995) and the creation and organizational diffusion of an environmental vision (e.g. Hart, 1995; Larson, 2000). Paper II contributes to this literature by showing *how* such corporate environmental visions and explicit executive commitment work in the development of environmentally differentiated offers. In a naïve interpretation, a vision or goal will simply make lower tier employees develop new offers in response to expressed goals. However, Paper II shows that in a large and product development oriented organization, the explicit goal creates a similar effect by increasing the focus and the resources available to already developed offers that fit the goal. Thus, investing additional resources in a solution originally customized for a specific customer might result in an application with a broader customer base. A variation of this effect is that sales staff might develop greater awareness of offers that might match goals, for example, via eco-labelling. Their increased awareness may in turn lead to an increase in the organizational resources spent on diffusing the offer on the market.

This sequence of events, i.e. an already developed offer being matched to a new goal, can be explained within the problem-solving perspective of the firm (e.g. Nickerson and Zenger, 2004). In this view, a firm's environmental goal or vision statement can be interpreted as a problem formulation. The developed offer can be interpreted as the solution to the problem. In light of previous work on organizations as problem solvers, it follows that, in large organizations, there may frequently be solutions 'waiting' to address problems (cf. Cohen et al., 1972). However, in the environmental strategy

literature, a one-directional sequence, that is, a goal resulting in product development, is often implicitly assumed (e.g. Larsson, 2000; Figge et al., 2002). Foregrounding this reverse sequence from solution to problem, is the main theoretical contribution of Paper II.

Another implication for considering the phenomenon from a problem-solving perspective is the importance of choosing a valuable environmental problem to address. It has been shown that formulating the problem appropriately is often as, or more, important to an effective problem-solving process as managing the search for a solution (Lyles, 1981; Pounds, 1969). What constitutes a valuable problem is dependent on 1) the cost of not addressing the problem and 2) the chances of finding a solution at less than that cost (Hsieh et al., 2007). The second aspect is highly dependent on the specific problem-solving abilities of the firm. This means that managers must formulate the environmental vision to correspond to a costly environmental problem that matches the capabilities of the firm.

In terms of section 3.1, the contribution to the environmental strategy literature is of the type a predictive statement. The predictive statement is that the introduction of a corporate sustainability vision can lead to an accelerated rate of commercialization of already developed but niche oriented offers, possibly bypassing the need for further (technological) development. But this is dependent on a good fit between the (implicitly) chosen environmental problem and the organizational capabilities of the firm. This partly answers *Research question 2: How can development of environmentally differentiated offers be managed effectively?*

It is important to note that the external validity of the predictive statement in Paper II is based primarily on conceptual reasoning rather than being empirically proved. The effect was illustrated by the studied case, and the insights gained by studying the case were crucial for my understanding of the effect. However, a single case study can rarely constitute sufficient grounds for a general claim regarding a broader population. Thus, the external validity of the predictive statement is based solely on so-called analytical generalization (Yin, 2009). This is achieved by showing that the phenomenon can be interpreted in terms of established theory that regards organizations as problem-solvers (e.g. Cohen et al., 1972; Nickerson et al., 2007), and relies on the generality of these theories to claim generality of the specific application of the theories. Since even these theories are not beyond doubt about their generalizability, further empirical verification of the phenomenon, either by replication studies or by quantitative work, is desirable to strengthen the external validity of the claim.

5.5 Risk transfer in circular business models

The causes of managerial hesitation to implement a service-based circular business model is the topic of Paper V. I will here discuss the results of the underlying study in relation to *Research question 3*: *What are the risks and opportunities associated with service-based offers designed for closed-loop material flows?*

Paper V shows that it is difficult to validate the viability of a service-based circular business model without incurring significant financial risk. Chapter 2 referred to the several claimed advantages of service-based circular business models such as decreased manufacturing costs (Stahel, 2010) and overall improved margins (Baines et al., 2007), enhanced customer relations (Walsh, 2010), improved brand protection (Seitz, 2007) and radically reduced environmental impact (Mont, 2004; Stahel, 2010). However, there have been calls for some explanation of the limited adoption of these business models by industry (Vezzoli et al., 2012). In this thesis, I address the issue through a longitudinal interventionist case study of a small bicycle manufacturer attempting to implement a service-based circular business model. The intervention enabled the study of a hitherto understudied phenomenon, the transition from a traditional, and linear business model to the introduction of a service-based circular business model. If adoption by industry is slow, observation-based research becomes more difficult because the phenomenon is less frequent. Thus, the case description in Paper V contributes to the environmental strategy literature by providing observations of a rare process.

An opportunity associated with a service-based circular business model as perceived by the owners-managers' of the firm was that the business model allowed the firm to meet low-cost competition in a competitive product category. The service-based revenue model was perceived as a way to leverage a local presence and to establish closer customer relations. The remanufacturing aspect was perceived as reducing the cost-disadvantage of local production compared to foreign low-cost competitors.

While the literature discusses some disadvantages to service-based circular business models (e.g. Mont et al., 2006; Kuo et al., 2010; Besch, 2005; Östlin et al., 2008), the case study in Paper V indicates that many of these can be overcome in practice - at least in the specific case studied in Paper V. However, one particular previously reported disadvantage remained as seemingly insurmountable in the case: the issue of risk previously externalized to the customer which, in a service-based circular business model, must be internalized by the manufacturer-cum-fleet manager (Mont et al., 2006; Stahel, 2010). Paper V analyses this difficulty in detail, using a entrepreneurial learning/business assumptions-testing framework based on the customer development methodology presented by Steven Blank (2005; Blank and Dorf, 2012). The analysis shows that the transfer of risk from customer to producer means that it will always be more difficult to validate the product-market fit assumptions and cost structure assumptions in the service-based circular business model, compared to an isolated-transaction-based linear business model for the corresponding physical product. It shows also that the financial impact of inaccurate assumptions will be larger in a service-based circular business model than in the corresponding linear business model. In the context of section 3.1, this constitutes a predictive statement type contribution. The predictive statement is that implementation of service-based circular business models imply higher risk for the firm than

implementation of a traditional, isolated-transaction type, linear business model based on the corresponding physical product.

Similar to Paper II, the external validity of the predictive statement in Paper V is based primarily on conceptual reasoning, so-called analytical generalization (Yin, 2009), rather than being empirically proven. The studied case supports the explanation and was the original source for understanding the problem. However, in terms of generalization by the principle of induction it is only a single observation. Further empirical verification of the problem through replication or quantitative studies, would strengthen the external validity of the claim. However, given the scarceness of the phenomenon, data collection sufficient for a statistical generalization would be difficult.

Much of the prior related literature has relied on concepts that include a broader array of possible business models. In particular the product-service systems literature (e.g. Tukker and Tischner, 2004; Mont, 2004) describes a wide array of business models with variable revenue models, and variable degrees of closed material flows. Paper V in this thesis focuses on a comparatively specific type of business model, which is based on remanufacturing, retained ownership of the physical product, and sale of a subscription service that includes access to the product. This narrow focus seems useful since it allows rather strong and specific claims about inherent risks, and assumption validation challenges related to the business model. In this sense, introduction of the concept of service-based circular business models can be viewed as a terminology type contribution to the environmental strategy literature.

5.6 Realization of the research aim

In the introduction chapter, the research aim of the thesis is stated as: to contribute to the environmental strategy literature by providing new theoretical viewpoints, methodological approaches to and empirical data on the development, commercialization and economic performance of environmentally differentiated offers. This section summarizes how the thesis addresses this research aim.

This thesis has provided three novel theoretical viewpoints. First, it introduced the concept of environmental differentiation and provides justifications for why it is valuable to study this as a phenomenon that evolves over time through social discourse and interaction, rather than from an (implicitly) objective, naturalistic perspective (e.g. Lankoski, 2000). The thesis presents arguments for that meaningful business research can be conducted despite the existence of epistemic and methodological challenges to defining environmental sustainability. It points out also that the resulting findings may prove robust to the challenges associated with that sustainability can be considered a moving target. While prior work uses proxies for environmental differentiation that are compatible with this approach (e.g. Forbes' sustainability ranking, or the Dow Jones sustainability indices), thorough discussion of and justification for this approach is lacking. There is also no discussion of why, from a business

research perspective, this approach might be preferable to more objective measures (e.g. CO_2-emissions, US Environmental Protection Agency Toxics Release Inventory).

Second, this thesis emphasizes and justifies the importance of value appropriation as an important research topic within the field of environmental strategy. Since firms often are able to create but not appropriate economic value by addressing environmental problems, focusing on appropriation may increase the relevance of the research for both managers and society at large.

Third, Paper I provides a theoretical framework for considering and communicating appropriation strategies suitable for firms that address environmental problems. This is a new theoretical viewpoint and draws together many hitherto separate environmental strategy research streams to focus on the overarching problem of value appropriation.

There are two ways in which the thesis seeks to contribute via new or underused methodological approaches. First, the quasi-experimental design utilized in Paper I is a novel methodological approach within the field of environmental strategy. It contributes to that literature by providing methodological triangulation (by being a novel methodological approach) and arguably superior internal validity (Shadish et al., 2002) compared to many other observational studies of the relationship between environmental differentiation and economic performance. Second, the interventionist approach utilized in Paper V, while possibly not novel to the field (cf. Mont et al., 2006), is a not widely diffused methodological approach. It enabled study of a scarce, but important phenomenon – the on-going search for and implementation of a service-based circular business model. It is also allows more direct dissemination of knowledge from the environmental strategy research community to industry, compared to pure observational studies that are often only indirectly disseminated via texts and education.

In relation to new empirical data, the thesis contributes via the three empirical studies. First, a database of accounting data for environmental technology firms was created, combining the register of the now-closed website of Swentec and public accounting data from Bolagsinfo. This is an empirical contribution because there are few existing quantitative studies of environmental differentiation in small firms. It adds data on the Swedish case to the data examined in the growing literature on the relationship between environmental differentiation and economic performance for small firms. Second, a survey based on the theoretical framework proposed in Paper I was administered to the CEOs of small Swedish firms. This is an empirical contribution because it allowed me to control simultaneously for several different appropriation strategies. The existing literature, to the extent that what corresponds to these appropriation strategies has been studied, has often focused on only one or two at a time. To examine them simultaneously is important because they may co-vary and, thus, effect sizes may be overestimated if one does not control for as many as possible in the same model. Third, the retrospective multilevel in-depth case study of the

large manufacturing firm provides an empirical contribution through observation of how a corporate environmental sustainability vision can facilitate development and commercialization of environmentally differentiated offers. The importance of such a vision has been noted in the environmental strategy literature (e.g. Hart, 1995; Larson, 2000), but there is no detailed empirical examination of the organizational mechanisms by which a vision may affect the development and commercialization of new environmentally differentiated offers. Paper II showed that such a vision can facilitate wider diffusion of already developed, customized offers and highlighted the importance of top management choosing a suitable (that is a good match with the firm's existing capabilities) environmental problem. Fourth, the interventionist study of the bicycle manufacturer is an empirical contribution that enabled examination of a currently rare phenomenon; search for and development of a new business model by an established firm transitioning towards a circular economy (Stahel, 2010).

5.7 Synthesis in light of the research questions

Three research domains are within the research aim were highlighted by the three research questions: *Research question 1*: To what extent are firms appropriating economic value from environmentally differentiated offers and what situations facilitate value appropriation? *Research question 2*: How can development of environmentally differentiated offers be managed effectively? And *Research question 3*: What are the risks and opportunities associated with service-based offers designed for closed-loop material flows?

To conclude the discussion, in what follows I summarize the answers to these research questions and the literature to which they contribute.

5.7.1 Research question 1: To what extent are firms appropriating economic value from environmentally differentiated offers and what situations facilitate value appropriation?

Paper III shows that small environmentally differentiated firms are not appropriating as much economic value from their environmentally differentiated offers as other firms they resemble (based on industry classification, firm age and firm size) appropriate from their offers. This is a contribution to the literature on the relation between environmental performance and economic performance (e.g. Orlitzky et al., 2003).

Paper I conceptualizes the appropriation strategies available to firms that are environmentally differentiated. It shows that the findings in much of prior environmental strategy literature can be summarized as cases of efficiency and quality gains; branding and reputational gains; regulatory or other public policy advantages; and value chain gains due to clever design of transactional relations. This is a contribution to the literature in the so-called greening debate (Linnenluecke and Griffiths, 2013) dealing with the drivers of environmental differentiation and the conditions for so-called win-win situations (e.g. Porter and Van der Linde, 1995a) and appropriation of value in cases of environmental differentiation (e.g. Christmann, 2000).

Paper IV shows that among the offer differentiation attributes derived from Paper I, only efficiency gains resulting in lower total cost of ownership are a robust predictor of the economic performance of the offer. Also this is a contribution to the literature related to the so-called greening debate, dealing with the conditions for the appropriation of economic value for environmentally differentiated offers (e.g. Lankoski, 2000; Christmann, 2000).

5.7.2 Research question 2: How can the development of environmentally differentiated offers be managed effectively?

Paper II shows that explicit environmental goals and vision statements facilitate the development and commercialization of environmentally differentiated offers. That environmental visions and goals can produce accelerated commercialization of existing solutions implies that their use may lead to a faster response from the organization than would be the case if their effect was only to encourage developers to construct new offers in response to the goal. Explicit top management support and clear goals are likely an effective way to manage the development of environmentally differentiated offers. An important caveat to this finding is that the problem formulation implied by the environmental vision must correspond with the problem-solving capabilities of the firm. In other words, the environmental vision must be carefully chosen to match the firm's existing resources, values and processes (Christensen, 1997). This is a contribution to the greening debate literature (Linnenluecke and Griffiths, 2013), specifically work that suggests that visions are important for the effective management of environmental differentiation (e.g. Hart, 1995; Larson, 2000).

5.7.3 Research question 3: What are the risks and opportunities associated with service-based offers designed for closed-loop material flows?

Paper V illustrates that service-based circular business models can provide an opportunity for a high-end brand firm to compete against (foreign) low cost production, replicating the findings in Besch (2005) and Heese et al. (2005). However, Paper V shows that proactive business model assumption validation is always more difficult to achieve for a service-based circular business model compared to the corresponding linear business model. This means that a service-based circular business model requires more financial commitment or slower up scaling than the corresponding linear business model. This is a contribution to the literature on remanufacturing and product-service systems (e.g. Mont et al., 2006; Stahel, 2010). Specifically, it responds to the perceived conundrum about the slow diffusion of service-based circular business models in industry despite their many suggested advantages (Vezzoli et al., 2012).

6 Future research

In this chapter I suggest some opportunities for future research which I believe would be interesting and practical and that would add to the current state of the knowledge related to the topic of this thesis.

I have suggested that the typology proposed in Paper I could constitute a useful tool for researchers searching for a comprehensive description of the appropriation model for environmentally differentiated offers or firms. However, more work needs to be done on the operationalization of this typology. While Paper IV presented an instrument based on the typology, it covers only a fairly narrow subset of the conceptual phenomenon. An empirically validated instrument to measure the four appropriation strategies proposed would be useful to enable deeper examination of the relative efficacy of different appropriation models under different conditions. It would also be of practical use in an audit of the environmental strategies of firms.

As previously mentioned, both the case studies would benefit from additional replication studies, as well as attempts at cross-sectional generalization via statistical analysis. It should be fairly straightforward to examine the generalizability of the findings for the effects of explicit top management goals related to environmental differentiation (from Paper II). Data collection could be via surveys, and analysis by descriptive summary of the responses, various significance tests, multiple regression or structural equation modelling. Quantitative analysis of the findings for the risks inherent in service-based business models might be more difficult. Furthering our understanding of risk management in circular business models would likely require additional case studies. In particular, it might be valuable to examine the business conditions that reduce or aggravate the risks described in Paper V. For example, the uncertainties emphasized might be partly mitigated through the adoption of a product design methodology allowing for increased flexibility in responding to changing customer needs. Service-based circular business models differ from traditional linear business models in how cash flow develops over time and also in the closeness of relations with customers. Closer customer relations may enable reception of earlier and more reliable signals about the (un)attractiveness of a product-service combination. Future research could look at the benefits and disadvantages of service-based circular business models by developing a deeper understanding of the trade-off between closer and more long-term customer relations, and increased initial financial risk. In other words, it should examine under what circumstances does improved long-term customer insight outweigh the disadvantage of early validation difficulties and tied-up capital.

The study of implementation of a service-based circular business model presented in this thesis focused on a small firm acting only in the Swedish market. It would be interesting to extend this study to larger and/or multinational firms. Larger firms have many more resources in the form of

design capabilities and supplier bargaining power. This may facilitate the business model and product design. On the other hand, global dispersion of customers may constitute a logistical challenge, a factor that has been identified as a potential barrier to circular business models (Besch, 2005). The organizational structure and corporate culture of large firms may also impose higher demands for a structured business development approach. To increase the adoption of circular business models in the wider economy, the development of such a structured business development approach for circular business models might be beneficial.

I also would suggest that it would be worthwhile to study the effects of additive manufacturing on circular business models. To the extent that both industry and individuals increasingly are adopting 3D printers, some of the profit logic of closed material flows may change. One of the best ways to achieve cost advantage from closed material flows under normal, subtractive manufacturing is via remanufacturing (Walsh, 2010), that is, by using salvaged used components as cheap inputs to the production process. However, were consumers to begin producing more components and complete products at home using 3D-printers, this might become less feasible.

One line for further research was brought to my attention through my supervision of two bachelor students (Falsen and Kuylenstierna, 2013). For their thesis, they interviewed firms in a Swedish chemical industry cluster in the west of the country, on the drivers for replacing natural gas with bio-methane. Bio-methane technologically is a near-perfect substitute for natural gas both as a fuel and a product ingredient. Both uses should produce about the same environmental benefits compared to natural gas. Falsen and Kuylenstierna found that the commercial and strategic benefits of environmental differentiation were perceived as much stronger by firms that were able to use the bio-methane as an ingredient in their products rather than as a fuel for their processes. This was especially striking in relation to the drivers for building legitimacy and consumer branding (eco-branding). This finding cannot be explained by prior theory, which, except for the case of consumer branding (Griskevicius et al 2010), treats the specific use of the environmentally differentiated input product as irrelevant for explaining its market diffusion and economic performance. Further work to examine more broadly how the attractiveness of environmentally differentiated offers is determined by the specific uses of the offer would be relevant for managers and would address what I perceive is a gap in the environmental strategy literature.

7 Implications for practice

The research objective of this thesis, as stated on page 1, is to increase society's rate of change towards a state of sustainable development by providing knowledge of the business opportunities and challenges related to the development and commercialization of environmentally differentiated offers. To achieve this objective, I have tried not only to contribute to the academic literature on environmental strategy but also to produce findings that have implications for practising managers and possibly also policy makers. Below is a summary of the practical implications of the findings in this thesis.

The results in Paper III suggest that managers, investors and entrepreneurs should be cautious about committing resources to environmental differentiation. Small environmentally differentiated firms are less profitable than similar, non-environmentally differentiated firms. This is likely driven mainly by the greater difficulty to appropriate economic value created by environmental differentiation.[26] This implies that decision makers need to perform extremely careful examination of the appropriation model of the firm or the offer being considered for investment. Taken together with findings from prior research, the finding of a negative association for small, established environmentally differentiated firms suggests that the good economic performance shown by larger firms might be driven by slack resources available in already profitable firms.

This has two implications for policy makers. First, if having more environmentally differentiated small firms is considered desirable, then this will likely require (increased) public policy support. Support might consist of regulatory or legal changes, or direct subsidies to the desired firms. The results in Paper IV suggest that public policy support directed towards buyers of environmentally differentiated offers is likely to be appropriated mainly by these customers, not by the firms selling the offer. It may suggest also that current levels of support are too low to compensate for the lack of competitiveness of the offers being supported. Second, it would seem that slack resources in firms have an indirect positive effect on environmental differentiation. Therefore, policy makers interested in increasing environmental differentiation in industry generally, might achieve this to some extent by either facilitating profitability of the firms or by increasing the power of agents (managers) vis-à-vis principals (shareholders).[27]

While many firms find it difficult to *capture* economic value from environmentally differentiated offers, there is also reason to believe that the opportunity for *value creation* is extraordinary high for environmentally

[26] Strictly speaking, it cannot be ruled out that the studied firms are altruistic or unusually incompetent at creating value.

[27] An important caveat to this argument is that it seems likely that it is the firm's relative economic performance not absolute performance that matters. Depending on the baseline used to compare profitability by firms and their investors, an improved economic climate might, ultimately, not affect the degree of environmental differentiation in industry more broadly.

differentiated offers. Since firms create value by solving problems, and since many environmental problems are very big problems, a solution to the appropriation problem would imply potentially very big business opportunities. While this thesis does not offer a complete solution to the appropriation problem, the results in Paper I should help in the search for a good appropriation model. It does this by helping business developers communicate and structure their thinking. An effective appropriation model related to environmentally differentiated offers needs to rely on the four appropriation strategies of eco-lean, eco-branding, eco-lobbyism and eco-transaction design. To apply these in practice, business developers must ask:

Will this environmental differentiation[28] allow us to capture value by…

- *…more resource effective choice of raw materials, processes and offer designs* resulting in a cost advantage or better product quality?
- *…improved reputation among customers, employees and other stakeholders,* resulting in increased sales or reduced marketing, hiring, siting or litigation costs?
- *…a better fit with the legal and regulatory frameworks, or subsidies,* resulting in a cost or differentiation advantage?
- *…closer contractual relations with customers or suppliers, for example via functional sales* resulting in increased overall value chain efficiency or a stronger bargaining position?

While Paper I provides examples of success stories related to all these appropriation strategies, business developers need to keep in mind the results of the statistical examination in Paper IV. This showed that, in relation to environmentally differentiated offers, low total cost of ownership (due to the resource effective offer design), is the only type of offer differentiation that is robustly (positively) related to economic performance. It is important to note that this result is related to only how the examined offers were differentiated on the market, which is a subset of the possible benefits of each appropriation strategy. Also, the finding holds only for the average firm: every firm and most offers are unique.

Another finding relevant to both businesses and policy makers is that of the higher risk inherent in service-based circular business models. While these business models are sometimes promoted as fantastic win-win opportunities (e.g. Stahel, 2010), the research in this thesis shows that these business models, of necessity, entail more risk than the traditional, linear business model based on the corresponding physical product. Decision makers pondering over whether to invest in or commit to such a business model need to be aware of the difficulty involved in proactively testing certain business assumptions when developing such business models. A possible solution would be slower scaling of the business to allow for more gradual market learning before committing substantial resources. Nevertheless, the advantages of a service-based circular business model might outweigh the increased risks. These advantages include potential for reduced resource

[28] This is applicable to environmental differentiation of both firm and its offer.

costs, increased margins, improved brand protection, and closer customer relations, which might result in improved competitive advantage over foreign low cost competitors.

For policy makers interested in a faster move to a circular economy, the drawbacks of such business models for individual firms need to be acknowledged. If the expected pay-off of service-based circular business models were more financially attractive, this might compensate for the greater difficulty to reduce risk. Regardless of political views about appropriate public sector size, one solution would be to shift the tax out-take from labour towards materials. If labour became comparatively cheaper and materials comparatively more expensive, this would increase the attractiveness for firms of service-based circular business models. Greater diffusion of service-based circular business models would imply increased demand for labour and reduced environmental impact. However, due to the international markets for raw materials such a shift would likely benefit the labour intensive sectors relatively more, to the cost of other sectors – especially the mining and other raw materials sectors. Accounting for all these aspects is, unfortunately, beyond the scope of this thesis.

Finally, for corporate managers interested in managing the development of environmentally differentiated offers more effectively, explicit goals and commitment are important and useful tools. Not only to spur novel activity among offer developers, but also to highlight and accelerate the commercialization and diffusion of existing solutions that might, by chance, already achieve the desired goal.

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