UNIVERSITÀ DEGLI STUDI DI FERRARA
DIPARTIMENTO DI ECONOMIA ISTITUZIONI TERRITORIO
Via Voltapaletto, 11 – 44100 Ferrara

Quaderno n. 5/2009

February 2009

Techno-organisational strategies, environmental innovations and economic performances

Micro-evidence from a SME-based industrial district

Davide Antonioli   Massimiliano Mazzanti

Techno-organisational strategies, environmental innovations and economic performances
Micro-evidence from a SME-based industrial district

Davide Antonioli and Massimiliano Mazzanti[1]

Abstract

The paper aims at providing specific evidence on the quite unexplored area of SME (Small-Medium Enterprises) strategies concerning environmental and techno-organisational innovations dynamics. The theoretical and empirical literature on innovation-performance relationships at firm level, mainly focused on medium-large enterprises, is the conceptual reference of the paper. The objective is to analyse what innovation drivers, taking an extensive view (core innovation drivers, training, industrial relations), are spurring SME labour productivity, the main source of firm competitiveness. Our specific focus on SME adds evidence on SME behaviour, embedding firms in a local context where idiosyncratic factors may explain large part of innovative behaviour and economic performances. The main focus of the paper is nevertheless the extent to which environmental innovations (environmental process product innovation adoptions, environmental R&D, EMS/ISO and other factors) are positively, negatively, or not related to economic performances.
Results show that, training and organisational innovations are the main 'non environmental' significant drivers, operating effects through various different elements. The role of mere process/product innovation is instead not relevant, signalling possible weakness of innovation adoptions in term of value creation or that investments take a longer time to exert effects. Environmental strategies, specifically auditing schemes, especially ISO14000, and 'environmental R&D', both appear to impact positively on firm productivity even with a short lag. Environmental R&D – rarely available as a measure in eco-innovation studies- re-integrates into the picture the role of input technological innovation. Environmental policy-related costs do not seem to exert any negative effect on performances, as possibly expected. Comprehensive innovative SME strategies thus seem to effectively impact on firm performances both through 'standard' organisational innovation levers and higher performance and workers involvement practices, and also new eco-innovation strategies. Tradeoffs between economic performances and 'environmental' strategies seem to be weak or not existing at all, signalling potential complementarities regarding firm core performances and environmental objectives at firm or local district (community) level. Firms to some extent internalize external cost element into the comprehensive innovation strategy of the firm. The impure public good nature of some environmental problems at local level may explain this win win output we find. Our results imply that (SME) firms playing in local production systems facing the challenges of competiveness may address joint private/public aims by implementing corporate social responsibility strategies, that entail environmental investments and involvement of workers in innovative decisions. This chance may be enhanced when the firm is embedded in local production settings and where industrial relations are good given CSR implies the recognition of medium long run economic performances as core objective.

Keywords: environmental business strategies, techno-organisational innovations, environmental innovation, R&D, Eco-labelling, SME, labour productivity.

JEL classification: Q2, L60, Q13, O31

[1] University of Ferrara, Department of Economics Institutions and Territory; contact: ntndvd@unife.it

1. Introduction

Over the last few years, the relationship between environmental performance (emission intensity, environmental efficiency, eco-strategies, etc.) and economic performance has received increased attention, also thanks to its role within the 'Lisbon Objectives' on growth and innovation and the 'Gothenburg priorities' on sustainable development.

Within this debate, manufacturing has received much attention, given its relatively high impacts on the environment, and higher innovation potential. The study of the relationship between technological change and economic performance has long been the focus of economics, dating back to the first fundamental contributions of classical economists. This research tradition continued and grew with Schumpeter, who placed innovation at the core of his analyses ever since his first, fundamental contribution in 1934, *The Theory of Economic Development*. In 1957, Solow furthered the analysis of the relationship between technological change and performance, addressing the issue within a theoretical framework based on the aggregate production function (see also on green growth models Solow (1974) and more recently Brock and Taylor (2005). In this work and in subsequent works, technological change is identified in the 'residual' component of economic growth: that is, in the component that cannot be explained by the contribution of productive inputs such as labour and capital. Starting in the late 1970's, this type of analysis, along with other analyses based on recursive structural models or other estimates (Crepon *et al.*, 1998), began to be used in order to study the relationship between innovation and economic performance at the firm level. Most of these studies (including Griliches and Mairesse, 1985, 1995; Hall and Mairesse, 1995; 2006; Crepon *et al.*, 1998; Cainelli *et al.*, 2006; Cainelli 2008) confirmed the positive impact of innovation on the productivity and economic performance of firms in both the manufacturing and service sectors.

Over the course of the last decade, this field of research began to focus on environmental innovations, particularly those regarding the intensity of emissions and economic performance and efficiency. There are two main reasons behind this growing interest. Nevertheless, the economic literature has only recently begun to focus on environmental innovations, namely those regarding the intensity of emissions and environmental performance/efficiency. There are two main reasons for this increased interest. The first is that environmental performance is now one of the main economic policy goals of European countries. The second, which is partly linked to the first, has to do with the growing impact of environmental regulation on private sector activity in many European countries.

So far, the main approach has been to consider environmental performance as tending to have a negative impact on private sector performance. In some industries – particularly those at the beginning of the chain of production (such as extractive industries) – environmental costs account for a significant share of the added value of firms, thus negatively impacting their competitiveness. The idea that improved environmental performance can be a potential source of competitive advantage for the private sector has only recently emerged. The literature in this field has identified two main ways in which this can happen: (i) the higher costs associated with polluting activities can encourage firms to acquire new technologies and production systems, which in turn entail lower production costs and thus higher productivity; (ii) the first firms to adopt these new technologies can benefit from having made the first move, by selling these innovations to other firms.

The value added of the paper is manifold: first, we provide evidence on SME productivity drivers concerning techno-organisational and environmental innovations, such as product/process innovations, EMS/ISO, R&D, TQM, training, and local idiosyncratic factors such as industrial relations and environmental policies; we thus present a rarely found rich array of drivers, bringing together standard innovation strategies and specific environmental strategies. Secondly, we base our investigation on recent and official data deriving from balance account sheets, from which we obtain productivity performances. The possibility of exploiting real performance data is also rare for SME. Third, in order to bypass the flaws of cross section datasets and to assess causality links more robustly, the empirical model is based on diachronic relationships between productivity and covariates/drivers.

The paper is structured as follows. Section two presents both a survey of the literature on techno organisational innovation, industrial relations and their effects on firm performances, and outlines the realm of environmental innovation drivers and economic performances, that constitutes one of the main focuses of this paper. Section three describes the data and research hypotheses. Section four discusses the empirical model and comments on main outcomes. Section five concludes offering insights for future researches.

2. Innovations and economic performances

This section presents an updated review of the relevant literature focusing first on the more general framework of techno-organisational innovations and their performance effects, also looking at the role of industrial relations and other factors that may play a role in district based industrial local production systems. Then, we move into the specific issue of environmental innovations. The literature review will highlight the state of the art and the main value added of this paper: the rare focus on SME playing in local systems, the role local idiosyncratic factors, and the assessment of economic performance effects of (eco) innovations and other competitive strategies, a rare evidence in general, even rarer for SME.

2.1 Techno-organisational innovation and industrial relations

It has been widely recognized that innovation activity is fundamental in sustaining firm's competitive advantages. It has been also ascertain that innovation is a broad concept that may encompass, at least, both technological and organizational aspects (OECD, 2005)[2].

The importance of maintaining a broad perspective on innovation has been spurred by the now well rooted concept of knowledge based economy (Foss 2005), which is an "expression coined to describe trends in advanced economies towards greater dependence on knowledge, information and high skill levels and the increasing need for ready access to all of these by business and public institutions" (OECD, 2005). The diffusion of knowledge intensive technologies of production as well as knowledge intensive organizational practices shifted the attention of a wide part of economists on the importance of the ways knowledge is managed within the firms (Kremp, Mairesse 2004; Hall, Mairesse 2006). The firms themselves can be considered as knowledge/learning organizations (Nielsen, Lundvall 2003; Lundvall 2006) capable of generating and spreading knowledge (Nonaka, Toyama, Nagata 2000) inside and outside their boundaries.

The conceptual background that justifies the adoption of our integrated view on the innovation activities stems from contributions that can be put under the heading of knowledge based perspective of the firm (Foss 2005). Focusing the attention on a specialized literature (Teece 1986, 1996; Teece, Pisano 1998; Coriat, Dosi 2002; Chandler 1992) that identifies in the (dynamic) organizational capabilities co-evolving assets and activities to the technological innovations we can understand the importance of "new organizational practices" coupled and complementary to technological innovation.

Thus, "new" organizational practices (EC, 2002), which require/imply a more skilled workforce, the flattening of the hierarchical structure, delegation of responsibility, some degree of decisional decentralization and autonomy in managing the job tasks, coupled with technological innovations contribute to sustain firm's competitive advantages (Caroli and Van Reenen, 2001; Black and Lynch, 2001; Lynch, 2007; Bartel, Ichniwski and Shaw, 2007; Hall, Lotti and Mairesse, 2007)

The human capital of the employees becomes a fundamental resource since "innovating organization benefits from a strong skill-base" (Leiponen 2005, p.304) capable of sustaining and directing the organization's absorptive capacity. Thus, the importance of training activities (Zwick 2005; Conti 2005), which help in generating and accumulating skills and competences complementary to technological innovations, is clear: the mere introduction of technological innovations may be not conducive to better performances (productivity paradox) if it is not supported by adequate organizational practices (Laursen, Foss 2003; Michie, Sheehan 2003; Pini, Santangelo 2005), when the latter have to be understood also as adequate human resource management practices (Brynjolfsson, Yang 1996; Arnal, Ok, Torres 2001). Put it another way, the organizational design should include human resource management practices that imply higher levels of employees commitment and involvement.

Both theoretical insights and the empirical evidence usually lead to speak in favour of a positive linkage between techno-organizational innovation and firm economic performance.

---

[2] We here neglect the innovation in marketing activities, focusing the attention on techno-organizational changes.

A less explored idiosyncratic element that potentially influences the firm performance is the industrial relations system. Trade unions may be an element that enhances or hinders the productivity of a workplace as well as profitability, investment in capital and in innovation activities (Booth 1995; Menezes-Filho, Van Reenen 2003; Metcalf 2003; Menezes-Filho, Ulph, VanReenen 1998; Machin, Wadhwani 1991)

Although conceptual literature does not provide unambiguous insights (Menezes-Filho & Van Reenen 2003; Metcalf, 2003; Naylor, 2003), it is common to find evidence of a neutral or positive influence of unions on productivity and negative influence on profitability[3]. Whether the positive effect overcomes the other, qualifying unions as surplus-enhancing, should be analysed case by case. It may be hypothesised that the results depend on the quality of the industrial relations system at different levels: national, local or firm levels. In fact, if industrial relations are cooperative then we would expect more workforce commitment to the firm, a higher moral and a more stable environment with positive consequences on the firm efficiency. On the contrary, if the industrial relations are adversarial, unions act in a conflicting way, management ignores the union voice and there is no kind of alignment between unions and management goals, then we would expect negative effects.

2.2 Eco innovations: drivers and effects on performances

2.2.1 Innovation drivers

We now shift the attention on the main issue of the paper: the relationships between environmental innovation strategies and SME performances. The related literature has as original milestone of inspiration the discussion of the Porter hypothesis and the framework of environmental regulations effects on firm performances and innovation paths. This leads us to the other pillar: the literature on eco-innovation drivers and effects.

For a detailed critique of the “Porter” hypothesis (Porter and Van der Linde, 1995) we refer among others to Jaffe et al. (1995) and Mohr (2002)[4] who empirically and theoretically address the hypothesis that environmental regulation may benefit affected firms. This hypothesis, takes different gradual forms from “strong” (private costs are in the end lower than private benefits, even excluding social benefits) to light assumptions (net costs remain positive on average with some sectors turning out winners and other losers in the “environmental” oriented economy). The stream of diverse analyses stemming from this original debate is to some extent a reaction to the neoclassic frame, and points, from different perspectives to a possible complementarity/positive correlation between labour productivity and environmental efficiency, is a hypothesis which implicitly emerges from the different levels of such streams of literature dealing with innovation, policy effects, firm performance under endogenous scenario and following exogenous impacts. Complementarity may be opposed to the “substitution hypothesis” which derives from a usual neoclassic reasoning. In fact, if the firm is optimizing resource allocation in production before environmental regulations, any additional abatement cost or innovation cost deriving from policy enforcement leads, at least in the short run, to an equal reduction in productivity, since labour and capital inputs are re-allocated from “usual” production output to “environmental output” (pollution reduction). As stressed by Krozer and Nentjes (2006) this emphasis on substitution and negative relationship between the two efficiencies may stem from the role played in the neoclassic reasoning by both an assumption of optimal allocation of resources in the BAU and by the role of input prices and green taxes as innovation levers.

For beginning the short survey, we pick up a seminal work is by Jaffe and Palmer (1997) who study environmental innovation by defining R&D and patents as dependant variables, at industry level. In a panel framework, they find that higher lagged abatement costs lead to higher R&D expenditures.

Brunnermeier and Cohen (2003) employ panel data on manufacturing industries to provide new evidence on the determinants of environmental innovation. They measure innovation by the number of patents (waste treatment and containment, recycling and reusing, acid rain prevention, waste disposal, alternative energy sources, air pollution, water pollution) and they find, exploiting a simple reduced

[3] For empirical evidence see among others: Hirsch, 1991; Addison et al., 2000; Addison and Belfield, 2001; Pencavel, 2003; Addison, Schnabel and Wagner, 2001.

[4] His model shows that endogenous technical change makes the idea feasible.

form that it responded to increases in abatement expenditures, while monitoring and enforcement activities associated with regulations do not impact innovative strategies.
In the European setting, evidence on environmental innovation is recently provided by Frondel et al. (2004), who exploit OECD survey data for Germany at firm level (manufacturing industry), in order to investigate whether environmental auditing schemes (voluntary management-oriented organizational innovation) and pollution abatement innovation are correlated. The main conclusions are that the enhancement of corporate image is a potential force behind the adoption of EMS, while policy inputs do not seem to affect this organizational innovation.
As far as EMS are concerned, McKeiver and Gadenne (2005) analyse in a context of SME (firms with less than 200 employees) the external and internal factors that may affect the adoption of formal and informal audit schemes like EMS and ISO14000. Formal schemes are defined as proper adoption of EMS/ISO, while informal activities are more related to environmental innovation and management occurring within an organization (waste management, energy conservation). Informal auditing thus conceptually links the realm of eco-auditing with the realm of environmental management and technology in a broader meaning. Biondi et al. (2000) propose an evaluation of efficiency and effectiveness of EMS/ISO management tools focused on SMEs. Such schemes may on the one hand complementarity connect to proper technological innovations, improving overall and /or environmental efficiency of the firm, while on the other hand increase the market value added of firms, through increasing the market niche and the mark up on average costs consumers are willing to pay.
Going on with works in the EU scenario, Horbach (2008) exploits a two years panel (2001, 2004), considering firms belonging to the "environmental sector" (firms offering goods or services related to the reduction of environmental impacts), then subdividing between innovative and non innovative firms (product innovation). A large vector of explanatory is tested, ranging from firm strategy to policy related factors.
Mazzanti and Zoboli (2005, 2009a,b) presents evidence for the manufacturing sector, focussing on the drivers of different adoptions of energy, emission and waste related innovations. They also analyse the effects on innovation of an extended set of drivers (environmental R&D, policy induced costs, EMS, industrial relations, other innovations).
Rennings - Ziegler - Ankele - Hoffmann - Nill (2003) also provide evidence on Germany, deeply focusing on auditing schemes like EMAS and correlated environmental organisational innovations. They use a sample of eco innovative firms adopting EMS. This is to some extent a weakness since it prevents a general analysis with non EMS firms. The main hypothesis they test is the influence of the «maturity» of EMAS (depending on age of EMAS, revalidation of EMAS and other elements) on environmental process, product and organisational innovation indexes. They find that EMAS has a positive effect on all three forms of environmental innovation at firm level, with a key role played by the R&D department.
Linked to the last commented work, two other papers deal with the correlation between EMS and technological innovation. Ziegler and Rennings (2004) analyse the hypothesis that EMS and other environmental organisational innovations correlate to process/product technological innovations, exploiting a sample of Germany manufacturing firms (2003 survey on firms)[5]. While R&D is positively related to both product and process environmental innovation, they find a weak evidence in favour of the correlation between EMS and innovation, which, added to more recent analyses commented above, draws out an ambiguous picture: some positive correlation is found, but not in all case studies[6]. Instead, this study shows that product designs and life cycle analyses are correlated positively with all forms of technological environmental innovation. Summing up, though evidence is not always robustly showing a positive correlation, there is certainly not a trade off between technological and organisational

[5] We note that, as in most studies of this literature, variables on innovations are forcedly subjective. Firms state their innovative adoptions and investments.
[6] Florida - Atlas - Cline (2001) analyse the relationship between organizational resources/organizational innovativeness and EMS schemes, exploiting firm-level data, finding a positive correlation. Organizational factors may thus play a role in the adoption of green designs. For a US analysis on EMS effects on environmental performances see also Khanna and Anton (2002).

environmental innovations; if not correlated, they may impact on the environmental and general performance of firms separately.
Frondel et al. (2004) instead focus attention on technological process innovation, and use a MNL model to test whether end of pipe measures or integrated cleaner production processes are driven by different factors. They use an OECD survey based dataset for 7 countries on manufacturing firms. They exploit a large set of drivers, ranging from internal firm based strategies to external policy variables. Main results are that policy stringency is more relevant for end of pipe innovations, while "market forces" like R&D, environmental accounting systems and audits, and cost saving motivations are more relevant for cleaner technologies.
This survey of recent paper on innovation drivers introduce the relatively less studied hypothesis related to the link between economic performances and innovation factors, including environmental strategies, which is the area on which this paper focuses.

2.2.2 Eco-Innovation and performances

The evidence on the economic effects of environmental strategies is very recent and quite scarce, though increasing over the last years. It has mainly dealt with the effect of policy factors rather than pure firm strategies. An interesting paper to start with is by Konar and Cohen (2001) who investigates the effect on firm market performance (S&P market value for 321 US corporates) of tangible and intangible assets, including among potential explanatory factors two environmentally performance-related elements, the aggregated pounds of toxic chemicals emitted per dollar revenue and the number of environmental lawsuits pending against the firm. The authors present regressions both for a usual Tobin's q proxy of market value and for a proxy of intangible asset of the firm. The main contribution is to include "environmental performance" as explanatory variables in estimating intangible assets. Empirical results show that both variables of environmental performance are associated with negative and robust impacts. Cohen et al. (1997) also analyse the relationship between environmental and financial performances. On the one hand, environmental performance, and the associated regulatory pressure, is costly, on the other hand a firm that is efficient in controlling pollution is likely to be efficient also at production. Moreover, a firm that does well financially can afford to spend more on cleaner technologies. Authors construct two industry balanced portfolio using 500 S&P Corporate firms, to compare both accounting and market returns of the high polluter to the low polluter portfolio. Overall, they find no penalty for investing in a "green" portfolio, or even a positive return from green investing. The fact that greener firms are doing as well or better than polluters may indicate that more efficient production processes also pollute less: a sort of complementarity may exist between overall production and environmental efficiency. On the other hand, greener firms may exploit better past performances in profits and productivity: this fact would identify a virtuous cycle for some and a vicious one for others. A widening gap, between innovatively-evolving agents, which attempt to increase the added value of production by integrated innovative strategies and more stagnant firms, responding to the challenge of international competition mainly by means of defensive behaviour could characterise the future dynamics of local industrial areas, if we refer to our concern.
Gray and Shadbegian (1995) instead use as performance indicators total factor productivity and growth rates for plants in paper (101 units), oil (101) and steel (51) industries over 1979-1990, testing the impact of environmental regulations and pollution abatement expenditures. This is a typical example of paper which is embedded in a mainstream reasoning around environmental strategies and firm performances. They find that $1 greater abatement costs is associated with $1,74 in lower productivity for paper mills, $1,35 for oil firms and $3,28 for steel mills. Those are variations across plants in productivity levels. Instead, when analysing variation over time or growth rates, the relationship between abatement costs and productivity, as well as the impact of other regulatory measures, is statistically insignificant The evidence on the "Porter hypothesis" is thus ambiguous: regulations do not increase long run firm performances, in this case productivity levels, but on the other hand a negative undermining effect is present only cross-sectionally.
Greenstone (2001) estimates the effects of environmental regulations (Clean air act) on industrial activity, using data for 1,75 million plant observations that comprise the 1967-87 US censuses of

manufacturers. In addition, a longitudinal regulation dataset allows for the identification of cross sectional variation in these regulations across counties, as well as changes in counties pollutants specific regulatory status over time. The regulation file is merged with the aforementioned plant observations. Evidence is based on a comprehensive panel dataset tested by specifying various specifications. It shows that environmental regulations retard industrial activity. Environmental regulations have negatively affected the growth in terms of employment, output and capital shipments for more polluting plants (sectors). The author stresses that "regardless of whether these policies pass or fail a cost-benefit test, this paper finding undermine the contention that environmental regulations are costless or even beneficial for the regulated". Such latter studies focusing on the US framework largely exploits available environmental expenses rather than innovation as proxies of "environmental commitment". A focus on expenditures rather than pollution indicators may be misleading if inefficient firms had both higher pollution costs and lower productivity. A spurious correlation could emerge between the two, depending on the of the firm's core of efficiency. We also note that average and marginal stories may differ: in average terms, we expect that total or average expenditures on abatement are positively correlated to polluting reduction (which is a part of environmental efficiency); while at the margin more efficient firms may spend fewer resources on abatement.

Consequently, though most contributions focus, given the interest in policy effects, on the relationship between productivity and abatement efforts (supposing abatement as a proxy of policy impact, which is partially true in our theoretical setting), our focus is on the correlation between labour productivity and environmental performance/strategy along the specific side of innovation efforts. Then, it is true, as the literature has increasingly stressed, that intended and unintended effects may potentially disentangled (this is an aim of next CIS wave regarding environmental innovation).

Finally, we point the attention to recent, even EU based studies, that focuses the lens to (short term) effects of environmental strategies on stock performances of corporations, by using standard cross section/panel approaches (Ziegler, Schroeder, Rennings, 2008) or "event" studies that analyse exogenous unexpected policy effects on short term performance of environmentally minded firms and not. The latter are criticised even in the aforementioned paper for their intrinsic very short term lens, claiming fro studies analysing such relationship in the medium long run scenario. Although valuable, and grounding on official datasets, we believe that evidence focusing on corporates and stock market performances is limited since the great majority of firms, especially in Italy, are of medium and even small size, and it is not present in stock markets. Then, even more relevant, we believe that innovation dynamics are more close to productivity trends which, in the end, are the leading engine of firm performances, including profitability. We argue that higher value added is present in studies that specify as key variables of interest efficiency or productivity measures linked to innovation factors. This is even truer within the environmental field.

Summing up, the empirical evidence, though rapidly developing, and patchy, seems to point out that firm may complementary invest in different technological dynamics, given the high interrelation between human capital and techno organizational innovation, and the entangled nature of various technological aims (labour oriented, environmental oriented, etc..) with respect to firm performance objectives, revolving around the pivotal role of firm productivity, which also depends on the (efficient and effective in terms of added value creation) use of environmental inputs and output (Bruvoll et al., 2003).

3. The data and research hypotheses

The extended survey has highlighted and reinforced the main added values of our paper: the focus on the unexplored realm of SME, the use of real firm performance indicators for SME, the lagged structure of the dataset and model, the rich set of innovation drivers.

In order to test a variegated set of research hypotheses that we concisely sum up below we exploit data deriving from two surveys on the same SME firms of a local production system in the province of Reggio Emilia. The two surveys based on a detailed structured questionnaire allow both a deep insights on firm features and a lagged structure of the empirical model. In addition, economic performances derive from official balance account sheets.

The local production system of Reggio Emilia, a Northern Italy province in Emilia-Romagna, is the geographical location of the manufacturing firms analysed in the present work. This local system is characterized by a predominant presence of SME. A particular characteristic of the Reggio Emilia manufacturing context, which is linked to the prevalence of SME, is the existence of two districts: the first includes non-electrical machinery and equipment - machinery for mechanical energy and agriculture in particular; the second includes non metallic mineral products - ceramic tiles in particular[7]. From the firm distribution by sectors and size (Tab.A.1 in Appendix), we can see that about half of the surveyed firms operate in a district-like environment, usually constituted by networks of SME. As a result of its features, the Reggio Emilia local production system can be considered to be a paradigmatic version of the so called '*Emilian model*' (Amin, 1999; Brusco, 1982), in which a well marked entrepreneurship spirit and an equally strong, deep-rooted unionism coexists with a productive apparatus characterized by the presence of a district-like production system.
In order to carry on the analysis we merge three datasets related to the Reggio Emilia local production system. The first drives by an extensive survey on 199 firms carried out in 2002 and covering techno-organisational innovation factors, high performance practices and industrial relations. This survey allows collecting unique information, for the period 1998-2001, on several firm's characteristics: (i) firm's structural data; (ii) occupational structure and internal labour markets; (iii) techno-organizational characteristics; (iv) communication, consultation and participation; (v) reward schemes.
The second source of information comes from a detailed survey on 144 firms about environmental innovations administered in 2004 to a subset of the 199 firms previously contacted through the first survey. Such survey elicited information on (i) process and product technological innovation introduced over 2001-2003, aimed at increasing environmental efficiency in (a) emission production, (b) waste production and management (c) material inputs, (d) energy sources[8]. We asked then whether those innovations were (i) produced from within the firm (ii) stemmed from co-operative agreements with other firms, (iii) stemmed from co-operative agreements with research institutions, (iv) acquired from other firms. Whether innovation was associated to patenting activity was also inquired. Furthermore, the adoption of environmental corporate management schemes was elicited. As far as environmental policy is concerned, a question was devoted to whether the firm was subject to policies on (a) emissions and (b) waste/energy; we also asked how many years the policy had been implemented. Other questions elicited the expenses on environmental R&D, capital investments and direct costs (current costs plus tax payments, etc..) over 2001-2003. Finally, we asked whether the firm had exploited governmental environmental grants/subsidies over the past 3 years.
Finally, the third dataset we utilize for the analysis contains data stemming from official balance sheets for the year 2004 and provides us with figures on productivity in terms of value added per capita. The balance sheets data for SME we have at our disposal is one of the main value added of the empirical analysis here conducted, because we do not have to rely on perceived performance trends when analysing the impact of innovation on productivity, rather we are able to use 'real' performance variables. The merge of the three data sources brings about a final sample of 89 firms, with unique characteristics in the fields of innovation and environmental studies. Moreover, it also preserves a good capacity to represent the overall population of 257 firms.
The hypotheses about the signs of the relationships among the sets of covariates and the productivity variable are synthesized in table 1. Let briefly comment on the underlying hypotheses. First, following the streams of literature commented on in section 2.1, we expect to find a positive effect of techno-organizational innovation and HPWP in general, including training, on firm productivity. More than on other performance indicators such as profitability, such investments in tangible and intangible assets

[7] For a more detailed description of the local context we refer the reader to Antonioli et al. (2004) and Antonioli et al. (2007).

[8] The taxonomy of environmental realms is largely consistent with recent OECD studies (Darnall, Jolley, Ytterhus, 2005), on recent EU based studies (Getzner, Ritt, 2004) and with seminal conceptual papers (Rennings, 2000; Kemp, 1997). We are aware that we do not analyse the adoption of innovations differentiating by type (end of pipe/structural; process/product). We transparently state that this choice depended on the "constraint" defined by telephone interviews, which do not allow an interaction between researchers and firm managers, which is needed when complex issues related to innovation definitions are dealt with.

should bring about positive effects on the core value of productivity. The key question is then revolving around 'the lag' of such eventual impact. In this paper for both standard and eco-innovations we test a short-medium run lag, given productivity levels are for 2004, and innovation/HPWP factors refer to the period 1998-2001 or 2001-2004. We may state that we test a short run lag for eco innovation drivers (referring to 2001-2004) and a short medium lag for other innovation levers. It is worth noting again that the merge of different sources of data mitigates structural 'endogeneity flaws' affecting CS studies. Complementary to the above listed innovative practices, we include the high relevant role that may play management-unions and management-workers relationships in highly unionized industrial areas such as the districts in Emilia Romagna. The assumption that follow from cited literature streams is that good (cooperative) industrial relations and good (participative) workers involvement in some business strategies entailing tecno-organisational innovations and HPWP could cause higher performances in such 'participative' oriented firms. The effect on performances of a good quality of relationships between management and the counterparts is obviously indirect, passing through an enhanced intensity of innovation adoptions. Unions and workers may also contribute to the implementation of innovation by selecting which innovations better complement mere productivity effects with quality of workers conditions, itself a source of higher productivity to some extent. In fact, some innovations may spur productivity on the one hand and undermining workers conditions on the other, thus infringing a source of labour productivity (the labor conditions of workers in the firm).

The role of the environmental related activities on labor productivity is more ambiguous and we consequently may expect both positive and negative signs. First, if we focus the attention on the role of eco-innovation factors in stimulating economic performances[9], the hypothesis, also referring back to what discussed in section 2.2, is that, taking a Porter/CSR perspective (Porter, van der Linde, 1995; Jaffe et al., 1995; Reinhardt et al., 2007), eco innovation strategies may bring about positive effect on economic performances. EMS and ISO adoptions can surely increase the value of the product in the market, (eco)R&D can increase the overall innovative intensity of the firm in both economic and environmental grounds, linking to other R&D dynamics. Process and product innovations may actually influence productivity with an ambiguous ex ante expected sign. In fact on the one hand the adoption of eco innovations can merely be driven by non strategic reasoning (compliance with a policy), thus diverting resources from other productive investments. The case of end of pipe technologies may be an example: a cost borne to be compliant with environmental laws with no effect on economic productivity. On the other hand, as for R&D, the adoption of integrated clean technologies can bring together environmental and economic productivity aspects. This strategy may stem either from a simple reasoning of mere compliance, as above, but more valuable insofar it implements a restructuring of the production process that can impact both environmental and economic values generated by the firm, or from a proactive CSR based view. In the latter case, the firm is taking a long run perspective on its environmental investments encompassing private and public benefits, integrating the two sides. The strategy may increase firm competiveness in terms of value and efficiency. Opposite forces may then act at the same time, with a possibility of compensation (which will result in a not significant effect of innovation adoptions). This possibility is higher in the short run, where innovations costs are concentrated. The more the scenario is moving into the long run, the higher the chance of experiencing benefits from eco-strategic innovations should increase.

A last factor we investigate is related to the impact of policies on firm performances. We test this link, which may be positive, not significant or negative depending on the same reasoning we carried out above. In fact, environmental regulations can spur positive private benefits for firm, in the medium long run, only if firms react by innovating and taking a full CSR proactive action. We analyze the effect by different proxies (see below): the current environmental costs/expenses associated to environmental management and also policy cost (e.g. paying taxes, buying pollution permits) and the number of years a firm has been subject to both waste and emission policies. We do expect negative or negligible effects on productivity, being the time lag we analyze embedded in the short run. We may conclude this section by stating that both environmental innovations and environmental regulatory costs (that may bring about innovation effort) are linked to the same conceptual framework from which we derive our

[9] For a theoretical discussion on eco innovation drivers we refer to Mazzanti and Zoboli (2009a,b).

set of hypotheses. Environmental regulation may influence innovation and thus market rents and values. In the long run, the cost of regulation, or environmental R&D expenditure, may be more than compensated for by the benefits of innovation in terms of higher efficiency and/or higher value added. This conclusion seems to run counter to the conventional wisdom that environmental regulation (like any other regulation, of course) or spontaneous investment in greener performance imposes significant direct and indirect costs on firms and industries, with the primary effect of impacting negatively on economic performance, and especially on (labour and total factor) productivity. Following these mainstream reasoning, if the firm is optimising resources in production, over the implementation of (new) environmental regulation, any additional abatement or innovation costs deriving from policy enforcement will lead, at least in the short run, to an equivalent reduction in productivity/performance, since labour and capital inputs are re-allocated from 'usual' or scheduled production output to 'environmental output' (pollution reduction). This emphasis on substitution may stem from the roles in neo-classic reasoning of the assumption of optimal allocation of resources in the *status quo* and of input prices (and green taxes) as innovation levers. In fact, resource prices have been the main driver of change only in the specific conditions of strong relative price changes coupled with structural economic transformations. More generally it is technology that affects prices by changing factor combinations and capital intensity. In other approaches, the development of new production processes is viewed as an ongoing process within firms and sectors less reliant on input prices, except in particular circumstances (Kemp, 1997; Krozer, Nentjes, 2006). Economies of scale and scope are another argument leading to a departure from the conventional view. Among other factors, complementarity (Mazzanti, Zoboli, 2008) and economies of scale and scope might lead to states where the productivity effect of environmental investments or compliance becomes positive (plausibly in the medium long run).[10]

Tab.1 - Hypothesized signs of influencing variables on the productivity *(VA/E)*

Influencing factors	**VA/E**
Techno-organizational Innovation / HPWP (Training, Process/product technological innovation, plant flexibility, etc..)	+
Partecipative practices (High involvement work practices and (Cooperative) Industrial Relations)	+
Environmental Innovations (ISO; EMS, R&D, Adoption of process/product innovations)	+/-
Environmental costs/environmental policy	+/-

4. Empirical analysis

4.1 The empirical model

In order to test the above described hypotheses we structure a 'hybrid' cross section regression model that exploits the lag between economic performances and innovation drivers.

As a general specification of the econometric model we estimate the following form:

(1) Prod $(VA/E)_{i,04} = \beta_0 + \beta_{1i,98\text{-}01}$ [structural variables] + $\beta_{2i,98\text{-}01}$ [techno-organisational innovations/ HPWP] + $\beta_{3i,98\text{-}01}$ [participative practices] + $\beta_{4i,01\text{-}03}$ [environmental innovations] + $\beta_{5i,01\text{-}03}$ [environmental policy/cost] + ε_i

10 "The choice to invest in either change in production process or end of pipe will be used to evaluate the extent to which production and abatement is undertaken jointly. End of pipe technologies are considered to reflect evidence of the existence of a separable production function, with production the conventional output and abatement of pollution as essentially separate plants within a single facility. Different resources are used for each plant. Production process is considered to reflect a production process in which abatement and production of the conventional output are integrated, allowing for the complementary use of inputs in both abatement and production" (Labonne, Johnstone, 2007, p.3).

where β is a vector of coefficients for each set of covariates, the dependent variable refers to 2004, *i* identifies each firm, the sets of covariates refer both to the periods 2001-2003 and 1998-2001.

The variables in the above reduced form may be shortly described as follow, while for detailed information on their construction we remind the reader to the table 2.

Dependent variable. The productivity indicator is constructed on the bases of balance sheets information for the year 2004. The ratio between the firm value added and the number of employees (VA/E) is an expression of per capita productivity.

Structural variables. The vector of structural variables captures as much as possible the firm specific heterogeneity in our 'hybrid' cross sectional environment, in order to reduce, to some extent, the likelihood of relevant variables being omitted. Along with usual controls like sector dummies and firm size, here captured by a continuous variable (number of employees), we can control for firm typology, the workforce composition, the percentage of turnover on national markets and the production typology in terms of intermediate goods or final/ready to market goods.

Techno-organisational innovations/HPWP. Innovation variables encompass several spheres. In fact, the administered questionnaire allowed collecting information not only on product and process innovations, but also on organizational changes, including those practices that international literature defines as High Performance Work Practices (TQM, JIT, quality circles, job rotation and team working organized in a single index, plant flexibility), and training activities, such as the coverage in terms o employees involved of training practices. The expected sign associated to the variables belonging to this broad set is positive.

Participative practices variables. The index of industrial relations takes into account both formal (e.g. presence of bilateral technical commissions or existence of firm level bargaining) and informal aspects of the firm level relations between management/union representatives and management/workers. It represents a synthetic index of the cooperation intensity between the social parts at firm level; thus, we can expect a positive relation with productivity, as suggested by theoretical insights. In addition to an index that captures the intensity of a traditional form of workplace representation through unions presence we are able to test the significance of an index synthesizing the employees involvement/participation in firm activities.

Environmental innovations and policy/costs. The richness of environmental related information represents a further value added of the data at our disposal, when compared to other international studies on the relationship between eco innovation, environmental policies and firm economic performance. The set of variables here considered includes both information on firm activities concerning environmental innovations, for example process innovations introduced in order to reduce emissions, and firm activities related to the 'green' policy compliance, such as the adoption of technologies aiming to reduce waste generation in the production process.

Tab.2-Descriptive statistics and variable contents (89 firms)

Variables *Acronym*	*Description*	*Min*	*Max*	*Mean*
	Dependent			
VA/E	Logarithm of value added over employees for the year 2004	7.91	173.73	54.91
	Structural Variables			
Sectors Dummies (Chemical, Machineries, Non-metallic mineral products)	Binary variables (0,1)	0	1	/
SIZE	Number of employees in 2004	50	2239	233.50
GROUP	Belonging to a group: binary variables (0,1)	0	1	0.30
NAT_TURN	Percentage of turnover made on national markets	0	1	0.48
MKTREV	Percentage of production sold on the market	0	1	0.83
SK_RATIO	Skill ratio: managers, middle-managers and specialized blue collars over clerks and not-specialized blue collars	0	3.36	0.85
	Techno-organizational Variables			
INNO_PROD	Product innovation: binary variable (0,1)	0	1	0.03
INNO_PROC	Process innovation: binary variable (0,1)	0	1	0.71

Tab.2-Continue				
OUTS	Index that captures the diffusion of outsourcing strategies for several firm ancillary activities	0	1	0.28
PLANT_FLEX	Flexibility in production activities	0	1	0.36
INNO_ORG	Index that captures the diffusion of team working, TQM, JIT, quality circles and job rotation	0	1	0.25
HIERARC_INT	Index of hierarchical intensity: number of hierarchical levels divided by the number of firm's formalized functions (e.g. Production, marketing, sales)	0.13	1	0.28
COV	Index showing the percentage of employees involved in training programmes (0 nobody; 1=1-24%; 2=25-49%; 3=50-74%; 4=75-100%)	0	1	0.48
BONUS	Index that captures the presence and diffusion of bonus schemes	0	1	0.33
	Participative Variable			
INNOPART	Index based on the number of modalities (7) the management adopts in order to involve the employees	0	0.70	0.25
IND_REL	Industrial relations index that informs on the intensity in cooperative behaviour between management and unions at firm level	0	0.87	0.33
	Environmental variables			
EMAS	Environmental innovation to reduce emissions: binary variable (0,1)	0	1	0.03
ISO_{9000}	Formal certification ISO_{9000}	0	1	0.19
ISO_{14000}	Formal certification ISO_{14000}	0	1	0.15
RSN	R&D expenditure per employee (M Euro)	0	0.05	0.001
CERTIF	Auditing schemes	0	1	0.30
ENVCOST	Current expenses in environmental management and policy compliance (e.g. taxes, permits)	0	0.02	0.001
YRSWAS	Number of years the firms has been subject to waste policies	0	25	7.57
YRSEMIS	Number of years the firms has been subject to emission policies	0	26	8.92

4.2 Econometric issues

We briefly summarise what main issues are of relevance for results interpretation.

Due to the richness of factors, a careful analysis of the correlation matrix is preliminary attempted, showing that high correlations are here not a major flaw. When excessive correlations are found, nevertheless, variables are included separately in the estimated regressions. This is aimed at reducing collinearity problems, selecting a limited set of not highly correlated covariates for testing each specific hypothesis. The correlation matrix shows that correlations are on average quite low between the main factors we investigate (Tab. 3).

Then, heteroskedasticity, a major flaw in cross sections, is addressed by using white corrected estimators. Concerning regression analysis, a "from general to particular" backward stepwise method is here applied, which may result more consistent with this framework since over fitting specifications, starting from a conceptual model, is less severe than excluding relevant factors, and can be resolved by eventually deleting non-significant variables step by step.

Tab. 3- Correlation matrix

		1	*2*	*3*	*4*	*5*	*6*	*7*	*8*	*9*	*10*	*11*	*12*	*13*	*14*	*15*	*16*	*17*	*18*	*19*	*20*	*21*	*22*	*23*	*24*	*25*	*26*
1	VA/E	1.00																									
2	EMAS	0.20	1.00																								
3	ISO9000	0.12	0.07	1.00																							
4	ISO14000	0.37	0.26	0.10	1.00																						
5	YRSWAS	-0.18	0.18	0.03	0.09	1.00																					
6	YRSEMIS	-0.05	0.10	0.10	0.05	0.59	1.00																				
7	RSN	0.13	0.05	-0.03	-0.04	0.00	0.18	1.00																			
8	ENVCOST	0.01	0.01	0.10	-0.07	0.02	0.15	0.20	1.00																		
9	Size	0.02	0.10	0.02	0.03	0.14	0.16	-0.05	-0.08	1.00																	
10	Group	-0.15	0.01	0.18	-0.08	0.13	0.10	-0.07	0.01	0.39	1.00																
11	Chmical	0.00	-0.04	0.03	0.20	0.12	0.06	0.04	0.00	-0.10	-0.14	1.00															
12	Machineries	-0.13	-0.24	-0.10	-0.12	-0.12	-0.20	0.04	-0.18	0.02	0.00	-0.28	1.00														
13	NonMetllicMineralProducts	0.10	0.37	0.04	-0.06	0.19	0.22	-0.03	0.15	0.01	-0.03	-0.11	-0.66	1.00													
14	NAT_TURN	0.00	-0.14	0.12	0.13	-0.24	-0.01	0.04	0.15	-0.11	-0.02	0.23	-0.24	-0.06	1.00												
15	MKT_REV	0.24	0.10	-0.19	0.09	0.03	-0.08	0.05	0.14	-0.02	-0.15	0.10	-0.14	0.17	-0.11	1.00											
16	SK_RATIO	0.21	0.08	0.15	0.16	0.05	0.04	-0.01	-0.03	-0.04	-0.05	-0.11	-0.08	-0.01	0.07	-0.03	1.00										
17	COV	0.16	-0.04	0.26	0.13	0.06	-0.06	-0.06	0.03	0.00	0.28	0.22	-0.03	-0.20	0.08	0.07	0.08	1.00									
18	OUTS	0.00	-0.05	-0.24	-0.08	0.20	0.15	0.01	-0.02	0.08	-0.17	0.10	-0.02	-0.02	0.02	0.00	-0.07	-0.15	1.00								
19	PLANT_FLEX	0.19	-0.02	0.13	0.04	0.02	0.01	0.06	-0.08	-0.02	-0.03	-0.09	0.37	-0.35	-0.13	0.00	0.08	0.13	-0.10	1.00							
20	INNO_PROD	-0.02	-0.03	-0.09	-0.08	-0.05	0.03	-0.01	-0.05	0.17	0.15	-0.04	0.01	0.06	-0.14	0.10	-0.05	-0.21	0.00	-0.24	1.00						
21	INNO_PROC	-0.09	0.12	-0.08	0.00	0.15	-0.09	-0.14	0.01	0.04	0.19	0.01	0.09	0.00	-0.04	0.17	-0.02	0.13	0.08	0.01	-0.30	1.00					
22	BONUS	0.25	0.14	0.09	0.05	-0.02	0.07	0.04	-0.06	0.21	0.20	0.07	-0.06	0.04	0.06	-0.11	0.13	-0.01	-0.06	0.04	0.14	0.11	1.00				
23	HIERARC_INT	-0.04	0.01	0.06	-0.09	-0.03	0.15	0.14	0.15	-0.06	-0.04	-0.13	0.12	0.02	-0.01	0.07	-0.07	-0.03	-0.15	0.00	0.07	0.19	-0.06	1.00			
24	INNO_ORG	0.19	-0.19	0.19	0.25	0.18	-0.01	-0.07	-0.18	0.01	0.19	0.04	0.13	-0.33	-0.02	-0.04	0.12	0.38	0.04	0.27	-0.14	0.07	-0.07	-0.28	1.00		
25	INNO_PART	0.18	-0.19	0.08	0.14	0.16	0.06	-0.05	-0.15	0.05	0.27	0.09	0.14	-0.35	0.02	-0.03	0.05	0.29	0.08	0.24	-0.16	0.14	0.03	-0.29	0.79	1.00	
26	IND_REL	-0.14	0.15	0.11	0.19	0.13	0.12	-0.10	-0.13	0.21	0.25	-0.19	0.00	0.01	-0.02	-0.16	0.24	-0.02	-0.01	-0.04	-0.18	0.14	0.00	-0.21	0.10	0.18	1.00

We also observe that the characteristics of the data at our disposal allow us to solve/mitigate some econometrics problems emerging in the analysis of pure cross section data. The use of real ex-ante and/or ex-post, to the surveys data, performance indicators avoids the emergence of simultaneity bias in the estimates, mitigating one source of possible covariates endogeneity (Wooldridge, 2002). Indeed, the nature of our 'hybrid' cross section is helpful to mitigate the simultaneity problem exploiting the temporal lag between performance variables, stemming from balance sheet, and variables coming from the administered surveys. In addition, it is worth stressing that the wealth of information deriving from the two surveys reduces to some extent the likelihood of relevant variables omissions and consequently reduces the likelihood of incurring in biases due to unobserved heterogeneity.
Finally, when environmental innovations are considered it can always be argued that on important variables correlated to the eco-innovations is omitted: management quality. It is not the environmental innovation, or other techno-organizational innovations, to affect firm performance, but it is the managerial quality: good managers are likely to be associated to higher rate of innovation and to higher economic outcomes. However, on this point we want to follow the reasoning put forward by Black and Lynch (2001): if good managers intensively adopt techno organizational innovations, environmental innovations and intensive/extensive training activities, then because we are able to include such variables in our estimations it is unlikely that much of the bias remains.

4.3 The drivers of productivity for SME: innovation strategies and environmental factors

We here comment on the main results achieved by regressing productivity performances on (eco) innovation actions, HPWP, and other structural factors that are associated to our firms, including industrial relations. All results are shown in table 4[11].
The analysis is carried out through an incremental empirical strategy, starting from a baseline set of usual innovation drivers and firm characteristics, then adding industrial relations factors and finally introducing elements related to environmental strategies such as auditing, innovation adoptions, R&D and policy related costs.
First, from the set of innovations and HPWP it emerges that structural features like size and sectors are not significant (table 4, column 1), and thus omitted from the table. Among those, only the share of market related revenue (opposed to those operating mainly on subcontracting) shows a positive significant sign in the coefficient. It is the strategy of the firm on product markets that matters, not size and manufacturing sectors of reference.
Quite interesting and counterintuitive to some extent, group membership is related to productivity through significant negative link: the underlying reason may be that the economic performances in such local system has often associated to a bell shape with respect to size. Medium sized firms are those performing better; large firms are mainly involved in group strategies, then the evidence we find is consistent to other recent evidence on this manufacturing system (Antonioli et al., 2009).
Within the bundle of innovative and HPWP strategies, training and 'organisational innovative actions' are those arising as more significant. More specifically, training coverage (COV), the additive total index of HPWP (INNO_ORG, embedding quality circles, TQM, team working, JIT and job rotation) adoptions and the use of monetary bonus related to employee's efforts (BONUS, instead an organisational innovation on labour elements) emerge as main drivers. While product innovation adoptions quite counter intuitively do not impact on productivity, process innovation is associated to a negative and moderately significant coefficient.
This is nevertheless consistent with what found in recent investigations on the same local production system (Antonioli et al., 2009): technological innovations rank only third as performance driver, with a role definitely lower compared to that of training and organisational innovations. Consistently with expectations, training and organisational innovations impact on labour productivity. All in all, organisational and human capital oriented strategies seem to matter more as far as economic performances are concerned. The reason behind this lack of effects from technological innovations may depend on: the different time lags technological and organisational innovations take for having

[11] We present in the table a sub set of the variables identified in table A2 since we omit statistically insignificant covariates.

impacts on productivity; the negative sign of INNO_PROC could also depend on the diverted investments necessary for adopting such innovations, that in the short run crowd out other productive value creation strategies more dependent on current technological assets. Finally, we analyse as most works the adoption in terms of binary variables. The intensity and 'radicalness' of innovation are other aspects worth investigating in future works.

Analysing the single HPWP elements included in INNO_ORG, what we observe is that its significance is driven by team working, just in time, and quality circles, all highly significant, but not by TQM and job rotation (we do not show such ancillary regression with separated effects, but they are available upon request). The reason why TQM is not significant may depend both on the quite general content of this HPWP, which may sometimes present forms of formal rather than effective adoption.

Secondly, when we add and consider the variables related to 'good' industrial relations and workers involvement in firm organisational innovation strategies (IND_REL, and INNO_PART) both the synthetic index of industrial relations and the workers involvement index emerge positively linked to labour productivity, as found in other studies (Addison 2005, Pencavel, 2003), thus showing that the relationship between management and unions/workers in this local production system are good, innovative oriented and even performance effective. The good quality of industrial relations and the unions/employees involvement in strategic innovation decisions is a factor that may (indirectly, through a stimulus to innovations) increase firm performances. Within the economic literature this "industrial relations driver" model opposes to the "management driven" model, and roots on procedures of consultation and handing over of decisional functions, from management to employees. This involvement is activated through the implementation of working groups with operative tasks, and joint commissions by managers, employees and union representatives, which aim at decentralising decisional processes. This approach may be particularly effective when the aim is to reshape a fordist-taylorist structure into a participatory based and more horizontal (less hierarchical) organization. Nevertheless, only INNO_PART shows a statistically significant coefficient (table 4, column 2) in this specific analysis; some other papers on Emilia Romagna and Reggio Emilia found effects of industrial relations on firm performances, through impacts of industrial relations on innovation intensity at firm level (Mazzanti et al., 2006; Antonioli, 2009). F test and R^2 both increase in value after including more covariates, and the constant loses explanatory power. We note that training impacts more, while other evidence is untouched[12]. INNO_ORG is omitted in this case for its high correlation with industrial relations factors.

Third, let us present what the role of environmental strategies is when included (table 4 columns 3,4). From a statistical viewpoint, we note that they further improve the fit of the regression, showing a potential case of omission of relevant variables if they were excluded, a potential flaw we highlighted.

Auditing schemes (CERTIF, containing both EMS and ISO schemes, adopted by around 30% of firms) adoption by firms is positively associated to productivity. The significance appears nevertheless to be driven by Iso14000[13], when we disentangle the total variable by using specific dummies. This is somewhat counterintuitive given that EMS is a stronger strategy in innovation terms. Nevertheless, this evidence may be consistent with the fact that EMS is rarer comparatively to ISO in small and medium firms. In addition, EMS showed a strict link to output process-product environmental innovations (Mazzanti and Zoboli, 2009b), which in fact here do not present connections to productivity, confirming the evidence we just found for non environmental process and product innovations. Though some lack of significance for those technological innovation of either kind may depend on the short lag between adoption and our productivity performance, all in all the evidence we present supports stronger impacts for (eco) organisational innovations. Alternatively, we may assume that organisational innovations tend to influence labour productivity through a closer lag with respect to

---

12 INNO_PROC is almost getting to a 10% significance. The negative sign of the coefficient could signal the relative low value of process innovation compared to product innovation in terms of value added generation. We have noted nevertheless that both product and process innovations (output index of innovations) here do not influence labour productivity.

13 CERTIF is significant at 10% (not shown in table).

technological innovations effects. ISO14000 obscures the role of INNO_ORG, though inside the general index we found that different elements play a role with different strengths.
As far as environmental R&D (expenses per employee) is concerned (table 4 column 5), a factor which has been seldom investigated in empirical studies, a major result of this analysis, is that its inclusion causes another sharp increase in the fit in terms both of R^2 and F test. The RSN variable is highly significant at 5% if correcting for heteroskedasticity, a plausible result given its distribution, and does not affect the significance of other covariates. If we consider jointly auditing and R&D, the latter does not fade away in significance; then, environmental strategies appear to play a key role even towards firm performances, with an already noted relative higher strength of eco organisational innovations. All in all, both eco innovation levers (technological and organisational) play a role in determining firm productivity. As for standard innovation, we do not find instead a significant effect for the adoption of eco-innovations (process and product). This may depend on the lag such adoptions need to exert effects, or on the need to investigate 'intensity' of innovations (e.g. expenses, radicalness) rather than mere yes/no adoptions as done in most studies including our.
Regarding R&D relationship with productivity, it is a sign that environmental investments are not undermining firm performances even in the short run, and they also bring about significant effects. They might be targeted to increasing efficiency at a general level of reasoning, and they also may generate partially appropriable rents[14]. The significant role played by R&D as technological drivers in explaining performances brings back the potential of innovation for increasing firm performances.
We note the fact that are eco-R&D expenditures per employee, and not merely the presence of some R&D in the firm (measured and tested by a dummy, not shown and not significant), which arise significant. This may suggest that it is the intensity of innovation, and not just the simple adoption of innovations that matter. This may explain to some extent why some other output innovation factors here captured by dummies end up with being not really significant. This intensity is usually difficult to elicit and capture, especially for intangible and non monetary factors. Further research should in any case focus more on the differences between both radical and incremental innovation and between intensive efforts and less intensive ones. Monetising expenditures may be a way among others to ground the analysis on more specific and concrete figures.
Finally, the 'policy proxies' we include show mixed evidence. On the one hand, the numbers of years waste policies (WASPOL) are experienced in a given firm seem to lower performances. This is not emerging for emission related policies, maybe more recent as well. The interpretation may be also that regarding emission firms tend usually to first introduce end of pipe technologies rather than fully restructuring processes. The latter option may have at least in the short run a negative effect on productivity, which is not instead present when end of pipe technologies are implemented. End of pipe strategies are less likely to be feasible for waste, given the nature of the environmental problem, which needs from the beginning a structural approach. It is also relevant to stress that, while waste policies were already implemented in the early and then late nineties (packaging waste EU directives), emission policies have witnessed a more recent development, and often SMEs are not covered by emission taxes or emission tradable permit schemes at EU and Italian levels.
We also note that the variable capturing current environmental expense/costs per employee (COSTN)[15] is not significant in any regression. This evidence is against a mainstream hypothesis by which environmental policy costs decrease productivity, as discussed in the literature survey above. Added to other evidence, it seems to corroborate some sort of Porter reasoning, by which competitive strategies and investments in innovation assets, including environmental strategies and environmental innovation, may increase firm performances, or at least not depressing it, if not in the very short run. We do not find evidence of negative effects on performances, however we have found evidence of non significant impacts for some factors we tested, that we presume may depend on the close time lag we

[14] We elicited R&D expenditures asking firm which share of turnover is devoted to environmental R&D, then translating figures to monetary per employee (using official turnover data). It may be that, given the novel and to some extent difficult question, firms have over valued environmental R&D. if this were true, our R&D figure would capture also some "standard" R&D expenditures, not purely environmental.
[15] Whose correlation with RSN is 0.199.

specify in the model. Future analyses may test whether the evidence is sensitive to a larger lag with productivity.

Tab.4 - Labour productivity effects of (eco) innovation strategies

Dep.var. value added/employees	1	2	3	4	5
Constant	24.31**	19.59*	23.65**	23.36**	23.40**
Structural variables					
Firm Size	Yes	Yes	Yes	Yes	Yes
Sector dummies	Yes	Yes	Yes	Yes	Yes
GROUP	-14.59***	-16.54***	-12.21***	-12.18***	12.08***
MKTREV	17.98***	17.19***	16.65***	16.64***	12.88**
Techno-organizational variables/HPWP					
COV	13.58*	16.18**	12.79**	13.02**	11.95**
INNORG	21.52**	/	15.82*	14.64*	21.47**
INNOPROC	-7.51*	-8.26**	-7.81*	-7.45*	/
REWARD	28.30***	27.05***	26.24***	26.54***	22.76***
Participative strategy variables					
INNOPART	/	41.76**	/	/	/
Environmental variables					
EMAS	/	/	7.69	/	/
ISO_{14000}	/	/	16.57*	17.84**	18.92**
RSN	/	/	/	/	586.15***
WASPOL	/	/	/	/	-0.864***
N	89	89	89	89	89
F test	3.43 (0.0006)	3.62 (0.0004)	3.86 (0.0001)	4.19 (0.0000)	5.00 (0.0000)
Adj R^2	0.233	0.247	0.296	0.302	0.371

OLS corrected for heteroskedasticity is used; *means 10% significance **means 5% significance; ***means 1% significance; SIZE and sector dummies (Chemical, Machineries, Non metallic mineral products) are included but not shown as not significant. / means not included, following mainly a pre-analysis on correlations among covariates, with the aim of mitigating collinearity.

5. Conclusions

The paper aims at providing specific evidence on the quite unexplored area of SME strategies concerning (jointly) environmental and techno-organisational innovations dynamics. We provide evidence on SME labour productivity drivers, using official balance account data, from which we obtain productivity performances, and rich survey information. The drivers we analyse concern techno-organisational and environmental innovations, such as product/process innovations, EMS/ISO, eco-R&D, training, and idiosyncratic local factors such as industrial relations and environmental policies. We thus present a rarely found rich array of drivers, bringing together standard innovation strategies and specific environmental strategies. This richness seems to pay in terms of statistical performance of our empirical model.

Results show that regarding standard innovations, training and organisational innovations are, as expected, the main significant drivers. The fact that control structural factors do not exert effects on performances (besides some negative performance linked to the chemical firms) is a signal that innovation strategies are more relevant than ‘exogenous’ facts, at least in the medium run, as size and sector of production.

The role of technological innovation is instead less relevant here, signalling possible weakness in terms of innovation intensity and/or a longer time span for such techno innovation in determining real

productivity effects. This relative ranking nevertheless confirms the results of previous studies on the same firms.
Environmental strategies, specifically auditing schemes, especially ISO14000, and expenses in environmental R&D, appear to improve the fit of the model, and both impact positively on productivity. This is the key result of the paper. Eco-R&D, a specific factor we test here and that is seldom accounted for in its specificity (the next CIS covering eco innovations for the first time will not deal with eco-R&D), re-integrates into the picture the role of technological innovation. It is also worth noting that current expenses associated to environmental costs do not seem to exert any negative effect on performances, as possibly expected. Some criticality emerge concerning waste policies, but not for emissions. Comprehensive innovative SME strategies thus seem to effectively impact on firm performances reducing, or even eliminating, tradeoffs between standard business actions and strategies encompassing environmental objectives. In addition, local idiosyncratic factors like participation and involvement of unions and employees in managerial decisions towards innovation actions correlate positively to productivity. Environmental innovations seem to be well embedded in the multi-innovations set of potential drivers firm may exploit to enhance their competitiveness in the medium long run; environmental strategies do not even have a negative impact in the short run we here focus on.
Future analyses could improve the understanding by studying medium-long run type of lags between the time innovations occur and performances are experienced. The analyses on complementarities or trade off between different eco and not environmental innovations, and within categories, is also a fruitful research direction. Finally, the construction of panel data sets derivable from consequential surveys on the same firms are another potential value added from a methodological ground, also highlighting the role of the dynamics we here deal with by using lags between innovations and performances.

Appendix

Tab.A1-Firms distribution

Sector	N of employees											
	50-99		100-249		250-499		500-999		>999		Total	Total
	%	Abs. Val.	%	Abs. Val.	%	Abs. Val.	%	Abs. Val.	%	Abs. Val.	%	Abs. Val.
Food	0.8	2	1.9	5	1.2	3	0.8	2	0.8	2	5.4	14
Other industries	0.8	2	0.0	0	0.0	0	0.0	0	0.0	0	0.8	2
Paper	1.6	4	0.0	0	1.2	3	0.0	0	0.0	0	2.7	7
Chemical	3.1	8	2.7	7	0.8	2	0.0	0	0.4	1	7.0	18
Wood	0.0	0	0.8	2	0.0	0	0.0	0	0.0	0	0.8	2
Machineries	28.0	72	16.0	41	5.1	13	2.7	7	3.5	9	55.3	142
Non metallic mineral products	9.7	25	6.6	17	1.9	5	2.7	7	0.8	2	21.8	56
Textile	1.6	4	1.6	4	2.7	7	0.0	0	0.4	1	6.2	16
Total	45.5	117	29.6	76	12.8	33	6.2	16	5.8	15	100.0	257
Sector^	**N of employees**											
	50-99		100-249		250-499		500-999		>999		Total	Total
	%	Abs. Val.	%	Abs. Val.	%	Abs. Val.	%	Abs. Val.	%	Abs. Val.	%	Abs. Val.
Food	0.0	0	0.0	0	0.0	0	2.2	2	0.0	0	2.2	2
Paper	1.1	1	0.0	0	1.1	1	0.0	0	0.0	0	2.2	2
Chemical	2.2	2	2.2	2	0	0	0.0	0	0.0	0	4.5	4
Machineries	27	24	23.6	21	9	8	4.5	4	2.2	2	66.3	59
Non metallic mineral products	4.5	4	10.1	9	3.4	3	2.2	2	0.0	0	20.2	18
Textile	3.4	3	1.1	1	0.0	0	0.0	0	0.0	0	4.5	4
Total	38.2	34	37.1	33	13.5	12	9.0	8	2.2	2	100.0	89

^ Note: Our working sample lacks of two sectors with respect to the population. Because the numerical relevance of such sectors is clearly marginal in the population itself we do not consider such drop a major flaw of our working sample.

References

Addison J., Belfield C. (2001). Updating the Determinants of Firm Performance: Estimation Using the 1998 Uk Workplace Employee Relations Survey. *British Journal of Industrial Relations*, vol.39, n.3, pp. 341-366.

Addison J., Schnabel C., Wagner J. (2001). Works Councils in Germany: their Effects on Establishment Performance. *Oxford Economic Papers*, vol.53, n.4, pp. 659-694.

Addison J., Siebert S., Wagner J., Wei X. (2000). Worker Participation and Firm Performance: Evidence from Germany and Britain . *British Journal of Industrial Relations*, vol.38, n.1, pp. 7-48.

Amin, A. (1999). The Emilian Model: Institutional Challenges. *European Planning Studies* , vol.7, n.4, pp. 389-406.

Antonioli D. (2009), Industrial Relations, Techno-organizational Innovation and Firm Economic Performance, *Economia Politica*, forthcoming.

Antonioli D., Mazzanti M., Pini P. (2009), Innovation, Working Conditions and Industrial Relations. Evidence for a Local Production System, *Economic and Industrial Democracy*, vol.3, n.2, forthcoming.

Antonioli D., Mazzanti M., Pini P. (2009), Productivity, Innovation Strategies and Industrial Relations in SME. Empirical Evidence for a Local Manufacturing System in Northern Italy, *International Review of Applied Economics,* forthcoming (current version in Working Paper DEIT n. 21, http://www.unife.it/dipartimento/economia/pubblicazioni/collana-quaderni-dipartimento).

Antonioli D., Mazzanti M., Pini P., Tortia, E. (2004). Adoption of Techno-Organizational Innovations, and Industrial Relations in Manufacturing Firms: An Analysis or a Local Industrial System. *Economia Politica* , vol.21, n.1, pp. 11-52.

Arnal E., Ok W., Tores R. (2001). Knowledge, Work Organization and Econominc Growth. OECD, Paris.

Bartel A., Ichniowsky C., Shaw K. (2007), How Does Inofrmation Technology Affect Productivity? Plant-level Comparisons of Product Innovation, Process Improvement and Workers Skill, *The Quarterly Journal of Economics*, vol.122, n. 4, pp. 1721-1758.

Biondi V., Frey M., Iraldo F. (2000), Environmental Management Systems and SMEs: Motivations, Opportunities and Barriers Related to EMAS and ISO 14001 Implementation, *Greener Management International*, Octobre, n.29, pp.55-69.

Black, S., & Lynch, L. (2001). How to Compete: The Impact of Workplace Practices and Inofromation Technology on Productivity. *The Review of Economics and Statistics* , vol.83, n.3, pp.434-445.

Booth, A. (1995). *The Economics of the Trade Union.* Cambridge: Cambridge University Press.

Brock W., Taylor M. (2005), Economic Growth and the Environment: A Review of Theory and Empirics, in Aghion P., Durlauf S. (eds.), *Handbook of Economic Growth*, Elsevier.

Brunnermeier S., Cohen M. (2003), The Determinants of Environmental Innovation in US Manufacturing Industries, *Journal of Environmental Economics and Management*, vol. 45, pp. 278-93.

Brusco, S. (1982). The Emilian Model: Productive Decentralization and Social Integration. *Cambridge Journal of Economics* , vol.6, n.2, pp.167-184.

Bruvoll A., Bye T., Larsson J., Telle K. (2003), Technological changes in the pulp and paper industry and the role of uniform versus selective environmental policy. Discussion paper 357, Statistics Norway, Research Department, Oslo, Norway.

Brynjolfsson, E., & Yang, S. (1996). Information Technology and Productivity: a Review of the Literature. *Advances in Computers* , vol.43, pp179-214.

Cainelli G. (2008), Spatial Agglomeration, Technological Innovations, and Firm Productivity: Evidence from Italian Industrial Districts, *Growth and Change*, vol. 39, n. 3, pp. 414-35

Cainelli G., Evangelista R., Savona M. (2006), Innovation and Economic Performance in Services: A Firm-Level Analysis, *Cambridge Journal of Economics*, vol. 30, n. 3, pp. 435-58

Caroli E., Van Reenen J. (2001). Skilled-biased Organizational Change? Evidence from a Panel of British and French Establishments. *The Quarterly Journal of Economics* , vol.116, n.4, pp.1449-1492.

Chandler, A. (1992). Organizational Capabilities and the Economic History of the Industrial Enterprise. *The Journal of Economic Perspectives* , vol.6, n.3, pp. 79-100.

Cohen M. Fenn S. Konar S. (1997), Environmental and Financial performance: are they related?, *mimeo*.

Coriat B., Dosi G. (2002). The Nature and Accumulation of Organizational Competences/Capabilities. *Rivista Brasileira de Inovacao* , vol.1 n.2, pp 275-326.

Crepon B., Duguet E., Mairesse J. (1998), Research, Innovation and Productivity: An econometric analysis at the firm level, NBER Working Paper 6696.

Darnall N., Jolley G.J., Ytterhus, B. (2007), Understanding the relationship between a facility's environmental and financial performance, in Johnstone N. (eds) *Environmental Policy and Corporate Behaviour*, Edward Elgar, London.

EC. (2002). New Forms of Work Organization: The Obstacles to Wider Diffusion. European Commission, Final Report. .

Florida R., Atlas M., Cline M. (2001) What Makes Companies Green? Organizational and Geographic Factors in the Adoption of Environmental Practices, *Economic Geography*, vol.77**,** n.3, pp. 209–214.

Foss N. (2005). *Strategy, Economic Organization, and the Knowledge Economy. The Coordination of Firms and Resources.* Oxford: Oxford University Press.

Frondel M., Horbach J., Rennings K., Requate T. (2004), Environmental Policy Tools and Firm-level Management Practices: Empirical Evidence for Germany, CAU economics working paper n.2, Department of Economics, Kiel, *mimeo.*

Getzner M., Ritt T. (2004), Quantitative and Qualitative Employment Impacts of Environmental Innovations, *International Journal of Environmental Technology and Management,* vol. 4, n.4 pp. 375 - 399

Gray W., Shadbegian R. (1995), Pollution, Abatement Costs, Regulation, and Plant-level Productivity, *NBER Working Paper* 4994.

Greenstone M. (2001), The Impacts of Environmental Regulations on Industrial Activity: Evidence from the 1970 and 1977 Clean Air Act Amendments and the Census of Manufacturers, *NBER Working Paper* n.8484.

Griliches Z., Mairesse J. (1983), Comparing productivity growth: An exploration of french and U.S. industrial and firm data, *European Economic Review*, vol. 21, n.1-2, pp. 89-119.

Griliches Z., Mairesse J. (1995), Production Functions: The Search for Identification, NBER Working Paper 5067.

Hall B., Lotti F., Mairesse J. (2008), Innovation and Productivity in SMEs: Empirical Evidence for Italy, NBER Working Papers 14594

Hall B., Mairesse J (1995), Exploring the relationship between R&D and productivity in French manufacturing firms, *Journal of Econometrics*, vol. 65, n.1, pp. 263-293

Hall B., Mairesse J. (2006). Empirical Studies of Innovation in the Knowledge Driven Economy. NBER Working Paper No. 12320.

Hirsch B. (1991). Union Coverage and Profitability Among U.S. Firm. *The Review of Economics and Statistics* , vol.73 n.1, pp. 69-77.
Horbach J. (2008), Determinants of Environmental Innovations, New Evidence From German Panel Data Sources, *Research Policy*, vol.37,n. 1, pp. 163-73
Jaffe A. Palmer K. (1997), Environmental regulation and innovation: a panel data study, *The Review of Economics and Statistics*, vol.79, n.4, pp. 610-619.
Jaffe, A., Peterson, S.R., Portney, P.R., Stavins, R. (1995), Environmental Regulation and the Competitiveness of US Manufacturing: What Does the Evidence Tell Us?, *Journal of Economic Literature*, vol.33, pp.32-63
Kemp R. (1997), *Environmental Policy and Technical Change. A Comparison of the Technological Impact of Policy Instruments,* Edward Elgar, Cheltenham.
Kemp R. (1997), *Environmental Policy and Technical Change,* Edward Elgar, Cheltenham, UK
Khanna M., Anton W. (2002), Corporate Environmental Management: Regulatory and Market-Based Incentives, *Land Economics*, vol.78, n.4, pp.539-558
Konar S Cohen M. (2001), Does the market value environmental performance?, *The Review of Economics and Statistics*, vol.83, n.2, pp.281-89.
Kremp E., Mairesse J. (2004), Knowledge Management, Innovation and Productivity: A Firm Level Exploration Based on French Manufacturing CIS3 Data, NBER Working Paper 10237.
Krozer Y., Nentjes A. (2006), An Essay on Innovations for Sustainable Development, *Environmental Sciences,* vol.3, n.3, pp.163-74
Labonne J., Johnstone N., 2007. Environmental policy and economies of scope in facility level environmental practices. *mimeo.*
Laursen K., Foss N. (2003). New Human Resource Management Practices, Complementarities and the Impact on Innovation Performance. *Cambridge Journal of Economics* , vol.27, n.2, pp. 243-263.
Leiponen A. (2005). Skills and Innovation. *International Journal of Industrial Organization* , vol.23, n.5-6, pp 303-323.
Lundvall B.-A. (2006). Knowledge Management in the Learning Economy. DRUID Working Paper No. 06-6.
Lynch L. (2007). The Adoption and Diffusion of Organizational Innovation: Evidence for the U.S. Economy. IZA Discussion Paper No. 2819.
Machin S., Wadhwani S. (1991). The Effects of Unions on Investment and Innovation: Evidence from Wirs . *The Economic Journal* , vol.101, n.405, pp. 324-330.
Mazzanti M., Zoboli R. (2005), The drivers of environmental innovation in local manufacturing systems, *Economia Politica*, n.3, pp.399-438.
Mazzanti M., Zoboli R. (2008), Complementarity, firm strategies and environmental innovations, *Environmental sciences*, vol.5, n.1, pp.17-40
Mazzanti M., Zoboli R. (2009a), Embedding Environmental Innovation in Local Production Systems: SME strategies, networking and industrial relations, *International Review of Applied Economics*, vol.23, n.2
Mazzanti M., Zoboli R., (2009b), Environmental efficiency and labour productivity: trade-off or joint dynamics?, *Ecological Economics*, vol.68, n.4, pp.1182-94
McKeiver C., Gadenne D. (2005), Environmental Management Systems in Small and Medium Businesses, *International Small Business Journal,* vol.23, n.5, pp. 513–537
Menezes-Filho N., Van Reenen J. (2003). Unions and Innovation: A Survey of the Theory and Empirical Evidence. In J. Addison, & C. Schnabel (eds.), *International Handbook of Trade Unions.* Cheltenham: Edward Elgar.
Menezes-Filho N., Ulph D., Van Reenen J. (1998). R&D and Unionism: Comparative Evidence form British Companies and Establishments. *Industrial and Labour Relations Review* , vol.52, n.1, pp.45-63.
Metcalf D. (2003). Unions and Productivity, Financial Performance and Investment: International Evidence. In J. Addison, & C. Schnabel (eds.), *International Handbook of Trade Unions.* Cheltenham: Edward Elgar.
Michie J., Sheehan M. (2003). Labour Market Deregulation, 'Flexibility' and Innovation. *Cambridge Journal of Economics* , vol.27, n.1, pp. 123-143.
Mohr R. (2002), Technical Change, External Economies, and the Porter Hypothesis, *Journal of Environmental Economics and Management*, vol.43, n.1, pp. 158-168
Naylor R. (2003). Economic Models of Union Behaviour. In J. Addison, & C. Schnabel (eds), *International Handbook of Trade Unions.* Cheltenham: Edward Elgar.
Nielsen P., Lundvall B.-A. (2003). Innovation, Learning Organizations and Industrial Relations. DRUID Working Paper No. 03-07.
Nonaka I., Toyama R., Nagata A. (2000). A Firm as a Knowledge-creating Entity: A New Perspective on the Theory of the Firm. *Industrial and Corporate Change* , vol.9, n.1, pp.1-20.
OECD. (2005). Oslo Manual. Guidelines for Collecting and Interpreting Innovation Data. OECD, Paris.

Pencavel J. (2003). The Surprising Retreat of Union Britain. NBER Working Paper No. 9564.
Pini P., Santangelo G. (2005). Innovation Types and Labour Organisational Practices: A Comparison of Foreign and Domestic Firms in the Reggio Emilia Industrial Districts. *Economics of Innovation and New Technology* , vol.14, n.4, pp.251-276.
Porter M., Van der Linde C. (1995), Toward a New Conception of the Environment-Competitiveness Relationship, *Journal of Economic Perspectives*, vol.9, n.4, pp. 97-118
Rennings K. (2000), Redefining Innovation – Eco Innovation Research and the Contribution From Ecological Economics, *Ecological Economics*, vol.32, n.2, pp. 5-17
Rennings K., Ziegler A., Ankele K., Hoffmann E., Nill J. (2003), The Influence of the EU Environmental Management and Auditing Schemes on Environmental Innovations and Competitiveness in Germany. An Analysis on the Basis of Case Studies and a Large Scale Survey, *Discussion paper 03-14*, ZEW, Mannheim
Schumpeter J. (1934), *The Theory of Economic Development*., Harvard University Press, Cambridge.
Solow R. (1957), Technical Change and the Aggregate Production Function, *Review of Economics and Statistics*, vol.39, pp.312-320.
Solow R. (1974), The economics of resources or the resources of economics, *American Economic Review*, vol.64 n.2, pp.1-14.
Teece D. (1986). Profiting From Technological Innovation: Implication for Integration, Collaboration, Licensing and Public Policy. *Research Policy* , vol.15, n.6, pp.285-305.
Teece D. (1996). Firm Organization, Industrial Structure and Technological Innovation. *Journal of Economic Behavior & Organization* , vol.31, n.2, pp.193-224.
Teece D., & Pisano, G. (1998). The Dynamic Capabilities of Firms: An Introduction. In G. Dosi, D. Teece, & J. Chytry, *Technology, Organization, and Competitiveness: Perspectives on Industrial and Corporate Change*. Oxford: Oxford University Press.
Wooldridge J. (2002). *Econometrics Analysis of Cross Section and Panel Data*. Cambridge, Massachussets: The MIT Press.
Ziegler A., Schroder M., Rennings K. (2008), The effect of environmental and social performance on the stock performance of European corporations, *Environmental & Resource Economics*, Forthcoming.
Ziegler A., Rennings K. (2004), Determinants of Environmental Innovations in Germany: Do Organizational Measures Matter? A Discrete Choice Analysis at the Firm Level, Centre for European Economic Research (ZEW), *mimeo*
Zwick T. (2004). Employee Participation and Productivity. *Labour Economics* , vol.11,n.3, pp.715-740.