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► **To cite this version:**

Diane-Laure Arjaliès, Jean-Pierre Ponsard. A managerial perspective on the Porter hypothesis The case of CO2 emissions. 2010. hal-00445847

HAL Id: hal-00445847

<https://hal.science/hal-00445847v1>

Submitted on 11 Jan 2010

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ÉCOLE POLYTECHNIQUE
CENTRE NATIONAL DE LA RECHERCHE SCIENTIFIQUE

**A MANAGERIAL PERSPECTIVE ON THE PORTER HYPOTHESIS
THE CASE OF CO2 EMISSIONS**

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January 2010

Cahier n° 2010-02

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A Managerial Perspective on the Porter Hypothesis

The Case of CO₂ Emissions

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January 2010

Résumé : les investisseurs et les entreprises réalisent de plus en plus que le changement climatique et les besoins qui y sont associés vont impacter structurellement l'économie. Dans cette optique, ce papier cherche à comprendre ces impacts sur la stratégie des entreprises, à travers l'étude des systèmes de management. Une typologie est proposée, basée sur un modèle en deux étapes. A l'étape une, la firme aborde la question du CO₂ sous l'angle du risque et de la mise en conformité. A l'étape deux, la firme est impliquée dans une réévaluation plus globale de ses relations avec ses clients et fournisseurs. Cette construction est basée sur trois études de cas : Dupont (chimiste), Lafarge (matériaux de construction) et Unilever (produits de consommation). Des implications sont tirées de cette analyse pour les investisseurs.

Mots-clefs : Emissions CO₂ – Responsabilité Sociale de l'Entreprise – Stratégie – Systèmes de Management

Abstract: investors and companies are increasingly aware that climate change and its associated needs for reducing CO₂ emissions are likely to impact structurally many areas of the economy. This paper offers a contribution to understand these impacts on companies' strategy, by studying management systems. A typology is introduced based upon a two stage model. At stage one, the firm becomes aware of the risk and CO₂ is a compliance issue. At stage two, the firm is involved in a more global re-assessment of its business portfolio including its relationship with suppliers and clients. The construction is based on three case studies: DuPont (chemicals), Lafarge (building materials) and Unilever (consumer goods). The implications of the analysis for investors are drawn.

Key-words: Corporate Social Responsibility – CO₂ emissions – Management Systems – Strategy

JEL Classification: M14 – M21 – M41

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1 Introduction

Over the past decade, the debate on climate change has dramatically shifted. The strong evidence presented by the scientific community through the Intergovernmental Panel on Climate Change (IPCC) process established by the United Nations Environment Program (UNEP) and the World Meteorological Organization (WMO) has largely settled the discussion about whether an action should be taken to stabilize atmospheric greenhouse gases (GHGs) (Parry et al., 2007). Climate change is now acknowledged as being a serious global threat which demands an urgent response. For example, the Stern Review on the economics of climate change estimates that without any global action, the overall costs and risks of climate change would be equivalent to losing at least 5% of global Gross Domestic Product (GDP) each year, which could rise to 20% if a wider range of risks and impacts are taken into consideration (Stern, 2006). The question is: what should be the response to address the challenge of global warming while maintaining at the same time an economic growth (Mc Kinsey Global Institute, 2008). With this in mind, environmental concerns are becoming an increasing central topic for strategic choices and decision-making by investors around the world.³

According to leading consultancy, investors would be more than 80% to consider climate change as a very or somewhat important factor when investing (Mercer Investment Consulting & Carbon Disclosure Project, 2009). The Carbon Disclosure Project (CDP) was launched in 2000 to collect high quality information on CO2 emissions. In 2009, it provided information concerning over 2,000 organizations in 66 countries, and grouped no less than 475 institutional investors – holding \$55 trillion in assets under management – and 60 purchasing organizations.⁴ However, despite assessing CO2 emissions as a key dimension to analyze when selecting companies for the portfolios, a significant number of investors acknowledge to keep working on how to integrate climate data into their existing systems, models and processes.⁵ Almost five years after the European Union Greenhouse Gas Emission Trading System (EU ETS) debut of operation, Mercer concluded its study by stating that only

³ For example, the Fonds de Réserve pour les Retraites (FRR) – the major French public pension fund – declared: “Environmental concerns and, in particular, the global warming’s impact on global economy and its different sectors put forward by the scientific community, raise a lot of questions a long-term investor cannot ignore when deciding its global investment strategy.” (FRR, 2009)

⁴ Carbon Disclosure Project : <https://www.cdproject.net>

⁵ For example, hardly any investor anticipated in 2006 the increase by 62% of Rhodia’s stock due to a major reduction in total greenhouse gas emissions (GHGs) in South Korea (Le Revenu, 2006).

a very small handful of investors have succeeded in directly and systematically taking into account climate considerations into their actual stock selection.

The discrepancy between the major restructuring consequences of the climate change challenge and the relatively slow response of financial professionals may be explained by two very different factors. Firstly, for years, environmental pressure had been perceived by investors neither as a risk nor as an opportunity which could structurally impact companies' bottom line. As a direct result, investors have historically regarded explicitly and addressing environmental factors in their investment strategies as incompatible with their fiduciary responsibilities (Innovest, 2007). The context has now significantly changed. Secondly, at a more fundamental level, the lack of academic consensus on the macro-impacts of environmental regulations on the profitability of firms did not provide a sound basis to develop operational tools.

Indeed, when analyzing the academic literature, two approaches emerge. On the one hand, a view, known as the "Porter hypothesis" (Porter, 1990; Porter & van der Linde, 1995) asserts that stricter environmental standards can spur innovations which enhance competitiveness and contribute to make companies more profitable. This virtuous mechanism is said to lead to the so-called "win-win" situation in which both a better environment and a higher financial performance are achieved. This view has benefited over the past decades from a growing interest among politicians and practitioners.⁶

On the other hand, according to a neo-classical economic perspective, tightening environmental regulations through norms or taxes, will reduce the choice set of the firm and cannot benefit a profit maximizing firm (Fogler & Nutt, 1975). Indeed, Palmer et al. (1995) use the standard economic framework to demonstrate that more stringent environmental constraints cannot generate a higher profit, even if the firm innovates. They also provide counter arguments as regards the fact that more stringent environmental evidence in the US in the 80's relative to the EU or Japan would have caused the possible loss of competitiveness of US industry.

⁶ Since Gore (1993), politicians have viewed the green economy as a chance for growth and competitiveness for the industry. See also Wagner (2003) on that subject.

The academic attention has then shifted from macro to micro evidence. Wagner (2003) reviews more than 20 empirical studies which have tested the Porter hypothesis and shows that no relationship between environmental regulations and financial performance can be demonstrated. Ambec and Lanoie (2008) identify three possible ways in which environmental constraints may induce higher profit: cost reductions, increased revenues and lower cost of capital. They review the empirical cases in this respect, pointing out positive or contradictory evidence.

Altogether, it is not surprising that investors be still in search for adequate tools to assess the impacts of more stringent CO₂ regulation on their portfolios. In this paper, we want to contribute to this question by providing a systematic framework to evaluate the response of firms to this new environment. We take the position that previous studies on the Porter hypothesis at the micro-level have neglected an important factor that could explain the ambiguity of the empirical results: the managerial dimension of strategy, i.e. the organizational conditions in which a firm elaborates and implements its strategy. We suggest that environmental regulations can systematically lead to a better financial performance only if the new strategic choices have led to a transformation of organizational processes and management systems. This view is in line with some previous work. For instance, Ambec and Barda (2002) associate the Porter hypothesis with agency problems. Gabel and Sinclair Desgagné (1998) attribute the hypothesis on the prevalence of organizational routines. Our model also takes into consideration the fact that agents in the firm operate under bounded rationality and informational constraints.

To elaborate our construction, we build upon a comparative study of three companies belonging to different sectors, to wit: DuPont (chemicals), Lafarge (building materials) and Unilever (consumer goods). These firms operate at different levels of the added value chain: DuPont provides components to manufacturers, Lafarge belongs to the manufacturing sector and Unilever delivers goods for the final consumers. This differentiated choice obeys a twofold will: 1) to provide a general model of change regardless of the firm's business and 2) to analyze the managerial dimension of the Porter hypothesis in firms which face different forms of environmental regulations and pressures regarding climate change. Indeed, we believe that organizational and business diversities are key advantages when developing managerial models.

The paper is structured as follows. Section 2 explains what we mean by a managerial perspective, building on Simons' synthetic work on organizations (Simons, 1995). It also reviews a preliminary positioning of firm's environmental and social strategy in those terms, based upon an empirical survey of large French firms (Arjaliès & Péan, 2009). This positioning will be used to construct our own typology. Section 3 introduces this typology. It is hypothesized that firms follow a two stage process: at the first stage, the strategy of the firm is associated with awareness/risk while at the second stage it is associated with vision/opportunities. The relevance of this model to structure the strategies actually followed by DuPont, Lafarge and Unilever is discussed in details. Section 4 revisits the Porter hypothesis. Section 5 comes back to the investors, and draws the implications of our results for the design of adequate tools to assess the impacts of climate change on portfolio analysis, giving due consideration to the factors that may trigger the passage of a firm from stage one to stage two. Section 6 concludes.

2 The managerial framework and some preliminaries findings on how firms manage CSR

2.1 The managerial framework

To adapt to its environment, a firm must keep innovating and evolving. According to bounded rationality perspective (Cyert & March, 1963), firms should encourage organizational learning (Argyris & Schon, 1978) and local initiatives for generating emergent strategies (Mintzberg, 1989) while controlling that the chosen strategies are well implemented. Simons (1995) has elaborated a comprehensive framework to analyze strategic and organizational change in this framework. It relies on four performance systems.

- The first two systems are key cognitive tools to 'frame' what can and cannot be done both in terms of behaviors and actions:
 - *Beliefs systems* set the core values of the company to create a sense of commitment and belonging on part of the employees.
 - *Boundary systems* set the framing for strategic elaboration and analysis. They orientate managers' actions by showing what is permitted.

- The other two systems refer to the planning and control procedures. In particular, they are concerned with the information systems needed to support these procedures.
 - *Diagnostic systems* typically involve a wide range of indicators, which reflect the different facets of a company's performance, for internal or external use. They aim at ensuring that managers meet the firms' strategic goals. Control is made by exception, with actions taken whenever reported data widely differ from targets.
 - *Interactive systems* involve a limited range of indicators to create a total determination of the management on a selected set of goals. Their purpose is to stimulate organizational learning by encouraging managers to innovate. The control takes the form of a very high degree of interaction along the hierarchical line. The interactive control systems will focus on areas varying from company to company according to a critical performance criteria.

It is the *joint* use of these four systems which permits firms to drive strategic renewal by favoring continuous innovation and ensuring that the implemented strategic actions are coherent and efficient. A summary of this process is provided in figure 1.

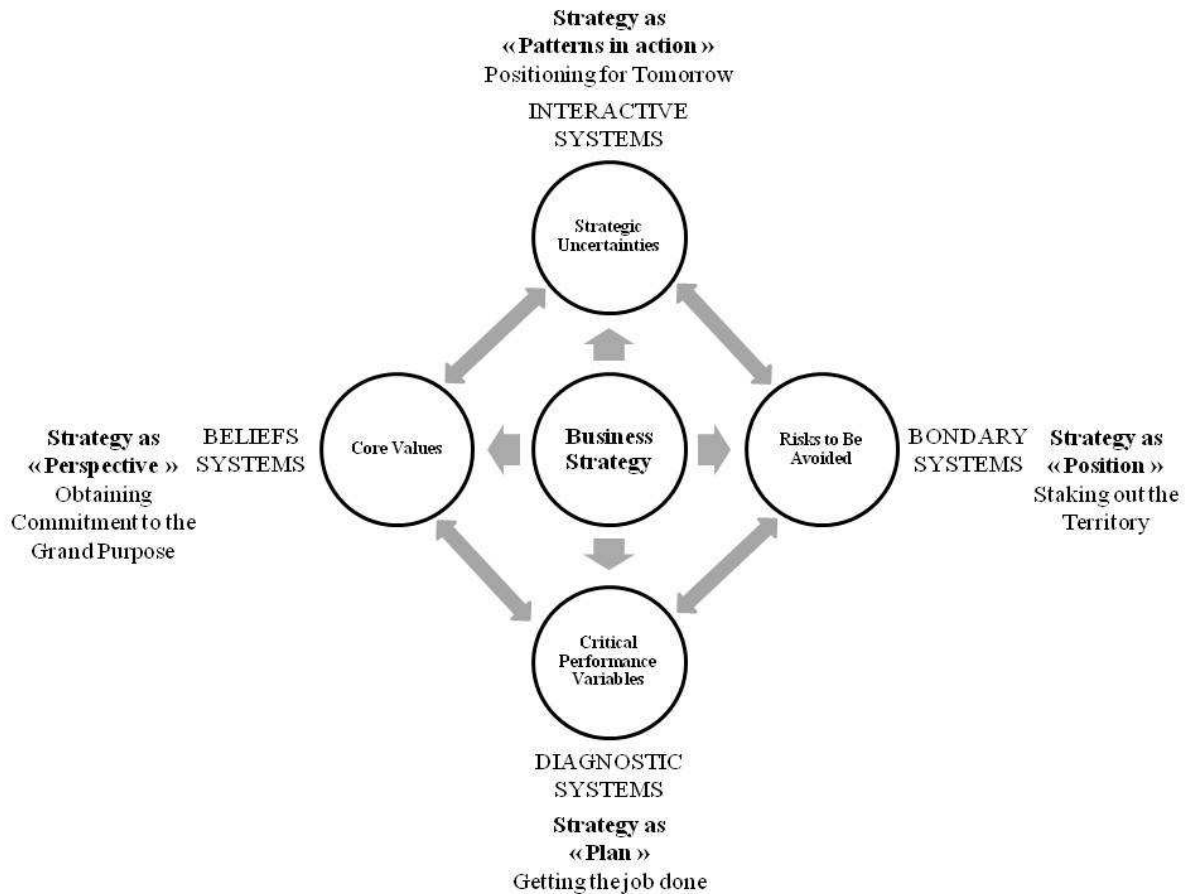


Figure 1: a dynamic relationship (source Simons (1995))

In his research, Simons gives particular attention to the differences between diagnostic and interactive systems. He points out the connection between the major sources of strategic uncertainty (regulatory constraints, cost efficiency, launching of new products...) and the interactive systems to be put in place. He also emphasizes that the design of managerial compensation should be different in both systems. Compensation should typically be based on objective criteria for the diagnostic systems which are result oriented, and on subjective criteria for the interactive ones which are process oriented. Objective and subjective criteria constitute the extrinsic part in the motivational system of the firm. The beliefs systems of the firm have a direct role on the intrinsic motivation of the employees and as such they contribute to their alignment with the goals of the firm.⁷

⁷ That intrinsic (i.e. symbolic) and extrinsic (i.e. financial) motivation need to be thought as complements has become an important issue (Bénabou & Tirole, 2006).

The relevance of this framework has been illustrated by a number of case studies made by Simons and others.⁸ Simons' approach will be used as a starting point for our model. Two other dimensions need to be added to provide our managerial framework. The first dimension refers to the necessary cross-functional aspect of environmental strategies: interactive systems should be designed so as to promote horizontal interaction, for instance between functional and operational departments to evaluate the risks, and to design appropriate responses. This cross-functional dimension of management systems is not addressed by Simons in his typology while it is an important feature in the implementation of turnaround strategies.⁹ The second dimension relates to the participation of external stakeholders such as NGOs and scientists in strategic deliberation. More than on any other corporate topics, environmental issues may involve an important number of firms' outsiders. As a result, Simons' framework should be used both at the internal and external levels, focusing explicitly on the relationships between firms and their stakeholders.

2.2 How firms manage CSR: some preliminary findings

In this section, we revisit a recent comparative analysis of the CAC 40 companies¹⁰ conducted by Arjaliès and Péan (2009).¹¹ The main finding of this analysis is puzzling: while companies have acknowledged the strategic importance of CSR for businesses, they still devote limited resources and time to such concerns. The study demonstrates that companies have not yet developed appropriate management systems to trigger strategic and practical change. According to the authors, this is the main reason explaining why no strategic renewal has yet been conducted by these companies to meet the CSR challenge. In line with our general management perspective, different elements can be put forward from this study:

CSR is now deemed to be essential for companies' long-term survival.

CSR has progressively become a major issue at the corporate level. Indeed, companies must meet an increasing number of demands regarding CSR both from their clients and stakeholders. As a result, CSR would become as of now a necessary pre-requisite for companies to be able to maintain their business and their so-called 'license to operate'.

⁸ See for instance Simons (1994), Bisbe & Otley (2004) and Marginson (2002).

⁹ In his analysis of change at Nissan, Goshn (2002) insists on setting ambitious targets for the company and on the key role of transversal working groups to by-pass the inherited compartmentalized organizational structure of the company. See also Ponsard and Tanguy (1993).

¹⁰ The CAC 40 companies are the 40 biggest French listed companies.

¹¹ This study is based on questionnaires and documentary evidence.

However, the integration of CSR concerns remains limited in practice.

The recognition of CSR as a corporate issue has not been translated into operational goals. Firstly, CSR has not yet generated many demonstrative business cases. Secondly, CSR demands are rarely framed on the situations experienced by operational managers in practice. Thirdly, companies face difficulties when implementing CSR strategies as a result of their lack of cross-functional approach. Finally, despite their assertion on CSR importance for business, most companies would still separate CSR issues from business related issues.

Diagnostic systems dominate for external reporting.

This focus of diagnostic systems on external reporting can be explained by the domination in practice of a risk approach of CSR. In other words, management systems would be first used to avoid behaviors which could endanger companies' license to operate and not to generate strategic opportunities. The study gives the evidence that the means dedicated by the companies to CSR are too limited to permit the generation of structural strategic change. For example, the important feedback dimension of control systems is lacking in many companies. This prevents from a systematic process of improvement of existing practices.

Interactive systems exist but their influence is limited.

As for diagnostic systems: interactive systems suffer from a lack of feedback, which makes the capitalization on innovative ideas difficult. Moreover, managers' commitment to such systems is limited, as a result of their perception of CSR as being meaningless for business as usual. Thus, whereas companies assert that CSR is likely to play a key role in terms of innovation and strategic renewal, only few of them are able to design interactive systems to achieve the associated goals.

This study provides a broad picture in which it demonstrates that CSR is more and more integrated into the beliefs systems of firms, but mainly as a risk/compliance issue. The diagnostic systems are adapted to provide the data required by external bodies (regulatory and social rating agencies, NGOs...) through emerging standards such as GRI (Global Report Initiative). Boundary systems are almost not impacted and there is no CSR action program followed by innovative interactive systems. This shows that companies still separate CSR actions from business as usual. We will see in this paper that detailed case studies provide a less extreme picture (see also the other case studies included in this volume). Our goal is precisely to provide a systematic framework to organize isolated case studies.

3 The two stage model for implementing a CO₂ strategy: from awareness/risk to vision/opportunities

In this section, we elaborate on the general framework introduced in section 2 to formulate the hypothesis on how firms implement their CO₂ strategy. The hypothesis is explained as a two-stage model. In simple words, stage one would correspond to the situation described in the preceding survey and applied to CO₂: climate change appears as an awareness/risk issue mostly of concern at the corporate level. We shall hypothesize that some operational actions may still take place, as long as the corresponding programs are directly aligned with the compliance goals formulated at the corporate level. Stage two is not based on the survey but on our detailed case studies. We shall hypothesize that firms in stage two will consider climate change as an opportunity and characterize the four management systems that, in our view, would support such a strategy. An important theoretical question will then be addressed: are there conditions that could trigger the passage for firms from stage one to stage two? This question will be addressed in section 4, while revisiting the Porter hypothesis.

3.1 The main ideas underlying the model

We start by giving the main ideas of the model and then discuss them in full.

– Stage 1: Awareness/Risk

CO₂ risk is identified but awareness is limited in the sense that only some managers in the firm, typically functional managers at the corporate level, are aware of this risk and can provide quantifiable measures in terms of loss of revenues and/or increase of costs. Neither the beliefs nor the boundary systems are affected by change.

Some specific actions may be undertaken to counter change due to CO₂ regulation in the environment, such as delaying its impact on firm's activities through lobbying and/or mitigating emissions in production.

Firm's control systems remain in place. Eventually, diagnostic systems are by increments updated to measure and mitigate the actual emissions. No specific interactive system is designed to elaborate and implement radical change.

– **Stage 2: Vision/Opportunities**

The core values of the firm address the challenge created by CO₂ emissions in a positive way through a reformulation of the firm's vision and corporate culture. This induces a reformulation of the beliefs and boundary systems to drive strategic and organizational change.

Changes in the boundary systems make possible strategic formulation at the corporate level for the whole sector, along the chain value, with the goal to identify the strengths and weaknesses of the firm relative to its competitors, suppliers and customers.

The strategic orientation is explained through action plans. These action plans are explicitly introduced into the control systems. Dedicated diagnostic systems are integrated into the general planning and control systems of the firm. Dedicated interactive systems are designed to follow up the targets associated with the new vision.

3.2 Revisiting DuPont, Lafarge and Unilever strategies through this model

Our model is now applied to revisit the respective implementations of CO₂ strategy in DuPont, Lafarge and Unilever. Figure 2 provides a synthesis view of these firms in 2008. It gives their CO₂ emissions levels as of today and summarizes their current targets on these emissions. The three firms generate CO₂ mainly through their manufacturing activities, with some or many European Union (EU) plants eligible for the EU-ETS¹², in our case for Unilever and Lafarge respectively. In the US, all firms have plants that would potentially be

¹² EU-ETS refer to the European Union Greenhouse Gas Emission Trading System, which is a major pillar of EU climate policy.

subject to a CO₂ regulation. However, the relative significance of these industrialized CO₂ emissions is more important for Lafarge, with cement representing both its major product and its main source of emissions, than for the other two companies which are diversified. DuPont is an upstream company which produces industrial components for electronics, textiles, motor vehicles, construction materials, agriculture and plastics and so forth whereas Unilever is a downstream company which produces consumer goods through around 400 brands covering food, household and personal care products. The 'test' of our model for these differentiated companies will provide an indication of their potential value to handle many different situations.

	DUPONT	LAFARGE	UNILEVER
Headquarters' location	Wilmington, USA	Paris, France	London, UK
Revenues	MM \$ 30.5	19 MM €	41 MM €
Employees	60 000	84 000	174 000
CO₂ emissions (Mt) from CDP 2008	9.3	108.9	1.2
Current Target in 2008	15% for 2015/2004 (absolute value)	20% 2010/1990 (relative value)	25% 2012/2004 (relative value)

Figure 2: DuPont, Lafarge and Unilever at a glance

The case studies were elaborated in two steps: step one, a standard questionnaire was filed by the authors based on public information (company reports, carbon disclosure reports (CDP), press articles, articles published in academic journals...); step two, interviews with companies' representatives were utilized to complement this outside view.¹³

We are using the outputs of these case studies to give substance to our model. In this construction, it will be important to keep in mind that we refer to CO₂ in a broad sense so as taking into account the diversity in which the operations of these three companies affect the

¹³ We interviewed executives from these three companies but also from other companies in the same sectors. We also interviewed financial analysts. We are indebted to these executives for their responses to our inquiry. The authors remain the sole responsible for the views and analysis presented in this paper.

climate. DuPont's involvement started with the recognition of the CFC impact on the ozone hole. Unilever's involvement mainly comes through the sourcing of palm oil and its impact on deforestation. There have been different policies to tackle these different impacts and the firms' responses varied accordingly. Moreover, the public questioning on the detrimental effects of CFC emissions on CO₂ emissions from manufacturing and on CO₂ emissions from deforestation have not appeared at the same time and triggered different responses.

The first scientific paper hypothesizing a connection between CFC and the ozone hole is from 1974. In 1987, the Montreal protocol to reduce and eliminate CFC was signed by 24 Nations and the EU. In 2007, 191 Nations revisited the Montreal protocol and expressed their satisfaction that all CFC production would end in 2010.

Awareness of the GHGs on global climate change has been much slower than awareness of the impact of CFC on the ozone hole. The IPCC (Intergovernmental Panel on Climate Change) was founded in 1989. The scientific hypothesis that connects CO₂ and global climate change has been clearly formulated but an agreement on this hypothesis has not yet reached the same level of consensus as for CFC and the ozone hole. The Kyoto protocol was open for ratifications in 1998, but it sets binding targets for only 36 industrial countries so far. Moreover, the Nations' commitment (i.e. countries in Annex B of the Protocol) to reduce emissions by 5.2% on the period 1990/2012 will not be reached. To say the least, the Copenhagen meeting, in December 2009, did not lead to an international binding agreement.

Deforestation had remained largely ignored by the Kyoto protocol. Firstly, deforestation mainly occurs in developing countries (which are not in Annex B). Secondly, following the principle of common but differentiated responsibilities, these countries did not have to commit to any reduction of emissions. Furthermore, despite international debate on this issue, forest conservation projects are excluded from the Clean Development Mechanism.¹⁴

This timing of events will have important consequences in the awareness process that occurred in the companies.

¹⁴ This created strong incentives for firms operating in industrialized countries to involve themselves into emission reduction in developing countries.

– Stage 1: Awareness/Risk

Keeping this historical context in mind, we are now discussing similarities and differences in the strategies of DuPont for the CFC risk and Lafarge for CO₂ risk. In both cases, the emissions concern the manufacturing operations of these companies.

Awareness

The quantification of the risks for both firms is easy. In the early eighties, DuPont had 50% market share in CFC in the US and 25% worldwide with this business accounting for 2% of total sales.¹⁵ In 2008, cement accounted for 57% of Lafarge total sales, the cost increase in cement at a price for CO₂ of 30€/t would induce an increase in cash cost of about 20€/t (based on an emission rate of .7 ton CO₂ per ton of cement). This puts the cement industry as the most affected sector in terms of cost increase (the unit cost being around 45€/t), making the EU cement industry vulnerable to pollution heavens (relocation in countries that would not regulate their CO₂ emissions).¹⁶

Actions at the corporate level to mitigate regulation

On both sides, awareness triggered some lobbying effort to delay regulation. DuPont launched a voluntary effort of industry through the Alliance for Responsible CFC as early as 1980. DuPont also publicly questioned the scientific connection between CFC and the ozone hole, but founded public research to get further evidence. Lafarge had discouraged early attempts to introduce a carbon tax in France in the nineties and prompted industry efforts during the renegotiation phases of the successive EU-ETS to have cement classified as a “sensitive” sector to reduce the impact of a unilateral CO₂ price in the EU on the competitiveness of the industry.

¹⁵ For a detailed account of DuPont CFC strategy, see Smith (1998). The data mentioned in this paper in relation to CFC mostly comes from this article.

¹⁶ Competitiveness issues for the cement industry are discussed in particular in Hourcade et al. (2007). See Ponsard & Walker (2008) for a quantification of these issues.

Corporate commitments

The risk for business also triggered positive actions. DuPont openly recognized that if a valid scientific connection was established between CFC and the ozone hole, it would immediately stop its CFC production. As a matter of fact, the scientific consensus was almost total prior the Montreal protocol. Consequently, in 1988, DuPont made public its decision to reduce its CFC production to zero by 1994.¹⁷ In 2000, the CEO of Lafarge made a public commitment to reduce the Lafarge emissions of CO₂ by 20% over the period 1990 to 2010. Such statements seemed to have come as surprises for operational managers in both companies. According to internal sources, these managers did not consider that it would be feasible.

No change in boundary systems but a slight adaptation of internal control systems

At the operational level, both companies integrated CFC and CO₂ risks respectively as being part of their business as usual. In DuPont, which is a 'science' company making its profit on technical innovations, the CFC risk induced R&D programs to elaborate substitutes to CFC, but the R&D budget remained in line with the average R&D spending in other areas. Lafarge operational commitment for CO₂ was associated with its ongoing energy efficiency program which involved optimization of inputs (gas, coal, electricity, biomass,...), optimization of yields, as well as the incremental substitution of cementations materials (slag, flying ashes) for clinker, being the high energy intensive ingredient in cement. Thus, in both companies, no radical change was encouraged through specific new programs and/or design of specific incentives. The nature of these operations demonstrates that both companies' boundary systems had not changed.

Differentiated impacts on beliefs systems

There are some interesting differences between the two companies in terms of beliefs systems. For DuPont, its CFC strategy has been progressively reintegrated into its larger corporate environmental targets. DuPont environmental commitments in 1989 involved 70% reductions in air toxics and 90% reductions in air carcinogens, 35% less in hazardous waste.

¹⁷ DuPont had just developed a clean substitute for CFC at that time. This certainly helped to make that a decision that was considered as a complete reversal by other members of the Alliance for Responsible CFC. Still the commitment to eliminate CFC by 1994 remained ambitious due to the many applications and the sunk investments in these applications.

In 1994, DuPont further committed to a 40% reduction in GHG emissions (2000/1990).¹⁸ In contrast, Lafarge operations in CO₂ were not connected to its long standing commitment on environmental issues (the license to operate for cement plants requires special attention to local stakeholders for quarries, logistics, emissions of gases and dust; this also concerns the other activities of Lafarge, thus its global involvement in environmental issues). Interestingly, Lafarge had its CO₂ goal certified by WWF in 2000, but did not use this partnership to change its beliefs systems. CO₂ remained a public relation issue at the corporate office to quantify the risk for the company and external lobbying efforts, and a reinforcement issue on energy efficiency programs for operations.

– Stage 2: Vision/Opportunities

So far, in our analysis, climate change issues have not substantially changed the vision of the firm. At this point in the analysis, we will look at a 'turnaround', something that denotes that the 'frame' used to stimulate initiatives, evaluate decisions, promote managers, has changed.

DuPont, as a result of CFC has a clear historical advantage in this matter. It provides an illustrative example of such a change. Unilever will provide another illustration.

Changes in beliefs systems at DuPont

In 1999, DuPont coined a new term to describe its vision, "sustainable growth". This vision was associated with a major move of the company from fossil fuel technology to green technology. It acquired Pioneer in 1997, a major seed and biotechnology company and divested Conoco in 1998, a major oil company (acquired only a few years earlier). Its commitments were reformulated to highlight the change. The sustainability targets made in 1999 for 2010 involved a large spectrum of new goals: (1) to be flat on energy (base 1990) in spite of growth, (2) to source 10% of its energy use from renewable energy, (3) to remain below 65% in terms of its total GHG emissions compared to 1990, (4) to generate 25% revenues from products based on non-renewable resources. As a result of these major

¹⁸ By 2003, it had reduced its emissions by 72%. Then it reset its base line in 2004, see current target figure 2.

strategic choices, DuPont's beliefs systems shifted from just thinking of CO₂ as a liability/cost reduction issue to thinking about it as an opportunity issue as well.

Changes in beliefs systems at Unilever

As seen in figure 2, CO₂ direct emissions from Unilever are relatively low. However, the indirect impacts of Unilever activities on climate change are very significant. We already mentioned the case of deforestation.¹⁹ Overall deforestation accounts for approximately 18 % of world total CO₂ emissions. Indonesia alone holds the global record for GHG emissions from deforestation, putting this country in the third place behind the USA and China in terms of total GHG emissions from human activity. That is the reason why, being the world leader buyer of palm oil, Unilever has been targeted by Greenpeace as fueling climate change. Taking now other products of Unilever such as detergents and personal care products, the usages of these products are intensive in energy. As a matter of fact, while manufacturing activities in Unilever are not accountable for large CO₂ emissions, suppliers and customers of Unilever products are. To respond to this challenge, Unilever introduced its new vision about climate change around 2006, following an earlier awareness/risk phase similar to the one described above. The reduction of CO₂ emissions for Unilever is now part of its overall vision to minimize its environmental footprint (water, sustainable agriculture, energy, packaging...) all along the value added chain while delivering valuable consumer goods.

Changes in boundary systems

The reformulation of the CO₂ issue as a whole value-chain issue can be illustrated through the launching of long term global programs. DuPont has engaged in the developing of the next generation of bio-fuels: Cellulosic ethanol, a joint venture with Danisco, and Biobutanol, under development with BP. DuPont also creates value-adding materials from renewable-sourced feed-stocks and bio-based ingredients for various industrial applications. DuPont is expecting that 60% of its business will stem from the use of biotechnology to reduce fossil fuels in the next decades. Such expectations need to be evaluated in the context of changes in the whole value chain with their indirect consequences for agricultural sustainability. In 2004, Unilever became a founding member of the Roundtable on Sustainable Palm Oil (RSPO). In May 2008, following a public challenge from Greenpeace, Unilever formalized its

¹⁹ On the link between Unilever and deforestation see the Greenpeace report (2008).

commitment to draw all its palm oil from certified sustainable sources by 2015. Through the RSPO, the company supports an initiative to put pressure on suppliers and users of palm oil to change their ways via certification bodies and NGOs. The future of this initiative remains uncertain, given the many usages of palm oil, often in small proportions to other ingredients, and by the many players at each level of the value added chain.²⁰ In some other activities, the global strategy seems easier to implement, such as in tea, an activity in which Unilever is also a world leader (Poret, 2009). In 2007, Unilever announced its commitment to achieve in 2015 a sourcing of all its tea sustainably from a Rainforest Alliance Certification. This certification involves measurements on ten sustainability indicators for producers: soil fertility, soil loss, nutrients, pest management, biodiversity, product value, energy, water, social capital and local economy. In all its divisions, Unilever managers implement a “Brand Imprint Tool” that prompts them to “think about where they source their ingredients and how they can get value from communicating this to consumers” (Paul Polman, Chief Executive Officer, Unilever website).

Diagnostic and interactive systems are systematically changed

To elect as part of a stage 2 strategy, we have to see how these visions have been integrated into firms’ management and management systems. The fact that the organizational chart and the control systems have changed are illustrative of such integration. For example, at DuPont, we now have a VP Chief Sustainability Officer, a Sustainable Growth Review for each business, a Corporate Environmental Plan, a more systematic link to compensation, decentralized competence centers for sustainable growth, local champions, awards... At Unilever, there are a Board-level Corporate Responsibility and Reputation Committee and a Corporate Responsibility, Issues, Sustainability and Partnerships (CRISP) leadership team, which review the BU strategic plans along the key performance indicators (KPIs) associated with the global sustainability targets. This illustrates the importance of both quantitative (KPIs) and subjective indicators (such as symbolic prizes associated to local champions and awards) in the incentive systems when conducting strategic renewal.

²⁰ On December 11, 2009 Unilever announced that it suspended its supplies from Sinar Mas, until it provides substantial, evidence that its operations did not involved deforestation in Indonesia. Greenpeace considered this as a consequence of its pressure on Unilever.

3.3 Putting the pieces together

The next two figures (3&4) summarize our two-stage model and its application to the DuPont case.

	STAGE 1	STAGE 2
CO₂ Strategic Approach	Awareness/Risk	Vision/Opportunities
Beliefs Systems	No change	– Integration of the climate policy strategy in the firm’s vision
Boundary Systems	No change	– Systematic review of portfolios’ activities including suppliers and clients’ relationships
Diagnostic Systems	<ul style="list-style-type: none"> – Measurement of CO₂ emissions at plant level – Incremental and local adaptation of energy efficiency programs – Compliance approach (regulation) 	<ul style="list-style-type: none"> – (Re)designing of the firm’s position in the value chain targets’ setting – Integration of environmental issues in strategic reviews – Joint design and cross-functional implementation of diagnostic and interactive systems
Interactive Systems	<ul style="list-style-type: none"> – Focus at corporate level on risks associated with ongoing and future regulation 	<ul style="list-style-type: none"> – Introduction of financial and symbolic motivations

Figure 3: the two stage model

	STAGE 1 (1980-1999)	STAGE 2 (1999-2009)
CO₂ Strategic Approach	Awareness/Risk	Vision/Opportunities
Beliefs Systems	<ul style="list-style-type: none"> – As regards environmental issues, ongoing compliance beliefs systems are not affected 	<ul style="list-style-type: none"> – New vision: holistic approach to sustainability through voluntary actions including “footprint reduction goals” and <i>for the first time</i> “market-facing goals”
Boundary Systems	<ul style="list-style-type: none"> – No questioning of DuPont’s portfolio since CFC represents only 2% of total sales 	<ul style="list-style-type: none"> – Major move from fossil fuel technology to green technology – Partnerships along the value chain
Diagnostic Systems	<ul style="list-style-type: none"> – Measurement of CFCs emissions at plant level – R&D programs to generate substitutes 	<ul style="list-style-type: none"> – Change of organizational chart and control systems – Nomination of a VP Chief Sustainability Officer, – Implementation of a Sustainable Growth Review for each business
Interactive Systems	<ul style="list-style-type: none"> – Launch of the Alliance for Responsible CFC to preempt regulation – Direct involvement in the elaboration of the Montreal protocol 	<ul style="list-style-type: none"> – Cross-functional competence centers – Local champions and awards

Figure 4 : application to DuPont

Our analysis confirms the importance of transforming the four types of management systems in accordance with the CSR challenge. It also demonstrates that shifting from a stage one strategy based on risk and compliance to a stage two strategy whose goal is to generate new innovations and strategic opportunities requires: 1) a cross-functional approach, and 2) a coherent transformation of the four systems aligned with the new strategic targets. As claimed, it provides a more nuanced view than the broad picture described in section 2. As it will be seen shortly, it also provides a systematic framework to organize case studies.

4 The Porter hypothesis revisited: what have we learnt?

In this section, we come back to the Porter hypothesis. Will an increased environmental pressure for the reduction of CO₂ emissions generate more profitability? Our contribution will be discussed at two micro levels: the firm level and the sector level.²¹ We build on our exploratory research to formulate questions that look interesting to pursue.

There are probably as many case studies in which firms benefit from more stringent environmental regulation and societal pressure as ones in which they experience an increase in costs and a reduction in profits. Our own case studies confirm these ambiguous results. But we can go one step further since we propose a systematic framework to organize these cases studies. It suggests that the beneficial case studies would be more likely to be in stage two and the detrimental ones in stage one. A systematic test of this proposition would bring light on the capacity of the corresponding firms to either take full benefit of the change or be sucked in a compliance/risk strategy. Our main contribution on this question concerns the hypothesis that, to be in stage two, a firm must design its management systems in order to be in an alignment of the middle managers with the vision of the firm formulated at the corporate level. Another contribution of our analysis concerns the dynamic nature of stage two. The strategic turnaround that we associate with such a repositioning implies that the potential benefit is risky and long termed. It certainly cannot be considered as a “free lunch” as suggested by a literal interpretation of the Porter hypothesis.

A more general question may be stated at the sector level. For instance, are there structural factors that would imply that firms in the cement sector would be more likely to be in stage one while firms in the chemical or agro-food sectors would be in stage two? In other words, would Holcim and Cemex be positioned as Lafarge, while Bayer and Rhodia would be positioned as DuPont, and Danone and Nestlé as Unilever? It would indeed certainly be worthwhile to see if our model may be applied at the sector level: could steel, petroleum be considered as in stage one while chemicals, food, automobile... be considered as in stage two? Our research suggests some clues to investigate this point: whether the nature of the sector facilitates some diversification, whether it is concentrated on manufacturing or on the

²¹ We leave aside the macro level.

design and/or the assembly of components, or the significance of R&D and the speed with which new products are introduced into the portfolio...

Finally, and probably the most challenging issue, is to address the question concerning the possible identification of the key factors that would trigger the passage from stage one to stage two at the sector level. For instance, one may consider that a sustained high price for petroleum would accelerate the passage of chemicals from stage one to stage two, assuming that it is not already there. The identification of some firms already in stage two, in a sector to be globally considered in stage one, would also be a key factor. For instance, it may be that some firms in the construction sector are already in stage two: such as construction builders which may have more flexibility to adjust their strategies than the manufacturers of cement and steel. Our research does indeed emphasize the changes that occur along the whole value chain and the development of partnerships to take advantage of these changes.

5 Implications for investors

In this section, we develop some implications that may be drawn from our work for investors that are concerned with the possible impact of climate change on the value of their portfolios.

It is interesting to note that the debate about CO₂ among investors is also progressively shifting away from cost and risk toward the question on how to capitalize on financial opportunities. Investors increasingly believe that climate change will present many business opportunities in the near future (Deutsche Bank Advisors, 2008; Oddo Securities, 2008). According to a former leading consultancy, firms which will recognize the challenge of climate change early and elaborate on it to innovate will benefit from a competitive advantage and therefore prosper (Lehman Brothers, 2007). However, despite acknowledging the potential for strategic renewal regarding climate change, most investors keep assessing companies with an awareness/risk approach and not a vision/opportunities one. For instance, the assessment tool being used the most by investors to evaluate a firm's CO₂ emissions consists of calculating its carbon footprint, by estimating its number of Certified Emissions

Reduction (CER).²² The purpose of such calculation is to evaluate the financial gains/loss associated with the *virtual* valuation of these climate credits on the emission trading market (e.g. virtual valuation since investors do not directly benefit/pay for these CER). Although this assessment permits the identification of the firms which have mitigated their CO₂ emissions (i.e. stage 1), it does not enable the selection of the firms which have conducted strategic renewal according to climate change (i.e. stage 2). Yet, it is this second type of companies that investors should select for their portfolios to generate better financial performance in the long term.

For investors to shift from a stage one to a stage two approach when evaluating companies' CO₂ strategic approaches requires building new assessment tools. Our two stage model is an attempt to fill this gap. Namely, it should provide some guiding principles to the question "which firms are in a position to materialize what gains?" It suggests analyzing differently a company in stage one from one in stage two. In line with recent approaches developed by brokers (Oddo Securities, 2008) and social rating agencies (Innovest, 2007) to assess firms based on their business opportunities regarding climate change, our analysis insists on the importance of studying the potential for strategic and organizational change generated by CO₂ emissions at the sector and firm levels. Firstly, we suggest maintaining the so-called 'best-in-class' approach, which consists of selecting the best firms regarding CO₂ emissions in each sector. Two reasons motivate this choice: on the one hand, when building a portfolio, a firm must be assessed in comparison to its peers; on the other hand, it cannot be ignored that most of investors will not exclude sectors such as oil or building materials from their portfolios even if they are considered as a laggards in terms of CO₂ strategies. Secondly, we suggest identifying different scenarios according to the stage of the sector regarding CO₂ strategies.

These two different scenarios can be outlined according to the following approach:

- *Scenario 1 - the whole sector is at stage one*: in a few sectors, all firms appear to be more or less at stage one regarding CO₂ emissions, possibly in real estate, oil or building materials. In such cases, the traditional approach based on risk/awareness

²² Certified Emission Reductions (CERs) are climate credits (or carbon credits) issued by the Clean Development Mechanism (CDM) Executive Board for emission reductions achieved by CDM projects and verified by a Department of Energy under the rules of the Kyoto Protocol.

when assessing firms would be the rule. For instance, an investor could start by identifying the level of CO₂ emissions associated with the firm's operations and ask for actions that mitigate these emissions. It could proceed to identify the CO₂ content associated with the products, anticipating that a carbon tax of this content will affect the market value of these products.

- *Scenario 2 - at least one firm in the sector is at stage two*: this means that climate change has generated business opportunities for the sector, possibly in chemicals, water or food products sectors. When faced with this situation, an investor must favor the most promising firms regarding CO₂ strategies. These firms can be identified using the different characteristics developed in the second stage of our model, such as the reformulation of the firm's vision, corporate culture, the integration of dedicated diagnostic, interactive systems in the general planning and control systems of the firm.

A more challenging grid would ask why and when a firm would move from stage one to stage two. Our analysis suggests that the key factors to consider would be the following ones:

- The 'new vision' that incorporates climate change as a major ingredient of the company culture should be based upon in depth internal studies identifying the risks for the company and its capacity to successfully address these risks in a stage one strategy.
- The involvement of the CEO in the formulation and the communication of the new vision is a key factor, which is usual in organization theory. To discern such an involvement from green washing, it seems important to link the CEO vision to the formulation of explicit new CSR targets.
- The quantification of these new targets should be integrated in the management control systems; note that it is possible to evaluate from outside if this is the case through an analysis of the KPIs introduced at the business unit levels, along with

changes in the compensation package, as well as in changes in the general strategic review process.

- The identification of a stage two strategy remains the change in the carbon intensity of the portfolio of activities of the firm, as well as their positioning into the whole value chain; the capacity of the firm to articulate its current strategy in this respect provides a direct indication that its vision has changed its boundary systems and is delivering results.
- An interesting factor for assessing the change from stage one to stage two may be that the firm now engages into positive partnerships and interactions with NGOs and scientists to formulate and implement its strategy.

This move from stage one to stage two is easier to identify in the second scenario (i.e. at least one firm in the sector is at stage two) than in the first scenario (i.e. all firms are at stage one). Indeed, in the second scenario, other firms can be assessed in comparison to the sector leader. In case of the first scenario, the reasons which explain why no firm has been in stage two must be searched: Do the technical problems that prevent from innovations require major breakthroughs? Are clients reluctant to change? Have the leaders an interest in the status quo? Are the competitive forces not so important? And so forth. Once the reasons identified, investors may choose 1) to keep using a stage one approach when selecting the firms in the sector; 2) to encourage the leaders of the sector to shift from stage one to stage two; 3) to favor firms at stage two belonging to other sectors but which can be good substitutes (for example, investing in firms belonging to the oil services sector instead of the more classical integrated oil & gas sector). While our research has identified the existence of different stages to position a sector, further research is clearly needed to explain what prevents some sectors from shifting from stage one to stage two.

6 Conclusion

The objective of this paper was to revisit the Porter hypothesis from a managerial perspective. We have proposed a framework to position a climate change strategy of a firm consisting of a simple two stage model: awareness/risk, in which compliance and incremental improvements are the rule, and vision/opportunity, which may induce a more global re-assessment of the portfolio of the firm including its relationship with suppliers and clients. Our construction is based upon three case studies: DuPont (chemicals), Lafarge (building materials) and Unilever (consumer goods).

The results have been used to revisit the possible relationship between an increase in environmental constraints and the profitability of the firm, contingently at the stage the firm is considered to be in. Moreover, a number of key factors that may trigger the shift from stage one to stage two have been identified: integration of the climate change policy into the beliefs systems of the firm, involvement of the CEO in the formulation of the environmental targets for the whole company, integration of these targets into the planning and control systems.

Our work suffers from a number of limitations: our empirical base should clearly be extended. This may lead to a refinement of the model. At some point, this should generate a number of hypotheses that would be amenable to systematic testing. On the more practical side, the implications we have developed for investors should be made more operational. In spite of its limitations, firms and investors may also be interested in using our model to position their own strategy. The clear architecture of the model would facilitate this positioning and, hopefully, provide a useful starting block for further analysis.

Acknowledgments

The authors wish to thank Jean-Philippe Desmartin, Olivier Godard, Pierre Tegner and Bernard Sinclair Desgagné, for their precious comments on earlier versions of this article.

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