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Environmentally-Oriented Innovative Strategies and Firm Performances in Services. Micro-Evidence from Italy

Summary

This paper aims at analysing the role of the environment in innovative strategies based on firm economic performance indicators such as employment, turnover, and labour productivity growth. We exploit a unique dataset of 773 Italian service firms with 20 or more employees comprising 1993-1995 CIS II data on firm innovation strategic motivations and 1995-1998 data on employment, turnover, and labour productivity from the System of the Enterprise Account (SEA). We specify a Gibrat-like empirical model in which the covariates include firm strategies (innovation and environmental), and a set of other explanatory variables and controls. Our econometric findings show a negative link between environmental motivations and growth in employment and turnover and a consequent not significant effect on labour productivity growth. The effect on employment is partly in line with past evidence and may derive from efficiency improvements (dematerialization processes) which also impact on efficiency by reducing workforce number. It is plausible that the net effect derives from the absence of low skilled employment and a creation of high skilled jobs, as a consequence of increased environmental awareness. The effect on turnover shows a negative impact from environmental innovation strategy, implying either a short-medium effect, possibly balanced in the long run by net benefits in terms of higher added value, or a real negative impact, which may be contingent on the observed period, when environmental strategies where not at the heart of strategic management policies. However, productivity-related effects (the core of performance indicators) are not significant. Mainstream hypotheses related to eventual negative impacts are thus not confirmed, although Porter-like effects and virtuous circles between environmentally strategies and performance do not seem to be present.

Keywords: Services, Firm Environmental Strategies, Firm Growth, CIS Survey, Innovation

JEL Classification: C23, D21, O32, Q55

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1. Introduction

The issue of environmental innovation is attracting attention and over the last five years has been an increased interest in environmental (less polluting) technologies, partly because they contribute to the 'Lisbon Objectives' on growth and innovation and the 'Gothenburg priorities' on sustainable development.

Although the empirical evidence is not conclusive, manufacturing has received much attention, given its relatively high impacts in environmental terms, and higher innovation potential. The service sector although it represents about 60-70% or more of total GDP in most OECD countries, has not the same sort of attention in the literature. If it is true that services are relatively more environmentally benign, it is also generally accepted that they are affected to different degrees by Baumol's disease, which reduces their innovation potential, and along a dynamic path potentially undermines increases in environmental and economic efficiency. Using NAMEA panel data, Femia and Panfili (2005) and Mazzanti et al. (2007) show that, from an environmental point of view, services are more efficient than industry, although not by as much as might be expected. The reason perhaps is that service sectors induce matter transformation even though their 'product' is not directly material. Similar evidence emerges from some of the studies on products' Life cycle Analysis and from material flow analyses based on input output frameworks (IPTS, 2006). From a different perspective, Kander (2005) recently observed that there is reason to be sceptical about the idea that the transition to a service economy will bring about dematerialization of production and consequent environmental improvements. This is because the shift to a service economy may be an illusion in terms of real production, if it is generated by a fall in the price of manufactured goods relative to services, which in turn is caused by more rapid productivity growth in manufacturing than in services.

This paper makes four contributions to the empirical literature. First, we provide new (perhaps the first) evidence on how environmental innovation strategies impact on firm economic performance indicators such as employment, turnover, and labour productivity growth. Second, in contrast to other (intrinsically) survey based analyses, we exploit real performance indicators rather than elicited subjective variables. Third, we use both employment and turnover in order to verify possibly different links to innovation as a driving force: labour productivity, the core indicator for firm economic performance is studied as a ratio of turnover and employment. Fourth, again unlike most firm-based studies using surveys, we exploit panel data derived from merging CIS survey data and balance sheet data[1].

[1] The literature includes an original milestone inspired by discussion of the Porter hypothesis and the framework of environmental regulations effects on firm performance and innovation paths (Porter and Van der Linde, 1995; Jaffe et al., 1996). The stream of diverse analyses stemming from this original debate points to a possible complementarity/positive correlation between labour productivity and environmental efficiency. Complementarity may be opposed to the 'substitution hypothesis'. 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

The paper is organized as follows. Section two provides a synthetic, but extensive survey of the literature one co-innovation drivers and effects. Section three describes the dataset, the empirical model and main methodological issues. Section four presents the empirical evidence. Section five summarizes outcomes and provides hints for future research in similar direction.

2. Eco-innovations and firm performances

The aim is to embed our analysis within the wider frameworks of eco-innovation and firms' environmental strategies, in order to spell out to the reader the areas of incremental value added. The survey, which we subdivide into three parts, is also aimed at defining the set of (open) research hypotheses.

A first stream of research deals with the drivers of eco-innovation strategies. One of the earliest studies was the seminal work by Jaffe and Palmer (1997) who studies environmental innovation (R&D and patents), at industry level, which was followed by Brunnermeier and Cohen (2003), which employs panel data on manufacturing industries to provide new evidence on the determinants of environmental innovation. They measure innovation by number of patents and find, that it responds to increases in expenditures on abatement measures, while monitoring and enforcement associated with regulation have no impact on innovative strategies. The European setting has recently been the source of some varied and interesting evidence: Rennings *et al.*, (2003) exploit OECD survey data in order to investigate whether environmental auditing schemes and pollution abatement innovation are correlated. Mazzanti and Zoboli (2005) present evidence for the manufacturing sector at a district level, focussing on an extended set of drivers (environmental R&D, policy induced costs, EMS, industrial relations, other innovations). Frondel *et al.*, (2004) use an OECD survey dataset on manufacturing firms and study internal firm-based strategies, external policy variables, and test drivers for end of pipe measures or integrated cleaner production processes. And for a recent comprehensive analysis we refer to Johnston (2007).

A second stream of research is focussed on eco-innovation and employment effects. The main contributions in this stream include Rennings and Zwick (2001), Rennings *et al.* (2001), Pfeiffer and Rennings (1999)[2]. What is relevant to our study is the main hypothesis that increasing environmental efficiency by environmental innovations strengthens competitiveness and the firm performance, with or without policy stimulus. An ancillary hypothesis is that eco-efficiency investments require higher amounts of

reduction in productivity, since labour and capital inputs are re-allocated from 'normal' production output to 'environmental output'. 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 neoclassic reasoning of assumptions of optimal allocation of resources and the role of input prices.

[2] They offer a synthetic summary of direct and indirect, positive and negative effects of different eco-innovations on employment.

labour. The reasoning is that on the one hand product innovation spurs employment since it creates new demand, while on the other process innovations decrease employment since they are usually labour saving. Some employment compensation may occur as a result of indirect price/market driven effects[3]. It should be noted that this is a two stage process in which first the firm decides whether or not to invest in innovation, and second optimizes the volume of labour following the innovation process.

Rennings and Zwick (2001) is based on a sample of eco-innovative firms for five EU countries, in the manufacturing and service sectors. This is a rather unique study which predominantly provides evidence related to the manufacturing sector but also includes some evidence concerning eco-innovations in the service sector. They find that in most firms employment does not change as a consequence of innovation, but this may be due to the limited period covered by the survey. Econometric results show that, apart from some effects registered for product innovations, eco-innovation typologies do not influence the level of employment, though as expected (Caroli and van Reenen, 2001), according to their evidence environmentally oriented innovation innovations seem to lead to a skills bias effect. Also, end of pipe innovations are related to a higher probability of job losses, while innovations in recycling have a positive effect on employment. Rennings *et al.* (2001) exploits an EU based survey in order to investigate diversified employment effects. Focusing on eco-innovators only, they conclude that process and product innovations tend to increase the probability of a higher stock of labour, while within process innovations and end of pipe technologies have a negative effect on employment. The skill bias is confirmed. In a rather descriptive study, Pfeiffer and Rennings (1999) show that the positive, negative or stable effects of eco-innovations on employment are possibly heterogeneous in terms of types of innovations. The fields where the increase is higher are end of pipe emissions control, waste disposal, and process and product integrated innovations.

Employment effects may be thus be unevenly distributed, with strong negative effects from environmental strategies/policies on low skills intensive industries and potentially positive effects on other industries. It could also be argued that product and process eco-innovation strategies may bring about (potentially negative) net effects on employment, attributable to a destruction of the low skilled labour force (administrative staff) and a creation of high skilled positions (R&D).

Finally, there is a stream of literature that has focused on eco-innovation and firm performances[4]. Konar and Cohen (2001) investigated the effect on firm market performance of tangible and intangible assets, including two environmental performance-related elements as explanatory factors. The empirical results show that both variables for environmental performance are associated with negative and robust impacts.

[3] See also Antonucci and Pianta (2002) and Pianta (2000) for treatments of employment effects from process and product innovations.

[4] We also refer the reader to some papers that cope with the drivers of firm environmental performance including, among others, Foulon *et al.* (2002), Cole at al (2005), Collins and Harris (2003).

Cohen *et al.* (1997) also analysed the relationship between environmental and financial performances. Overall, these authors found that investing in a 'green' portfolio did not incur a penalty and even produced positive returns. On the other hand, greener firms may be exploiting better past profits and productivity performances.

Gray and Shadbegian (1995) use total factor productivity and growth rates for plants over 1979-1990 as performance indicators to test the impact of environmental regulation and pollution abatement expenditures. They found that $1 more expenditure on abatement is associated with more than 1$ worth of productivity losses. They found that, when analysing variation over time or growth rates, the relationship between abatement costs and productivity is not significant. Greenstone (2001) estimates the effects of environmental regulations, using data for 1,75 million observations of plants in the 1967-87 US censuses of manufacturers. Environmental regulations negatively affect growth in employment, output and capital shipments[5].

Finally, we would point to recent EU based studies, that focus on the (short term) effects of environmental strategies on the stock performances of corporations, using standard cross section/panel approaches (Ziegler, Schroeder, Rennings, 2007) and 'event' studies that analyse whether there are exogenous unexpected policy effects on the short term performance of environmentally minded firms. The latter are criticized for their intrinsic very short term focus. Although valuable, and based on official datasets, we believe that the value of evidence focusing on stock market performance is limited since the majority of firms, especially in Italy, are of medium or small sized, and do not appear in stock market data. Innovation dynamics are close to productivity trends which, in the end, are the main engines of firm performance.

This review has highlighted and reinforced the main added value of our paper: the focus on the unexplored realm of services, the use of real firm performance indicators, the lagged structure of the dataset and the large number of firms, sub divided into innovative and non-innovative.

3. Dataset and methodology

3.1 The dataset

The investigation is based on an original longitudinal dataset built by matching data from two different statistical sources: (i) the second wave of the Italian Community Innovation Survey (CIS II) and (ii) the System of the Enterprise Accounts (SEA). The resulting sample is composed of 773 service firms with 20 or more employees for which a wide set of innovative data for the period 1993-1995, and

[5] Much of the current conceptual and empirical research is aimed at disentangling intended and unintended (e.g. merely costs saving) eco-effects stemming from innovations: only those linked to intended 'real' environmental strategies and effects are classified as eco-innovations. A broad definition of eco-innovations encompasses intentional and unintentional actions (Rennings, 2000).

a selected number of economic indicators such as employment and turnover for the period 1995-1998 are available.

Table 1 shows that our sample closely mirrors the full CIS II population in terms of percentage of innovative firms in total firms and overall structure. Table 2 shows the distribution of sample firms by service sectors and size.

Table 1 – A comparison between CIS II population and the sample

	CIS II POPULATION			*SAMPLE*		
Service sectors	Total firms	%	% innovating firms	Total firms	%	% innovating firms
Trade	8,310	43.7	29.3	227	29.4	48.0
Hotels & restaurants	2,186	11.5	19.6	45	5.8	40.0
Transport	2,828	14.9	29.6	230	29.8	47.8
Waste disposal	255	1.3	27.8	19	2.5	31.6
Software & related	972	5.1	54.3	55	7.1	89.1
R&D, engineering, technical consultancy	435	2.3	55.4	37	4.8	75.7
Legal & marketing	677	3.6	34.9	24	3.1	62.5
Security, cleaning, other business services	2,069	10.9	19.3	132	17.1	28.0
Post & telecommunication	55	0.3	10.9	3	0.4	100.0
Financial services	1,237	6.5	61.9	1	0.1	100.0
Total	**19,024**	**100.0**	**31.3**	**773**	**100.0**	**48.6**

Table 2 – The structure of the sample: service firms by sector and size

Service sectors	20-99		100-249		250 and more	
	N.	%	N.	%	N.	%
Trade	88	50.0	64	27.2	75	20.7
Hotels & restaurants	6	3.4	14	6.0	25	6.9
Transport	29	16.5	70	29.8	131	36.2
Waste disposal	5	2.8	4	1.7	10	2.8
Software & related	12	6.8	16	6.8	27	7.5
R&D, engineering, technical consultancy	9	5.1	12	5.1	16	4.4
Legal & marketing	6	3.4	7	3.0	11	3.0
Security, cleaning, other business services	21	11.9	47	20.0	64	17.7
Post & telecommunication	0	0.0	0	0.0	3	0.8
Financial services	0	0.0	1	0.4	0	0.0
Total	**176**	**100.0**	**235**	**100.0**	**362**	**100.0**

We measure service firms' economic performance using three indicators: (i) rate of growth of employment at current prices over the period 1995-1998; (ii) rate of growth of turnover at current prices over the period 1995-1998; and, finally, (iii) rate of growth of labour productivity, measured as the ratio between turnover at current prices and number of employees. As already mentioned these performance indicators are expressed in terms of current prices; thus, they may subject to price change effects.

Great care was taken in the empirical identification of the sector and size dummies which was based on earlier work on these issues (Cainelli *et al.* 2006). Sector dummies were selected to capture sector-

specific technological regimes as well as structural differences between sectors in terms of funding and conducting innovation activities. See the Appendix for a more detailed description.

For the reasons behind innovative strategies such as cost reduction, extending the array of services/products supplied, increasing or penetrating in new markets, developing services with lower environmental impact/output and so on, we constructed for each of these ten innovative strategies considered in the CIS II questionnaire a dummy variable, assigning the value 1 to the responses (d) averagely relevant, (e) very relevant and (f) crucial, and the value 0 to (a) not relevant, (b) low relevant and (c) moderately relevant[6].

Table 3 – Distribution of answers about innovative strategy by aims (%)

Aims	(a)	(b)	(c)	(d)	(e)	(f)	(g)	**Total**
[1] modify the array of services/products supplied	25.0	7.4	11.7	18.4	14.6	11.2	11.7	**100.0**
[2] extend the array of services/products supplied	18.1	2.9	7.4	13.6	25.3	25.0	7.7	**100.0**
[3] *develop services with lower environmental impact/output*	*45.7*	*9.0*	*6.9*	*10.9*	*7.2*	*7.7*	*12.5*	***100.0***
[4] maintain current market shares	25.5	5.1	6.1	14.4	18.9	18.4	11.7	**100.0**
[5] increase market shares	15.7	2.4	3.2	13.0	25.0	34.0	6.6	**100.0**
[6] penetrate new markets	27.4	6.9	8.5	12.5	14.4	19.1	11.2	**100.0**
[7] improve production/plant flexibility	17.6	3.2	7.4	18.1	23.1	22.1	8.5	**100.0**
[8] reduce production costs	13.3	2.7	6.1	17.3	22.6	30.9	7.2	**100.0**
[9] increase the quality of services/products	2.9	1.3	1.9	11.4	25.0	55.1	2.4	**100.0**
[10] improve the workforce job related welfare	8.8	5.3	12.2	25.5	21.8	19.4	6.9	**100.0**
[11] adapt technologies to currently prevailing ones	13.0	6.4	9.3	22.6	22.1	18.6	8.0	**100.0**

(a) not relevant; (b) low relevant; (c) moderately relevant; (d) averagely relevant; (e) very relevant; (f) crucial; (g) no answer

3.2. Empirical model, methodological issues and research hypotheses

The empirical specification in this paper is within the established and well developed literature based on Gibrat's law on proportionate effects. This hypothesis states that the probability of a given proportionate change in size during a specified period of time is the same for all firms in a given industry, regardless of their size at the beginning of the period (Mansfield, 1962). Following Evans (1987a, 1987b), we adopt a 'growth version' of this model, specifying the dependent variable as firm size growth and not firm size at time *t*. The independent variable remains size at time *t-1*. We test this hypothesis for employment, turnover and labour productivity. Although most studies focus on employment as a proxy for size, there are an (increasing) number of investigations on the literature based on other measures of size and performances, from profitability to asset value[7].

[6] We also estimated regressions assigning the value 1 to choices from (c) to (f). some results differ, but not regarding the strategy [3] *develop services with lower environmental impact/output.*

[7] For a recent work which like ours uses size measures such as real gross output, employment and real value added, see Harris and Trainor (2005), who analyse manufacturing sectors in a panel framework to study the relationship between growth and size, rejecting the law in all observed cases. Other recent works dealing with measures other or in addition to employment size are Dunne and Hughes (1994), Delmar *et al.* (2003), Audretsch *et al.* (2004), Del Monte and Papagni (2003), who deal with Italian manufacturing firms in 1989-1997. A very detailed and respected survey in this literature is presented by Santarelli *et al.*, (2006), to which we refer the reader.

According to this literature, it is also relevant to deal with exit/entry flows over the period. Gibrat's law could also be valid for certain defined sub-samples of firms (young, innovative, etc.). From a methodological point of view, this calls for econometric techniques that tackle sample bias.

Finally, in a very recent papers (Lotti *et al.*, 2007) argue that while the law may fail on an *ex ante* basis (that is on the total of firms) since small and medium sized firms (SMEs) grow faster, in an *ex post* 'equilibrium', after the market has cleaned the industry through competition pressures, this law may hold for the core of survivor firms. Short run and long run differences in the validity of Gibrat's law may thus be present, and associated with exit/entry flows and the evolution of industry towards a core set of firms. The period of observation is generally not so long as to detect these differences in the short to long run. Our study in any case is not primarily focused on testing Gibrat's law. Nevertheless, any result should be interpreted as biased towards the short to medium term[8].

The specification we use to empirically test the effects of environmental innovation strategies on firm growth controlling for other firm characteristics and innovative strategies is:

$$(1) \qquad \Delta_3 \ln\left(Y_{i,t}\right) = \ln\left(Y_{i,1998}\right) - \ln\left(Y_{i,1995}\right) = \alpha_i + \ln\left(Y_{i,1995}\right) + \sum_{j=1}^{10} D_strategy_{i,j,1993-1995} + \mathbf{X_i}'\boldsymbol{\beta} + v_i$$

where $Y_{i,1998}$ and $Y_{i,1995}$ are performance indicators for firm *i* in 1998 and 1995, measured either as employment, turnover or labour productivity (measured as the ratio between turnover and employees), $Strat_{i,j,1993-1995}$ is a set of dummy variables, capturing the intensity of each innovative strategy, X_i is the vector of controls, and v_i is the error term with the usual statistical properties.

In order to overcome potential selection bias, we estimated equation (1) using the Heckman two-step procedure (Cainelli *et al.*, 2006). The first step consists of estimating a probit model of a dummy variable. In our case, the latter takes the value 1 if the service firm has introduced a technological innovation during the period 1993-1995 and 0 otherwise, and is 'explained' by a set of variables available for all firms in the sample (innovative and non-innovative). The covariates used in the first stage are the following: a constant term, three geographic dummies (*North-West*; *North-East* and *Centre*), two size dummies (*D100_249* and *D250*), nine sector dummies and a group dummy (*DGroup*). The residuals of this regression were used to construct a selection bias factor, which is equivalent to the Inverse Mill's Ratio. This factor accounts for the effects of all unmeasured characteristics which are related to the selection variable. The Inverse Mill's Ratio is introduced as an extra explanatory variable in the second stage of the Heckman procedure, which consists of estimating the growth equation (1)

[8] Here we cannot assess the role of policies as the driver of innovation, or consequently performance. Nevertheless, if we exclude anticipation strategies, the period under observation is one when major policies were still not implemented at EU and national levels. We can assume therefore that such innovation strategies are purely endogenous and depend on firms' strategic management. This could explain in part the coherent but reduced number of first mover firms focussing on innovation for environmental purposes.

using Maximum Likelihood estimators and using the selection bias control factor as an additional independent variable. In this way, we obtain efficient and consistent estimates of the unknown coefficients of the equations. We check whether including or not controls (size and sector) in both stages (or only in the first stage affects the second stage results). To sum up, the empirical model of reference for the analysis is a model inspired and embedded in the Gibrat's law empirical literature with the emphasis on innovation-like covariates, which tackles the sample bias regarding innovation by setting a two stage Heckman model, which is usual in the literature referred to (see Calvo, 2007; Lotti *et al.* 2001 and Evans, 1987 for discussions on these methodological issues).

We re-specify the main research hypotheses we are testing.

1. The first is related to the effect of (eco) innovation strategies on employment growth [ECO-INNOVATION STRATEGY → FIRM ECONOMIC PERFORMANCES: EMPLOYMENT]. Assigning a specific hypothesis to this link is difficult as it is the net effect on employment levels and growth depending on the 'sum' of different positive and negative effects stemming from innovation changes and innovation adoptions. Generally speaking, in the absence of detailed data on the skill content of the workforce, we can expect that value added oriented strategies to impact positively and cost reduction strategies to impact negatively. In terms of the effects of environmentally oriented strategies, the theoretical and empirical literature has highlighted that these will depend both on the kind of innovation adopted (mainly product vs process) and on the type of workforce involved. It is the matching between these two elements that is important for defining eventual net effects. We can say that negative effects on the low skilled workforce and on levels and growth rates, relatively speaking, are more likely when process innovations are the key strategy of firms in relation to the environment.

Pfeiffer and Rennings (1999) provide a taxonomy of possible effects of eco-innovations, embedded in the wider realms of innovation ←→ employment dynamic relationships specifying hypotheses in relation to product, process, recycling and organizational innovations. Generally speaking, they stress that both positive and negative effects are possible. On the one hand there could be job losses deriving from increases in work productivity linked to the adoption of new technologies. On the other hand, new jobs stemming from increased competitiveness (brought about either by higher cost efficiency and/or by higher market value added potential could arise. Thus, the type and content of eco-innovation matter: process innovations are likely to cause direct negative effects and product innovations direct positive effects. Nevertheless, compensatory or reinforcing indirect effects, probably occurring in a medium long run scenario, are also likely to exist: process innovations could impact positively on final performance through higher productive efficiencies. Then, higher market shares could impact on employment. Product innovations tend to impact positively even in secondary stages, though the degree of complementarity between old and new products is not irrelevant in assessing

employment impacts in equilibrium. According to Pfeiffer and Rennings, and we largely support this view, recycling measures and organizational innovations (EMS) should impact positively, given their labour intensive content and, in the latter case, value adding processes. What matters is how the transition from (i) mere end of pipe measures to more complex eco-innovations, (ii) short run scenarios to long run equilibrium where demand has reacted to innovation strategies and costs saving measures have been fully internalized by firms, evolves and what are the differences along this path of employment effects.

2. In the second hypothesis, [ECO-INNOVATION STRATEGY → FIRM ECONOMIC PERFORMANCES: TURNOVER/PRODUCTIVITY] we can see from the above discussion, that the 'substitution hypothesis' which often derives from normal neoclassic reasoning, tends to hide the possibility that firms adopt environmental innovation in a non-policy BAU scenario. In fact, if the firm is optimizing resource allocation in production (before environmental regulation), 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).

Even heterodox minded authors (Rennings *et al.*, 2001, p.4) state that: "environmentally friendly innovation does not necessarily increase the productivity of a firm, however. They may even reduce productivity and require increasing labour inputs per unit because their are often not motivated by cost reduction or increasing sales (both potential positive drivers of productivity), but by compliance with environmental regulations (Cleff and Rennings, 1999) and therefore the net effect is unclear".

Thus, we can conclude that significant (negative, positive) or insignificant signs may be expected. Positive signs should prevail in a long run scenario, and negative in a short run effect. As our causal structure is short to medium run, we argue that the results are quite open. In addition, productivity effects stem from the composition of employment and value added (turnover effects). As for profitability effects which depend on the sum of cost and turnover impacts, evaluation of the results should take account of what occurs at the level of both employment and turnover. This is possible given the information we posses.

In both cases, then, the relationships between eco-innovation strategies and firm performances are highly sector specific. We are nevertheless prevented from carrying out analyses on specific sub-sectors, given the limited amount of if we disaggregate them.

Finally, we can see that the early 1990s, and this emerges from the shares of 'eco-firms', were characterised by low commitment to improving the environment. A quarter of firms, probably leaders and first movers, may have anticipated the market. If short run effects[9] prevail, and we assume that the

[9] Our lag structure could implicitly encompass time effects ranging from 1 to 6 years, given that the two periods are 1992-1994 and 1995-1998.

market was at that time not yet sufficiently mature to absorb environmental innovation, in terms, say, of higher demand from final consumers or other firms (suppliers, sub-contractors, clients), along vertical and horizontal market relationships, there will be a higher probability of negative effects of eco-strategy on productivity. In 2007 the picture may be different, there is no a stricter set of policy levers in place, even in services, and a more developed markets for eco-products at all stages, with a larger share of firms reinforcing the market and the competition in the market in these areas with higher firm awareness and greater firm commitment.

4. Empirical evidence[10]

4.1 Employment growth effects

Our main finding is of a negative relationship between eco-innovation strategies and firm growth. In addition we find that larger firms grow less. This latter result is consistent with findings such as Evans (1987a, 1987b), who studied manufacturing industries in a Gibrat's law framework, taking growth rates as the dependent variable[11], and Nelson and Winter (1982) who speculate on the empirical results, in terms of weather it is plausible that firm growth initially increases with size but then decreases. It is also consistent with new evidence which, on average, tends to reject the law more often compared to earlier studies that tend to confirm it (Lotti *et al.*, 2007).

In a 'pure' Gibrat framework specifying size in levels, Calvo (2006), like others, finds that smaller firms grow larger. This seems the most standard result we can expect. It should be noted that some authors claim that the validity of the law also depend on the stage of the firm's life cycle, since in start up periods small firms have to increase their competitiveness strategy and investments in order to survive (Lotti *et al.*, 2001). This is the reason why the law is often tested on total firms and on the sub-sample of survivors, for which the probability of validity is generally thought to be higher. As far as services specifically are concerned, our result, though not based on a completely similar model, diverges from the evidence provided by Audretsch *et al.* (2002, 2004). We note in any case that in addition to sector, size and other relevant firm related variables, the period of observation which is often contingent and arbitrary, might influence the extent which the 'law' is confirmed. This is in any case a general statement in empirical studies.

Taken jointly, these outcomes tell us that firm employment growth over 1998-1995 is lower in larger firms and in firms (25% of the total) adopting environmentally oriented innovation strategies. It should be noted that, though ancillary in our analysis, the innovation strategy aimed at preserving market quotas is associated with a negative coefficient on growth, while firms that try to extend market shares through innovations activities appear to grow more in employment terms. A value added oriented

[10] See Tables 4-6.

[11] Gibrat's law fails although the failure decreases with firm size.

strategy, therefore, is more rewarding in terms of performance. We note that here and at other levels of analysis that the inclusion in the second stage of size and sector controls does not affect the results.

One plausible interpretation of the significant negative impact of eco-innovation strategies on employment growth is the following. First, it may derive from efficiency improvements (dematerialization processes) that also impact on firm efficiency indicator through reductions in the workforce. Most environmental intensive processes could be hypothesised to be also labour intensive. A reduction in material and emission flows at the organizational level in the various steps of production and distribution of goods and services could easily be associated with cuts in labour inputs due to technology or services substituted by more efficient structures, processes or completely dematerialized. Such effects could be highly heterogeneous across sectors. Unfortunately, the estimates we carried out on major sub-sectors were not statistically meaningful, probably due to the reduced number of firms per sector. This could be the subject of further research: it may seem trivial but employment effects driven by technological changes may differ from trade to finance to R&D companies.

Nevertheless, and in addition, it would be helpful for future research to disentangle the effects on low and high skilled workers. Although it is evident that the net negative effect is an empirical possibility among others, quite contingent on the period and firms observed, it is also likely that it could derive from the destruction of low skilled employment and the creation of high skilled jobs, as a consequence of increased environmental awareness and strategy. Most environmental strategies (a counter example might be the waste management) are accompanied by a reduction in the low skilled workforce and an increase in highly qualified staff. In terms of numbers, the latter may be impacting less on the net figures, leading to negative impacts.

This is not inconsistent with the evidence from other studies. For example, Pfeiffer and Rennings (2001) assess the net employment effects of technical progress that can be expected from the ongoing transition from end-of-pipe technologies to cleaner production. Empirical evidence is presented on the basis of case studies and panel data, including a telephone survey in German industry. The main result is that cleaner production leads to the net creation of jobs in more firms than do end-of-pipe technologies. However, eco-innovations like other innovations, tend to require higher qualifications. Thus, the demand for skilled and high-skilled labour rises whiles the demand for unskilled labour decreases. The results imply that supporting cleaner production does not conflict with labour market policy. Thus, without the use of additional instruments (e.g., concerning a reduction in labour costs, increasing flexibility of labour markets) technology policy in general, and that supporting cleaner production in particular cannot be expected to make substantial contributions to the solution of mass unemployment in Germany.

An alternative or complementary interpretation is based on the concept of eco-innovations. We can expect that product innovations to be more benign regarding employment effects, since they are linked

to the creation of value added, while process integrated innovations (and to a lesser extent end of pipe technologies) may destroy the workforce, by substituting technological inputs or reducing the layers/steps in the production activity. Rennings *et al.* (2003) explore the determinants of employment changes due to environmental innovations in an establishment. The data stem from telephone surveys in five European countries. Based on the results of discrete choice models, they show that if the most important environmental innovation is a product or service innovation it has a significantly positive effect on the probability of an increase in employment compared with the probability of no noticeable change. In contrast, if the most important environmental innovation is an end-of-pipe innovation it has a significantly positive influence on employment decrease[12].

We stress that these studies rely on subjectively elicited discrete data on employment levels, and exploit a less rich array of firm innovation strategies, which is the core part of our reasoning. It should also be noted that our analysis is related to growth rates, not levels: eco-innovation strategies tend to reduce the rate of growth of firms in employments terms.

4.2 Turnover growth effects

First, the explanatory variables used in the first probit estimation confirm that size and regional and sectoral factors impact on firm innovativeness.

We note some other results – primarily that – environmental strategies are associated with a reduced growth in terms of turnover. This implies that short run effects underlined by the mainstream literature could be in action. Leaders might find it difficult to reap returns from such strategies for the reasons outlined above, or because the intensity (which we do not observe) is not sufficiently high to cause a change in production efficiency and demand through environmental innovation dynamics. We tend to exclude the possibility of real negative effects that may persist in the long run or in the evolution of markets, since such strategies do not arise from exogenous policy impacts, which are more likely to cause persistent negative effects. We opt for the idea that such negative effects are due to first movers acting in still not mature 'market' and institutional environments and to short to medium run dynamics, not in equilibrium.

There is also confirmation of a negative and highly significant link between size and size growth, and a positive effect of strategy aimed at improving the labour conditions of workers ([10] improving job related welfare for the workforce). This at first sight is an unexpected result. We can interpret it from the perspective and the empirical results of recent studies dealing with techno-organizational innovation

[12] Pfeiffer and Rennings (2001) analyse the effects on the basis of case studies on industries. They also rely on discretely elicited variables, the main limitation in our view. Nevertheless, the results are interesting: observed employment changes between 1994 and 1996 are minimal, but it is clear that environmental innovations led to an increased demand for qualified personnel. The research question for the future is whether this creation has a net positive/negative value at firm, sector, or economy level.

(HRM) and firm performance. There is mounting evidence that firm performance is driven by HRM and innovation factors[13]. Other works that have analysed to analyse the labour condition effects of such innovations provide ambiguous evidence, with both negative (stress related) and positive effects emerging (Askenazy and Caroli, 2006; Bain (1997); Gullie (2005)). This may be interpreted as a valued added enhancing effect strictly related to a higher workforce team and higher individual productivity, spurred by associated organizational and HRM practices and even by better job-related motivations. Thus, the win-win innovation-labour conditions (innovations strategy are in effect aimed at enhancing labour conditions and job satisfaction, e.g. HPWP such as total quality management, TQM; teamworking, job rotation etc.) scenarios implemented by firms may be the reason for our result.

4.3 Productivity growth effects

As expected specifications that define labour productivity (turnover/employment) confirm previous results. We summarise the primary elements in our reasoning. First, there is confirmation that innovation strategies linked to improvements in workforce job conditions impact on productivity growth as well as turnover. It is a flag of innovations on the Italian service sector.

Secondly, the drivers we observed as being significant for employment growth (extending market shares has a positive effect), are not present here. This means that stimulating employment growth (leading to lower productivity ceteris paribus) does not significantly reduce firm performance, probably because it also impact positively on turnover (and in effect, although not significant, the sign for strategy 7 is positive). The same is true for market oriented strategies that produce a negative effect on employment: they do not improve productivity, since they also impact negatively on turnover. Thus, overall, the only strategy that pays off is adopting or investing in innovation changes that have a labour-related content, in terms of higher job satisfaction[14]. If HRM, training and innovation are adopted jointly by firms, it is likely that productivity will be enhanced by such complementarity elements that do not undermine or that partly compensate for 'management by stress' effects (Coriat, 1995, 2002), enabling potential productivity gains. More specifically, the relationship between eco-innovations and job quality elements, intermediated by he links to other innovations and HRM strategies, is an unexplored area.

Third, and most relevant to here, employment and turnover effects seem to compensate for one another resulting in an observed insignificant relationship between eco-innovation strategies and productivity. In fact, this derives from a negative turnover impact. Eco-innovations strategies do not

[13] Many contributions since the mid 1990s have highlighted the limited short run effects of strategies biased towards organizational (cost) efficiency and the higher potential for increasing long run performance through innovation (Huselid, 1995; Black and Lynch, 1996, 2001, 2004; Ichniowski *et al.*, 1997).

[14] It may mean that monetary and non-monetary elements re-driving higher job quality and satisfaction. In any case, they are all linked to innovation changes: higher wages, higher qualifications, and better work environments.

show positive links with productivity, but do not appear to undermine growth, even in a relatively short term/market immature market scenario. In a long run scenario of industry equilibrium adjusting to environmental strategies, then it cannot be assumed that productivity would increase: it will depend on the relative strength of eventual employment and turnover rebound growth effects, on which we commented above.

5. Conclusions

The paper aimed to analyse the role of environmental objectives in innovative strategies with respect to firm performances. The usual mainstream-oriented assumption is that environmental aims, given the public good content of production and the optimal allocation of resources in the status quo, are in conflict with the pursuit of 'core' firm performance goals, at least in the short tun. Some approaches have emphasised the role played by environmental strategies, even in the absence of specific policies at firm level. We studied the role of environmentally motivated innovation within the web of innovative dynamics in firms, by analysing the various links between innovation strategies and performances, including environmental and the more usual competition oriented strategies (cost reduction, market, technological, organizational).

We exploited a unique merged database of 773 Italian service firms with 20 or more employees from 1993-1995 CIS data on firm innovation strategic motivations and 1995-1998 original firm performances data on employment, turnover and labour productivity.

Our findings show that there is a negative link between environmental motivations and employment and turnover, while, consequentially, the effect on labour productivity is not significant. The two effects seems to balance each other. Other innovative strategies impact on performance with expected signs. The effect on employment is partly in line with past evidence and is not unexpected. It may derive from efficiency improvements (dematerialization processes) which also have an impact by reducing the (rate of growth of the) workforce. Nevertheless, it would be helpful for future research to disentangle the effects on low and high skilled workers, as well as analysing different service sectors. It is plausible that there is a net effect deriving from the destruction of low skilled employment and the creation of more high skilled jobs, as a consequence of increased environmental awareness and strategy. As far as environmental issues are concerned, then, heterogeneity across services branches is high and might turn out relevant. The effect on turnover is negative impact of environmental innovation strategy (the share of firms is 25%, the lowest among the innovation aspects), implying either a short-medium effect, possibly balanced in the long run by net benefits in terms of higher added value, or a real negative impact that may be contingent on the observed period, during which environmental considerations were not at the heart of strategic management policies. Despite this, productivity-related effects (the core of performance indicators) are not significant. Mainstream oriented hypotheses regarding eventual

negative impacts are thus not confirmed, although, as we have pointed out, Porter-like effects and virtuous circles between environmentally strategies and performances do not seem to appear in this case study. We remark again that in depth studies on specific service sectors are needed in order to point out within services heterogeneity with regard the environmental-economci performances links. Larger datasets are need for such objective.

Finally, and an object for further research, we should point out that the CIS related strategies here are first and foremost an expressed motivation for innovation not an expressed adoption. From the results for employment and to greater extent turnover, they may indicate a bigger relative trade off ex ante rather than ex post, between the management of environmental and economic strategies in the firm. As we pointed out, unintended effects in environmental performance may spur from 'economic' innovation strategies (cost reduction, value added enhancement), leading to a complementary ex post effect between environmental and economic aims. For such an ex post assessment, economic and environmental indicators (emissions, waste, and other impacts) are needed. This is a complementary line of research which would be worth attempting at firm and sector levels.

Table 4 – The impact of innovation strategies on firms' employment growth: estimates

ESTIMATION METHOD	*Heckit*[(a)]		*Heckit*[(a)]		*Heckit*[(a)]	
	Coeff.	*t values*	*Coeff.*	*t values*	*Coeff.*	*t values*
SELECTION EQ.	[1]		[2]		[3]	
North-West	0.436**	2.62	0.483**	3.13	0.478**	3.05
North-East	0.263	1.52	0.324**	2.04	0.324**	2.02
Centre	0.303*	1.67	0.282*	1.68	0.281*	1.68
South	Ref.	Ref.	Ref.	Ref.	Ref.	Ref.
D20_99	Ref.	Ref.	Ref.	Ref.	Ref.	Ref.
D100_249	0.384**	2.66	0.404**	2.71	0.394**	3.35
D250	0.548	4.06	0.634**	5.11	0.630**	5.59
DTrade	0.585*	1.92	0.651**	2.27	0.655**	2.30
DHotel	0.272	0.76	0.403	1.22	0.419	1.30
DTrasp	0.372	1.24	0.443	1.52	0.420	1.47
DPost	6.860**	12.92	7.362**	18.46	7.299**	8.38
DFinan	6.832**	18.68	7.368**	14.81	7.209**	18.32
DComp	1.851**	4.96	1.952**	6.46	1.966**	6.77
DRDcon	1.254**	3.44	1.449**	4.60	1.421**	4.63
DLegmkt	0.815**	1.98	0.966**	2.82	0.947**	2.77
DOthbus	-0.021	-0.07	0.108	0.36	0.122	0.41
DWaste	Ref.	Ref.	Ref.	Ref.	Ref.	Ref.
DGroup	0.442**	2.47	0.390**	2.86	0.388**	2.87
SECOND STAGE EQ.						
Ln(employees$_{95}$)	-0.068**	-3.20	-0.059**	-3.02	-0.026	-1.57
D_strategy_1	…	…	-0.010	-0.19	-0.002	-0.06
D_strategy_2	…	…	0.026	0.45	0.022	0.39
D_strategy_3	…	…	*-0.140***	*-3.40*	*-0.131***	*-3.37*
D_strategy_4	…	…	-0.117**	-2.39	-0.116	-2.38
D_strategy_5	…	…	0.108*	1.86	0.097*	1.74
D_strategy_6	…	…	0.016	0.40	0.002	0.07
D_strategy_7	…	…	0.124**	2.32	0.125**	2.44
D_strategy_8	…	…	-0.034	-0.57	-0.037	-0.66
D_strategy_9	…	…	0.013	0.14	0.023	0.24
D_strategy_10	…	…	-0.019	-0.34	-0.003	-0.07
D_strategy_11	…	…	0.052	1.23	0.057	1.44
Sector dummies	No		No		Yes	
Size dummies	No		No		Yes	
Mills lambda	-0.025	-0.27	0.21	1.10	-0.033	-0.34
Censored obs.	397		397		397	
Uncensored obs.	376		304		304	
Obs.	773		701		701	
Wald chi2(1)	10.24		31.08		48.16	
Prob>chi2	0.0014		0.0019		0.0001	

(a) The regressions also include a constant term
** significant at 5%; * significant at 10%

Table 5 – The impact of innovation strategies on firms' sale growth: estimates

ESTIMATION METHOD	*Heckit*[(a)]		*Heckit*[(a)]		*Heckit*[(a)]	
	Coeff.	*t values*	*Coeff.*	*t values*	*Coeff.*	*t values*
SELECTION EQ.	[1]		[2]		[3]	
North-West	0.234*	1.89	0.344**	2.66	0.367**	2.47
North-East	0.189	1.53	0.255**	1.97	0.269*	1.75
Centre	0.154	1.22	0.196	1.48	0.223	1.42
South	Ref.	Ref.	Ref.	Ref.	Ref.	Ref.
D20_99	Ref.	Ref.	Ref.	Ref.	Ref.	Ref.
D100_249	0.347**	3.22	0.320**	3.04	0.465**	4.12
D250	0.538**	4.82	0.551**	5.21	0.699**	6.43
DTrade	0.406**	2.05	0.464**	2.16	0.418*	1.90
DHotel	0.044	0.21	0.190	0.82	0.163	0.70
DTrasp	0.069	0.37	0.153	0.73	0.125	0.59
DPost	7.364**	8.54	8.979**	7.10	9.286**	6.94
DFinan	3.571**	4.42	3.849**	3.82	3.533**	3.81
DComp	1.580**	3.39	1.711**	4.42	1.712**	4.18
DRDcon	0.830**	2.85	1.056	3.74	1.020**	3.69
DLegmkt	0.744**	2.20	0.853**	2.78	0.819**	2.61
DOthbus	-0.208	-1.04	-0.122	-0.55	-0.123	-0.56
DWaste	Ref.	Ref.	Ref.	Ref.	Ref.	Ref.
DGroup	0.091	0.77	0.028	0.25	0.036	0.32
SECOND STAGE EQ.						
Ln($sales_{95}$)	-0.069**	-4.20	-0.080**	-4.37	-0.062**	-3.25
D_strategy_1	…	…	-0.072	-0.76	-0.059	-0.62
D_strategy_2	…	…	0.122	1.15	0.112	1.15
D_strategy_3	…	…	*-0.144***	*-2.12*	*-0.133***	*-1.96*
D_strategy_4	…	…	-0.058	-0.77	-0.060	-0.79
D_strategy_5	…	…	0.083	0.86	0.066	0.68
D_strategy_6	…	…	-0.002	-0.05	-0.015	-0.26
D_strategy_7	…	…	0.053	0.56	0.061	0.63
D_strategy_8	…	…	-0.114	-1.05	-0.111	-1.00
D_strategy_9	…	…	0.085	0.74	0.109	0.96
D_strategy_10	…	…	0.188**	2.64	0.190**	2.69
D_strategy_11	…	…	0.080	1.26	0.088	1.42
Sector dummies	No		No		Yes	
Size dummies	No		No		Yes	
Mills lambda	-0.75	-6.25	-0.65	-5.0	-0.66	-5.07
Censored obs.	397		397		397	
Uncensored obs.	376		304		304	
Obs.	773		701		701	
Wald chi2(1)	17.61		29.16		35.47	
Prob>chi2	0.000		0.0037		0.005	

(a)The regressions also include a constant term

** significant at 5%; * significant at 10%

Table 6 – The impact of innovation strategies on firms' productivity growth: estimates

ESTIMATION METHOD	*Heckit*[(a)]		*Heckit*[(a)]		*Heckit*[(a)]	
	Coeff.	*t values*	*Coeff.*	*t values*	*Coeff.*	*t values*
SELECTION EQ.	[1]		[2]		[3]	
North-West	0.266*	1.87	0.358**	2.51	0.384**	2.52
North-East	0.184	1.26	0.232	1.57	0.247	1.57
Centre	0.184	1.23	0.173	1.14	0.234	1.43
South	Ref.	Ref.	Ref.	Ref.	Ref.	Ref.
D20_99	Ref.	Ref.	Ref.	Ref.	Ref.	Ref.
D100_249	0.421**	3.59	0.390**	3.50	0.463**	3.95
D250	0.578**	4.80	0.560**	4.85	0.663**	5.87
DTrade	0.437**	1.97	0.488**	2.15	0.468**	2.10
DHotel	0.008	0.03	0.204	0.80	0.170	0.69
DTrasp	0.165	0.78	0.271	1.22	0.246	1.13
DPost	6.460**	9.04	8.823**	7.61	7.573**	8.16
DFinan	4.133**	4.83	4.700**	4.18	4.362**	4.14
DComp	1.443**	3.60	1.626**	4.74	1.599**	4.46
DRDcon	0.924**	3.29	1.151**	4.26	1.114**	4.23
DLegmkt	0.889**	2.46	0.972**	3.02	0.934**	2.87
DOthbus	-0.285	-1.25	-0.156	-0.65	-0.188	-0.81
DWaste	Ref.	Ref.	Ref.	Ref.	Ref.	Ref.
DGroup	0.117	0.86	0.071	0.57	0.053	0.45
SECOND STAGE EQ.						
Ln(productivity$_{95}$)	-0.102**	-3.90	-0.091**	-3.41	-0.102**	-3.47
D_strategy_1	…	…	-0.068	-0.70	-0.062	-0.63
D_strategy_2	…	…	0.057	0.57	0.066	0.67
D_strategy_3	…	…	*-0.027*	*-0.39*	*-0.030*	*-0.44*
D_strategy_4	…	…	0.038	0.50	0.037	0.50
D_strategy_5	…	…	0.024	0.24	0.008	0.08
D_strategy_6	…	…	-0.003	-0.05	-0.022	-0.37
D_strategy_7	…	…	-0.074	-0.74	-0.066	-0.65
D_strategy_8	…	…	-0.108	-0.98	-0.096	-0.87
D_strategy_9	…	…	0.098	0.86	0.133	1.16
D_strategy_10	…	…	0.194**	2.49	0.203**	2.65
D_strategy_11	…	…	0.034	0.51	0.038	0.59
Sector dummies	No		No		Yes	
Size dummies	No		No		Yes	
Mills lambda	-0.66	-6.60	-0.59	-5.36	-0.62	-6.20
Censored obs.	397		397		397	
Uncensored obs.	376		304		304	
Obs.	773		701		701	
Wald chi2(1)	15.24		21.06		23.41	
Prob>chi2	0.0001		0.0495		0.136	

(a)The regressions also include a constant term
** significant at 5%; * significant at 10%

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Appendix

Variables description

Variable	Description
Geographic dummies	
North West	Liguria, Lombardia, Piemonte, Valle d'Aosta
North East	Emilia-Romagna, Friuli Venezia-Giulia, Trentino Alto-Adige, Veneto
Centre	Abruzzo, Lazio, Marche, Molise, Toscana, Umbria
South	Basilicata, Calabria, Campania, Puglia, Sardegna, Sicilia
Size dummies	
D20_99	20-99 employees
D100_249	100-249 employees
D250	259 and more employees
Sector dummies	
DTrade	Trade
DHotel	Hotel & Restaurants
DTrasp	Transport
DPost	Post & Telecomunication
DFinan	Financial services
DComp	Software & related
DRDcon	R&D, Engineering, Technical Consultancy
DLegmkt	Legal & Marketing
DOthbus	Security, Cleaning, Other Business Services
DWaste	Waste Disposal
Organisation	
DGroup	1 if the firm belongs to a business group, 0 otherwise
Innovative strategies	
D_strategy_1	Modify the array of services/products supplied
D_strategy_2	Extend the array of services/products supplied
D_strategy_3	Develop services with lower environmental impact/output
D_strategy_4	Maintain current market share
D_strategy_5	Increase market share
D_strategy_6	Penetrate new markets
D_strategy_7	Improve production/plant flexibility
D_strategy_8	Reduce production costs
D_strategy_9	Increase the quality of services/products
D_strategy_10	Improve the workforce job related welfare
D_strategy_11	Adapt technology to currently prevailing ones

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