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A LITERATURE REVIEW ON THE LINKS BETWEEN ENVIRONMENTAL REGULATION AND COMPETITIVENESS

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1. Introduction

In general, the effects of environmental regulation and market incentives on society can redistribute income streams and can have an impact on the standard of living. These effects are also often analysed in relation to the concept of "competitiveness". Literature and empirics on competitiveness focuses on price and cost developments of production factors and other parameters that can potentially affect economic growth, market shares and other performances of companies in the targeted sectors.

From a cost perspective, an increase in the fixed or variable costs of a production input is likely to lead to a deterioration of the competitive performance. More specifically in those cases where environmental policy reduces the possibility to use a particular input, decreases productivity and/or increases the price of the output. Economic literature emphasizes that the additional costs will have effects on profitability, prices, demand dynamics, innovation and productivity and investment decisions of the affected industries. A typical case is the buildings and construction (B&C) sector, which often is a substantial contributor to most countries' Gross Domestic Product, as it has a significant share within other economic indicators, such as national added value and employment. It is especially this sector has often been considered under threat by losing its competitiveness as a result of extensive energy and environmental regulations and policies addressing construction and construction-related activities.

Literature review describes the different ways of defining and measuring the effects of environmental regulation on market forces. In addition it synthesizes the most recent

knowledge on the relationship between environment and competitiveness and market dynamics, as well as produce an in depth analysis of the most recent empirical studies[1].

The structure of this paper is as follows. Section 2 refers to the definitions and measurements of competitiveness, as they are provided by various literature sources. Furthermore, section 3 explores the issue of the effects of environmental and energy policy instruments on competitiveness in economic sectors in general, while in Section 4 the focus lies on the B&C sector and the impacts of such policy instruments and the reactions the market actors undertake under the implementation of such policies. Finally, in section 5 some key conclusions and policy recommendations will be provided.

2. Definitions and measurements of competitiveness

The variety of perspectives and levels of analysis at which the concept of competitiveness may be considered complicates the formulation of an univocal definition of competitiveness both at a theoretical and political level.

The definition provided by the European Commission in its annual Competitiveness Report (European Commission, 2008) creates an evaluation framework for the impact of environmental policies on competitiveness stressing the importance of "domestic factors". Another definition of OECD of a nation's competitiveness emphasizes the ability of a country to produce goods and services which meet the test of international markets, while simultaneously maintaining and expanding the real incomes of its people over the long term[2] (OECD, 2003). A third "institutional" definition of competitiveness has been provided by the World Economic Forum, which considers the level of productivity of a country as a key

[1] This paper is based on the literature review and analysis that has been conducted within the framework of activities of the SKEP-EMPIRE project, check the project website for the complete literature review and other project deliverables: http://www.cesisp.unige.it/empire/index.htm.

[2] An OECD paper (2003) states that "*Competitiveness is primarily a matter of being able to produce goods that are either cheaper or better than those produced by other firms*".

element to determine the competitiveness of a nation. It defines the competitiveness as "*the collection of factors, policies and institutions which determine the level of productivity of a country and that determine the level of prosperity that can be attained by an economy*" (World Economic Forum – Global Competitiveness Report, 2007)

Starting from this "common ground", a deep understanding of the concept of competitiveness needs to provide answers to three major questions:

1. *Who is the entity that competes with others?*
2. *What is the "context" in which this entity competes with its competitors?*
3. *What are the drivers and factors that enable this entity to perform better than its competitors?*

2.1 Competitiveness from entities' perspective

The first question refers to the "entities" that are the relevant actors in the competition "arena". Literature distinguishes three basic typologies of actors: i) *a single firm* or *plant*, ii) *a cluster of firms,* i.e. an industry, a sector, a branch or a local productive system (e.g. an industrial district), and iii) *a territorial context* (i.e. a country or a region).

At the firm level, competitiveness implies that companies are able to produce goods and services more efficiently and/or effectively than their competitors. A strong competitive performance is achieved by relying on some "competitive factors", often with a particular focus on process productivity and the efficient use and/or access to strategic inputs. Jenkins (1998) states that, "*a firm is competitive if it can produce products or services of a superior quality or at lower costs than its domestic and international competitors. It is therefore synonymous of a firm's long-run profit performance and its ability to compensate its employees and provide superior returns to its owners"*. A recent paper for the International

Energy Agency defines competitiveness at the firm level as "*The ability to maintain and/or to expand [a] market position based on its cost structure*" (Reinaud, 2005).

At the sectoral level, competitiveness implies that competitive factors are activated and used by different "clusters" of companies (e.g. all the companies operating in similar industrial sectors in different countries) to realise a better performance in the relevant market (local and/or international markets). This level is related to the previous one, but not totally overlapping: in fact, a competitive industry can be composed by a high number of competitive firms, but also by some low-performing firms.

At the territorial level (country or region), the concept of competitiveness is not limited to a market perspective[3], but also to the "standard of living" within a certain geographical area. Competitiveness thus is not a zero-sum game, as one country's gain does not necessarily come at the expense of the other. Moreover, competitiveness of a country or region is the result of a wide range of drivers and performances at the regional, sector, firm and plant levels, and the interactions thereof with a number of institutional and social factors. It is therefore that competitiveness at the territorial level cannot be considered as the mere "sum" of the previous levels (i.e. firm/plant and sector level).

2.2 Dimensions of competitiveness

The second question refers to the "dimension" of competitiveness. We can distinguish at least three dimensions: international, national and local competitiveness.

At the international level, competitiveness refers to the success with which an entity (i.e. a country/region, a sector/industry, a firm/plant) competes against overseas counterparts. The most important and widely-used definition of international competitiveness are those provided by the OECD and the EC:

[3] Even if, for specific aspects – as the ability to attract foreign investments – they are "*like a big corporation competing in the global marketplace*" (Clinton, 1992, in Krugman, 1994).

- "*The degree to which (a country) under free and fair market conditions, produce goods and services which meet the tests of international markets, while simultaneously maintaining and expanding the real incomes of its people over the longer term*" (OECD[4]);

- "*Competitiveness is understood to mean high and rising standards of living of a nation with the lowest possible level of involuntary unemployment, on a sustainable basis*" (EC Competitiveness Report[5]).

At the national level, literature focuses on the measures of competitiveness, such as *levels* and *growth* of *Gross Domestic Product* or *Gross National Product* (SQW, 2006), *GDP per capita* (Esty, Porter *et al.*, 1991) and *international trade flows* (Florax, Mulatu *et al.*, 2001). In the view of most authors, the fundaments of national competitiveness rest on the efficiency with which resources are allocated and used at micro level (i.e. at sectoral and/or firm level).

2.3 Key variables of competitiveness

The third question refers to the analysis of the *key variables* affecting competitiveness as well as the *ways to measure them*. In an attempt to structure existing approaches, we may distinguish two major approaches:

- The first one tries to investigate the *drivers of the competitiveness* (e.g. the resource productivity at firm level, the degree of internationalization at sector level).
- The second approach focuses on the *external effects of the competitive success* (e.g. the market performance measured by market share; the turnover growth rate; the

[4] http://www.oecd.org/topic/0,3373,en_2649_37463_1_1_1_1_37463,00.html.
[5] .

financial performance measured by ROI or EBTIDA at firm level; the welfare of a nation measured by GDP *per capita*).

According to our framework of analysis, competitiveness can be measured at: the m*acro level* (territorial: international/national); the *Meso level* (cluster: sectoral/industry/district) and the *Micro level* (plant/firm).

a) At the macro level, measurements of competitiveness aim at describing how successfully a country or a region (made up of different sectors and many firms) competes with counterparts in other countries. As mentioned above, the most common indicators to compare competitiveness between countries are *Gross Domestic Product* (GDP) and *Gross National Product* (GNP) (SQW, 2006), *GDP per capita* (Esty, Porter *et al*., 2001) and *international trade flows* (Florax, Mulatu *et al.*, 2001). .

b) Measurements of competitiveness at the industry level especially refer to the ability of specific industries to compete for market shares with businesses operating in the same sector but located in other countries or regions. Most studies use *trade* (e.g. net exports), *investment flows* and *market shares* as proxies or indicators of sectoral competitiveness (OECD, 2003). Other studies seek to consider the drivers of trade competitiveness at the sectoral level, such as the *Total Factor Productivity* and/or proxy measures of *innovative capacity* (mainly R&D expenditure and patent applications) (Jaffe and Palmer, 1997). Finally, financial measurements such as *operating profit* and *Earnings Before Interest, Tax, Depreciation and Amortisation* (EBITDA), even if rarely, are also used in the literature as a measure of sectoral competitiveness (Carbon Trust, 2004).

c) At the *level of firms/plants*, competitiveness indicators relate to various aspects, such as the ability to sustain market shares, to sustain independent existence on the market or to sustain "normal" levels of profitability and returns. At the firm level, *productivity* is the key variable, simply defined as the "*measure of output per unit of input*". Productivity aims at

measuring the efficiency with which production is carried out; in other words, the ratio between the outputs and inputs that make production possible (raw materials, labour, capital etc). Many studies identify as an optimal measure of productivity the *Total Factor Productivity*, that is a synthetic measure of how firms are organised, structured, use technology and are managed (for example: Jaffe and Palmer, 1997; Dofour, Lanoie and Patry, 1998; Berman and Bui, 2001).

In conclusion, table 1 provides a summary of the overall framework that is established for analyzing competitiveness as well as on and the different ways to measure it.

Table 1 Measurement and indicators of Competitiveness – Summary table

Level of Analysis		**Measure of Competitiveness (Driver *vs* Performance)**	**Indicator**	**References**
MACRO	**International / National**	**Prosperity/Standard of living** *(Performance)*	*Growth rate of real GNP*	Jorgenson and Wilcoxen (1990)
			Level and growth of GDP and GNP	Jorgenson (1991)
			GDP per capita; GDP per capita adjusted for purchasing power	World Economic Forum (2007) Esty and Porter (2001)
		International Trade *(Performance)*	*Net Export*	Depperu (2006) Mulatu, Florax, Witaghen (2004) Rose (1997) Feenstra and Rose (1997)
			International trade flows	Mulatu *et al.* (2001)
		Productivity (*Driver*)	*Productivity growth*	Jaffe *et al.* (1995)
MESO	**Sector / Industry**	**Market Performance** *(Performance)*	*Market share*	Peterson (2003)
		Financial Performance *(Performance)*	*Earnings Before Interest, Tax, Depreciation and Amortisation* (*EBITDA)*	Carbon Trust Paper (2004)
		International Trade *(Performance)*	*Net Export*	OECD (2003)

		Investment *(Driver)*	*Investment flows*	OECD (2003) Leonard (1984;1988)
			Direct foreign investment	Blazejcack (1993)
		Productivity *(Driver)*	*Total Factor Productivity (TFP)*	Jaffe and Palmer (1996) Lanoie, Patry, Lajeunesse (2001)
		Innovation *(Driver)*	*R&D expenditure and Patent applications*	Jaffe and Palmer (1997)
		Resource endowment *(Driver)*	*Localisation*	Peterson (2003) Fortis (2000) Zoboli (1999)
			Cost of transport	O'Sullivan (1984)
			Proximity	Iraldo (2002) Dicken and Lloyd (1997) Krugman and Obstfeld (1995)
MICRO	**Firm / Plant**	**Market Performance** *(Performance)*	*Turnovers*	Dofour *et al.* (2007) Levy (1995)
			Market growth	Gray and Shadbegian (1993)
			Market share	Gray and Shadbegian (1993)
			Import or Export Performance (e.g. net exports)	Cagatay, Koska and Mihci (2004)
			Firm's or plant's survival over time on the market	Levinson (1995)
		Economic Performance *(Performance)*	*Return on Equity (ROE) and Return on Assets (ROA)*	Bragdon and Marlin (1972) Russo and Fouts (1994) Coeck and Verbeke (1997)
			Return on Sales	Levy (1995)
			Net Income	Freedman and Jaggi (1992) Brannlund *et al.* (1995)
		Financial Performance *(Performance)*	*Cash Flow (Equity and Assets)*	Freedman and Jaggi (1992)
			Return on Investment (ROI)	SQW (2006)
		Efficiency *(Performance)*	*Estimated Cost Function*	Gollop and Roberts (1983) Sims and Smith (1983)
			Ability to distribute costs of compliance	Helland and Matsuno (2003)
		Innovation *(Driver)*	*R&D Expenditure*	Jaffe and Palmer (1997)

			Patent Applications	Brunnermeier and Cohen (2003) Landjouw and Mody (1996) Popp (2003)
		Productivity *(Driver)*	*Output*	SQW (2006)
			Estimated Profit Function	Alpay *et al.* (2002)
			Total Factor Productivity (TFP)	Berman and Bui (2001)
			Labour Productivity	SQW (2006)
			Plant location or locational decisions	Levinson (1995)
		Resource endowment *(Driver)*	*Localisation*	Peterson (2003) Fortis (2000) Zoboli (1999)
			Cost of transport	O'Sullivan (1984)
			Proximity	Iraldo (2002) Dicken and Lloyd (1997) Krugman and Obstfeld (1995)

3. Environmental policy instruments: a classification according to their potential effects on competitiveness

Economic theories differ in their consideration of environmental policy instruments. For instance, *neoclassical models* assume that different technological options are available to all actors and actors constantly optimise costs and benefits. Alternatively, *Institutional models* assume that technological options are not necessarily available to all actors, due to the uncertainty of the innovation process and to the fact that actor behaviour is characterised by bounded rationality (Berkhout, 2001).

Environmental policy instruments are usually classified into three categories depending on the degree of strictness: *direct regulation* (*command and control*), *economic instruments* and *soft instruments*

3.1 The links between environmental policies and competitiveness

Economic theory provides different perspectives and theories on the relationship between environmental policies and a firms' environmental and economic performance. The debate developed over the last fifteen years across a wide range of theoretical questions aimed at investigating *whether, under what circumstances* and *how exactly* environmental issues and firm activities are related to competitiveness. A frequently analysed issue is to what extent internal and external factors and conditions affect the relationship between firms' environmental performance and their economic results.

Summarizing, we can identify three major theoretical approaches in literature:

1) The "traditionalist" view of neoclassical environmental economics argues that the purpose of environmental regulation is to correct negative externalities, and that consequently environmental regulation – in internalising the costs of the negative externality – corrects a market failure, while burdening companies with additional costs. Firms complying with regulation face higher production costs and reduce the management time devoted to pursuing other tasks. This is deemed to have effects on the competitiveness at firm, sectoral and national level (see previous section). Affected firms will lose market share due to higher production costs, industrial sectors will give up producing polluting goods and hence will change composition of their production, and industries will relocate to territorial contexts with less stringent environmental standards (Jenkins, 1998). This is particularly significant for those industries where the share of environmental costs in total manufacturing costs is considerably higher than for the manufacturing sector on average (Luken, 1997). Furthermore, some industries operating upstream in the production chain give rise to environmental impacts (and related external and social costs) relatively higher than the value-added associated with their production activities (Clift and Wright, 2000).

2) As opposed to the neoclassical perspective, a "revisionist" view emerged, stating that improved environmental performance is a potential source of competitive advantage, as it can lead to more efficient processes, improvements in productivity, lower costs of compliance and new market opportunities (Porter, 1991; Gabel and Sinclair-Desgagné, 1993; Porter and van der Linde, 1995a; Sinclair-Desgagné, 1999). Porter and Van der Linde (1995b) and Porter (1990) suggest that environmental regulations are potentially beneficial to firms, as they give incentives to change their production routines (technological or process innovation) in a way that leads to compliance and reduced costs through decreased resource inputs or increased efficiency, or can even lead to new marketable products (the "Porter hypothesis"). Such innovations may well offset the costs of compliance. Porter (1991) has gone on to suggest that if one country adopts stricter environmental regulations than its competitor-countries, the resulting increase in innovation will enable that country to become a net exporter of the newly developed environmental technologies. In case of product innovation, the competitive advantage will be greater if foreign countries adopt the regulation as well, in case of efficiency gains; this is not even required (Blazejczak and Edler, 2004).

Furthermore, companies can gain a "first mover advantage" from selling their new solutions and innovations early to other firms (Esty, Porter *et al.*, 2001). Therefore, according to this, at least in a dynamic, longer-term perspective, the ability to develop new technologies, production processes and products is a greater determinant of competitiveness and economic success than traditional factors of competitive advantage (Porter and Van der Linde, 1995b).

3) A third and more recent interpretation of the impacts of environmental policies on competitiveness is the so-called "Resource-based view". According to this approach, competitiveness of companies depends on the quality and quantity of the resources available and by the ability of companies to optimise their use. It departs from the Porter's approach and enlarges the typologies of resources that companies can rely on. This theory refines the

analysis of how environmental policy influences economic performance for at least two reasons. First, it has a strong focus on *performance* as the key "outcome" variable, and second, research works adopting the resource-based view explicitly recognize the importance of *intangible assets*, such as *know how* (Teece, 1980), *corporate culture* (Barney, 1986), and *reputation* (Hall, 1992).

Early applications of the resource-based theory to evaluation of environmental policies and strategies mainly focused on the analysis of firms' internal dynamics (Porter, 1991; Shrivastava, 1995).

More recently, Aragón-Correa and Sharma (2003) integrated perspectives from literature on contingency, dynamic capabilities, and the natural resource-based view of the firm to propose how dimensions of the general competitive environment of a business influence the development of a dynamic, proactive corporate strategy for managing the business' natural environment interface.

3.2 Findings from literature and within relevant empirical studies; and ways to measure the effects of policy measures on competitiveness

By focusing on measuring either the traditionalist view or the Porter hypothesis or the resource-based view, empirical research helps in validating or confuting theoretical considerations. This renders empirics a necessary part of understanding *how much* environmental policies and issues can be related to economic performance, and *how* and *under what circumstances* this (cor)relation occurs.

In order to thoroughly investigate the relation between environmental regulation and performance the authors used several research methods: sophisticated *regression analyses* searching for correlations (De Vries and Withagen 2005, Brunnermeier and Cohen 2003), c*ase study analysis* to investigate specific casual links and circumstances through in-depth

descriptions of real situations (Hitchens *et al.* 2001; Berkhout, 2003); *portfolio studies* to analyze real or model portfolios of environmentally proactive and environmentally reactive firms and comparing their respective returns (Rennings *et al.* 2003a); and *event studies* to assess market responses after a positive or negative environmental event (Schaltegger and Wagner, 2003; Linn, 2006).

At national scale, Jorgenson and Wilcoxen (1990) found that, over the period 1974-1985, the combined effect of mandatory pollution abatement costs and investment as well as compliance with standards was to reduce the average growth rate of real GNP in the US by 0.2 percentage points.

Other studies focused on the negative effect of environmental regulation on firm/sector's productivity. Gallop and Robert (1983) estimated that SO_2 regulations slowed down productivity growth in the U.S. in the seventies by 43%. Still, according to Gray and Shadbegian (1998, 2003), more stringent air and water regulations have a significant impact on paper mills' technological choice in the U.S. However, their results suggest that it tends to divert investment from productivity to abatement.

A second set of surveys argue that there is not enough empirical evidence showing that environmental regulation severely affects international trade, firms' and industry productivity and/or business location, and economists shouldn't therefore care too much about industrial competitiveness (Roberts (1992), Cropper and Oates (1993), Jaffe *et al.* (1995), Glass (1996) and Ekins and Speck (1998)).

Regulatory compliance expenditures are the most commonly used comprehensive measure of environmental regulatory burden on industry. However it falls short of providing a truly exogenous measure of regulatory burden, since the level of the associated costs also depends on the *nature* of an industry's response to regulation (Jaffe and Palmer, 1997).

Jaffe and Palmer (1997) summarize the statistical relationship among pollution control expenditures, measures of innovative activity, performance across industries, and time. They consider two measures of innovative activity: (i) total private expenditures on R&D and (ii) the number of successful patent applications by domestic firms in an industry. Their results differ between the two measures of innovative activity: they find that increases in compliance expenditures within an industry are associated with increases in R&D shortly after. However, there is little evidence that industries' inventive output is related to compliance costs.

Other empirical studies seem to confirm the Porter hypothesis. Drawing upon U.S. data, Brunnermeier and Cohen (2003) find a positive relationship between environmental regulation and environmentally-related successful patents. Popp (2006) provides evidence that the introduction of environmental regulation on sulphur dioxide in the U.S., and on nitrogen dioxides in Germany and Japan, was shortly followed by a very significant increase in the number of relevant patents. Arimura *et al*. (2007) find a positive significant relationship between environmental regulation stringency and the probability of investing in environmental R&D.

We emphasize that according to Porter in order to stimulate innovation, environmental regulation should focus on outcomes and not on processes (i.e. only *certain types* of environmental regulation stimulate innovation) and that "*properly designed* environmental regulation can trigger innovation that may partially or more than fully offset the costs of complying with them" (1995b). Jaffe and Palmer (1997) analysed this hypothesis, by distinguishing three distinct variants:

- the "weak" version; asserting that environmental regulation will stimulate *certain kinds* of environmental innovations, although there is no claim that the direction or rate of this increased innovation is socially beneficial;

- the “narrow” version; stating that *flexible* environmental policy instruments, such as pollution charges or tradable permits, provide firms with a greater incentive to innovate than *prescriptive* regulations, such as technology-based standards;

- and finally, the “strong” version; positing that *properly designed* regulation may induce innovation more than compensating the cost of compliance.

In presenting the case for environmental market-based policy instruments, some author’s support the “narrow” or even the “strong” version of the Porter hypothesis (Andersen *et al.* 2000; Kreiser, 2002; Sterner, 2003 among others). A dominating argument is that market-based instruments leave to the firm the choice of what environmental technique to adopt. Therefore in the longer term, they have the potential to boost technological innovation, because of the continuous pressure they exert on firms to look for more efficient solutions. This dynamic efficiency potential is a demonstrated advantage over the most common forms of direct regulation prescribing standard techniques or establishing relative or absolute emission levels, and “leaving the regulated companies alone” after compliance.

From an empirical perspective, studies suggest that such instruments have had no major adverse effect on competitiveness so far at the macro and sector level (EEA, 2006). This is partly due to the design of the instruments (use of low rates of taxes and tax-exemption possibilities), and partly to well-designed measures that compensate those affected by recycling revenues.

Ambec *et. al.* (2007) tested the significance of the three different variants of the Porter hypothesis using data on the four main elements of the “causality chain” (i.e.: environmental policy - research and development - environmental performance - competitive performance). Their analysis is based upon a database which includes observations from approximately 4.200 facilities in seven OECD countries. They find great empirical support for the “weak” version of the Porter hypothesis and qualified support for the “narrow” and “strong” version

of the hypothesis. With respect to the latter, they found that environmental policy induces investment in environmental R&D, and this, in turn, has a positive effect on business performance.

With reference to the effects of *voluntary* economic instruments in environmental policy on competitiveness, Rennings et al. (2003b) investigate the impact of the EU Environmental Management and Auditing Scheme (EMAS) on environmental innovations and competitiveness in Germany. They found a weak relationship between EMAS on indicators of market success, although a positive impact on the increase of turnover and exports can be shown if a facility had achieved significant learning by EMAS. Furthermore, a recent study by Iraldo et al. (2009), based on a sample of 100 interviewed organizations investigated whether or not an EMS implemented within the EMAS Regulation has an effect on firm performance both from an environmental and a competitive point of view. The econometric analysis shows a positive impact of well-designed environmental management system on environmental performance and, as a consequence, on technical and organizational innovations. Effects on market performance, resource productivity and intangible assets are not strongly supported.

Finally, on the basis of the resource-based view of the firm, Fouts and Russo (1997) found that environmental performance and economic performance are positively linked and that industry growth moderates this relationship, with the returns to environmental performance higher in high-growth industries. Their findings indicate that "it pays to be green" and that this relationship strengthens with industry growth. To sum up, it can be said that the same policies that internalize negative environmental spillovers can pay off by simultaneously generating greater positive organizational spillovers that accrue internally and privately to the firm.

In conclusion, the table 2 provides a summary of some of the most significant empirical findings we reviewed on the effects of environmental regulation on competitiveness according to the three major theoretical approaches of our analysis.

Table 2 Links between environmental regulation and competitiveness – Summary table

Theoretical Approach	Environmental Regulation		Competitiveness		Results*	Reference
	Measure	**Indicator**	**Measure**	**Indicator**		
NEOCLASSICAL	**Stringency**	*Costs of pollution control*	**Prosperity/standard of living** *(Performance)*	*Growth rate of real GNP*	--	Jorgenson and Wilcoxen (1990)
	Stringency	*Pollution abatement investment*	**Investment** *(Driver)*	*Productive (non-abatement) investment.*	--	Gray and Shadbegian (1998)
	Stringency	*Function of severity of the emission standard*	**Productivity** *(Driver)*	*Estimated cost function*	--	Gollop and Robert (1983)
	Stringency	*Pollution abatement costs*	**International trade** *(Performance)*	*Import volume and duties paid*	--	Ederington and Minier (2000)
PORTER	**Form of regulations**	*Types of environmental policy instrument*[6]	**Innovation** *(Driver)*	*R&D expenditure*[7]	+	Lanoie *et al.* (2007)
	Stringency	*Investment in pollution control equipment/total cost*	**Productivity** *(Driver)*	*Total factor productivity*	++	Lanoie, Patry and Lajeunesse (2001)

* (++ strong positive correlation; + positive correlation; -- strong negative correlation; - negative correlation).

[6] The different forms taken into account are technology-based standard, performance-based standard, input tax, emission or effluent charge.

[7] The used variable ia a dummy.

	Stringency	*Pollution control operating costs*	**Innovation** *(Driver)*	*Environmental-related patent applications*	+	Brunnermeier and Cohen (2003)
	Stringency	*Pollution control capital costs*	**Innovation** *(Driver)*	*R&D expenditure*	*not significant effect*	Jaffe and Palmer (1997)
				Patent applications	**++**	
RESOURCE BASED VIEW	**Stringency**		**Resource endowement** *(Driver)*	*Green capabilities*	**+**	Rugman and Verbeke (1998)

4. Competitiveness in the building and construction sector

This section highlights issues concerning competitiveness of the B&C sector as a result of environmental policies.

4.1 Sector characteristics

Primarily, the B&C sector may be divided into three linked ambits:

1. Manufacture and supply of construction materials and components;
2. Construction, represented by the NACE category F45.
3. Activities of design and technical consultants such as architectural, surveying and engineering practice, defined by *NACE category K74.2 – construction-related professional services* (Manchester Business School, 2006).

Recently the B&C sector has developed a specific ambit of application: the sustainable construction, which can be defined as *"a dynamic of developers of new solutions, investors, the construction industry, professional services, industry suppliers and other relevant parties towards achieving sustainable development, taking into consideration environmental, socio-economic and cultural issues"* (Taskforce on sustainable construction, 2007).

The residential segment represents 46% of the total EU B&C sector's production, the non-residential segment the 31% and civil engineering 23%[8]. The sector is targeted by environmental and energy policies due to its high environmental impact and the multiplicity of market actors involved in it.

4.2 Sector competitiveness

[8] Source: EUROSTAT and FIEC

The competitiveness of the B&C sector acts on different geographical levels and cannot be easily nationally or regionally specified. The EU's international trade in construction goods and services is responsible for many major projects around the world, whose earnings contribute significantly to the European overall trade balance.

SMEs enterprises are dominant in this sector, with competitiveness concerns at a local and national level. Furthermore, within the EU direct competition amongst firms from different Member States is very small. Nevertheless, local and national markets do have a strong indirect effect on competitiveness in the EU, because of high resource efficiencies. The Manchester Business School (2006) stated that the principal influence of construction on the competitiveness of the European economy comes through its use of resources or, more simply, its level of costs.

In addition, B&C firms are competing locally and regionally and this drives improvement in quality and value offered to clients. Construction practices vary in different nations, both in technical aspects and in industry structures and up until today there are no processes or significant trends towards convergence of procedures and practices (Porter and Schwab, 2008).

The development of the B&C market is influenced by several related factors, which form drivers for policy actions. The table 3 shows the main factors as stated in the EU Communication "A Lead Marketing Initiative for Europe", (Taskforce on sustainable construction, 2007).

Table 3 Factor effecting B&C market

Factors	Effects' description
Concept of sustainable construction	A new concept with the aim to integrate objectives of sustainable development into construction activities. Its influence on market developments is indirect, because it depends on the decisions of market actors to integrate the objectives of sustainable development in their decision process.
Focus on initial costs:	many decisions are taken on the basis of the lowest costs instead of quality, safety and environmental criteria and life-cycle costs. This applies indistinctly to customer and construction firms.
Public Procurement	incentives to encourage innovative proposals are given to the public clients, for example the Green Public Procurement provides a framework for action with respect to environmental criteria. However, public clients rarely make use of these opportunities, especially for construction works falling outside the scope of the EU public procurement directives. This might be due to legal uncertainties linked to the specific context of construction, to a lack of knowledge in environmental matters, to insufficient political and managerial support and/or to budgetary or other constraints.
Regulations	A series of EU Directives and member States legislations concern sustainability issues related to construction assets, construction activity or construction product industry have been developed. With particular reference to the Directives about: Building Energy Performance (2002/91), Energy Services (2006/36), Waste Framework (2006/12), Drinking Water (98/83/EC), Construction Product (89/106/EC), Equal Treatment in Employment and Occupation (78/2000/EC), etc.
Standardisation	the standardisation process is quite fragmented and adapts very slowly to technological progress and market developments.
Fragmentation of the supply chain	the supply chain is composed of many actors: owners; users; architects and engineering specialists; (sub)contractors; product manufacturers; product distributors; material suppliers; service providers; insurance companies; inspection, certification and regulatory bodies.

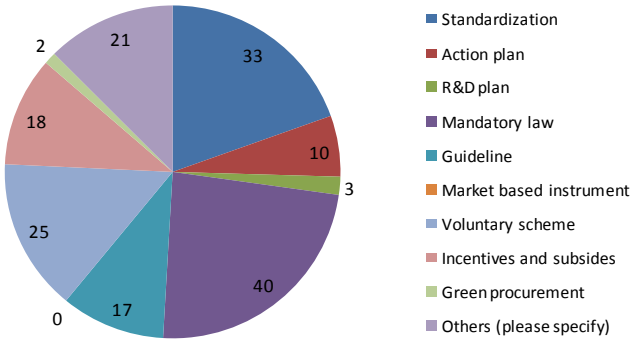
4.3 Policy instruments overview

Departing from the market parameters defining the B&C sector and the competitiveness issues as explained above, a plethora of policy instruments affecting the behaviour of the sector exists. In this paper, we present some main findings from the EMPIRE project, where policy instruments were analyzed for France, Italy and the Netherlands.

Policies in the EU target at all three ambits of the sector: Construction materials, Building Construction and Eco-design improvement. The majority of policy instruments refer regulations linked mainly to hazardous materials and energy efficiency improvement. A strong boost towards such policies is provided by the EU Energy Performance Building Directive (EC 2002), where

energy standards must be applied to new and renovations of existing buildings. Furthermore, voluntary agreement schemes are also used in all three countries, as they can reduce the actual costs of implementation of standards. To this end voluntary schemes are often linked to energy and environmental standards. Another category of instruments used at a smaller degree, are financial incentives. These mainly comprise subsidies, taxes and tax rebates rewarding energy efficient behaviour and compliance with regulations in the B&C sector. Instruments that are used to a much lesser extent are green procurement, R&D plans and market based mechanisms (referring mainly to certificate trading mechanisms). In figure 1 we present the contribution of categories of policy instruments in the case study countries.

Figure 1 Policy instruments in the B&C sector



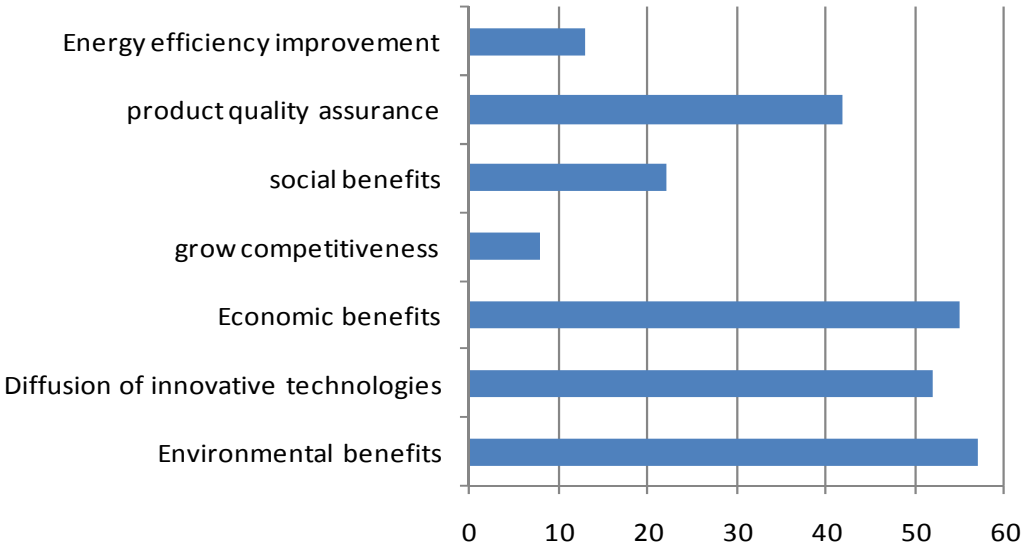
Furthermore, with a more detailed classification of the instruments on the various phases of construction (i.e. from construction materials, architectural design, to construction itself), we identified that almost 21% of the instruments refer purely to the construction phase for both residential and non residential subsectors. Surprisingly, almost half of them (10%) reflect the design phase, as the latter is mainly addressed by the Construction and Ecodesign Directives and some national codes. Furthermore, 25% of policies refer to all construction phases, or do not address the subsectors as they are formulated. An analysis of the sectoral arrangement of the policies is presented in Figure 2.

Figure 2 Construction phases addressed by policy instruments

	construction materials	constructions	construction materials, constructions	construction materials, designers	constructions, designers	all
residential	1	5				1
not residential		1				1
infrastructure						1
residential, not residential	5	20	1	3	10	11
all	5	9		1	3	17

The main targeted effects of B&C sector policies are to a large extent environmental (decrease of pollution and emissions, reduction of CO_2 emissions) and economic ones (cost-effective new technologies, lower construction and materials costs). Furthermore, as expected, regulations and financial policies lead companies in the sector towards adopting the most cost effective measures (the so called 'low hanging fruits'). These technologies are generally mature in the market. In Figure 3 we demonstrate the distribution of policy instruments per category of targeted impact or effect.

Figure 3 Distribution of policy instruments per impact category



5. Conclusions

The review of the literature on the link between environmental policies, environmental and competitiveness performance highlights that the available empirical evidence does not allow us to state that any strand of research has succeeded over the others, as no unique relationship has prevailed in literature or empirical studies so far. For this observation, a number of explanations have been brought forward. These include *methodological reasons*, such as the lack of statistical data or its low quality or the fact that environmental data is often available for short time periods only. Furthermore, various *theoretical explanations* are developed, such as the influence of different corporate strategies or a relatively small influence of environmental issues in industry on the economic success of firms.

Overall, the relationship between environmental policies, environmental performance and competitiveness may vary depending on *the source* of the regulation, *its form* and *the environmental assets* it is seeking to protect. The *methods of assessing* the relationship may also generate different estimates of the direction and strength of the effect of regulation on competitiveness. For instance, longitudinal or time series studies can capture the passage of time and the dynamic adjustment process to an extent that cross-sectional studies - even at different points in time - would find more difficult.

Two variables in particular have proved to be both (i) key in defining to what extent and under what conditions environmental regulation exerts adverse or positive effects on competitiveness and (ii) difficult to nail down: *forms of regulation* and *responses by business*. The form of regulation may be as important as its stringency in determining the nature of its relationship with competitiveness; though, there is little from the literature that helps define or capture the form of regulation. Especially in terms of how regulation allows flexibility for business responses at the same time as it achieves its environmental objectives. Still, recent studies support the idea and provide evidence that the key question is not "*which instrument is best*", but "*which mix of instruments is best*". This implies that using market-based instruments alongside other environmental measures such as

regulations is optimal both in terms of using the preferred mix of instruments to meet environmental objectives as well as in combination with other (e.g. economic and social) objectives. The relationship between environmental policies, environmental performance and competitiveness may also vary depending on the characteristics of the businesses and sectors concerned (e.g. market power may apply only to some businesses as the ability to pass on any increased costs from regulation to the consumer). Taking into account these factors in analytical methods and assessments may be crucial in understanding the nature of the relationship between environmental regulation and competitiveness.

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