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

Quaderno n. 19/2007

October 2007

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Environmentally-oriented innovative strategies and firm performances in services. Micro-evidence from Italy

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Abstract

This paper aims at analysing the role of environmental purposes behind innovative strategies with respect to service firms' economic performance indicators such as employment, turnover, and labour productivity growth. In so doing, we exploit a unique merged database of 773 Italian service firms with 20 or more employees consisting of 1993-1995 CIS II data on firm innovation strategic motivations and 1995-1998 original firm performances data on employment, turnover, and labour productivity, drawn from the System of the Enterprise Account (SEA). The empirical model we specify is based on Gibrat-like approach, where covariates are firm strategies, including innovations strategies and environmental minded strategies, and a set of other explicative variables and controls. Our econometric findings show a negative link between environmentally minded motivations and both employment and turnover growth, while, as a consequence, the effect on labour productivity growth is not significant. The effect on employment is partially in line with past evidence and it may derive from efficiency improvements (dematerialization processes) that also impacts on efficiency through reducing the workforce. It is plausible that the net effect is deriving from a destruction of low skilled employees and a creation of high skilled ones, as a consequence of increased environmental awareness and strategy. The effect on turnover claims for a negative impact of 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, that may be contingent to the observed period, wherein environmental strategies where 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 said, Porter-like effects and virtuous circles between environmentally strategies and performances do not seem to appear in this investigation.

JEL: C23, D21, O32, Q55

Keywords: services, firm environmental strategies, firm growth, CIS survey, Innovation.

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1. Introduction

The issue of environmental innovation has attracted a mounting attention over recent years given the importance tackling the double externality; that is, (i) environmental negative effects and (ii) innovation spillovers. With regard to the current European situation, one can observe an increasing interest in environmental (less polluting) technologies, partly depending on the contribution they can make to jointly reach the 'Lisbon Objectives' on growth and innovation and the 'Gothenburg priorities' on sustainable development (IPTS, 2004).

Although empirical evidence is not conclusive, major attention has been placed on manufacturing, given the relatively higher impacts it has in environmental terms, and the higher innovation potential. Although the service sector represents about 60-70% or more of total GDP in most OECD countries, it has not received specific attention in the literature. Nevertheless, its role should be investigated more in depth both at the firm and industry level. If it is true that services are relatively more environmentally benign, it is also well known that the Baumol's disease affects them with different degrees, reducing their innovation potential, potentially undermining over a dynamic path increases of both environmental and economic efficiencies. This is an innovation related motivation, pointing to the fact that a reduced innovative content, though in presence of lighter overall impact, is worth being examined for its dynamic implications on the economy. Even though the general picture for both industry and services is in favour of a delinking process concerning emissions, and of a positive correlation between environmental and economic (labour) efficiencies, some critical points arise, even including services, confirming that their benign environmental role should not be taken for granted (Mazzanti, Montini, Zoboli, 2007). Using NAMEA data, Femia and Panfili (2005) show that service activities are more efficient from an environmental point of view, though not as much as one could have expected. The reason may be that those sectors induce matter transformation even if the 'product' is not directly material. This also emerges in some cases from studies on products LCA and from material flow analysis based on input output frameworks (IPTS, 2006). Along 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 improvement. This is because the shift to a service economy may be an illusion in terms of real production, if it is instead generated by the fall in the price of manufacturing goods relative to services, which is in turn caused by more rapid productivity growth in manufacturing than in services.

The aim of this paper is to empirically investigate the role of environmental purposes behind innovative strategies with respect to service firms' economic performances. We exploit a unique merged database of 773 Italian service firms consisting of 1993-1995 CIS II data on firm innovation strategic motivations and 1995-1998 original firm performances data on employment, turnover, and labour productivity.

This paper makes four contributions to the empirical literature. First, we provide new and maybe first evidence on how environmentally-minded innovation strategies may impact on firm economic performances indicators such as employment, turnover, and labour productivity growth. This is surely a value added in the eco-innovation literature, but also on the wider field of studies dealing with innovation drivers and effects at empirical level, where service based evidence is also in its infancy (Cainelli *et al.*, 2006). The second contribution is that, differently from other (intrinsically) survey based analysis; we exploit real performance indicators rather than elicited subjective variables. Third, we use both employment and turnover in order to verify possibly different links with innovation as driving force. Labour productivity, the core indicator for firm economics performances, is then studied as a consequence as a ratio of turnover and employment. Drivers are a rich set of firm structural features, and more important eleven innovation strategies, including environmentally obtained ones. Fourth, differently from most firm based studies based on surveys, we exploit a panel structure, merging CIS survey data and balance sheets data. The lagged structure allows us to empirically test the links between innovation strategies and firm economic performances.

The paper is organised as follows. Section two presents a synthetic but extensive survey of the literature one co innovation drivers and effects. Section three outlines the data set, the empirical model and main methodological issues. Section four presents the various empirical evidence. Section five summarises outcomes and discusses hints for future research along this direction.

2. Eco-innovations and firm performance: the state of art

The aim is to embed our analysis in the wider frameworks of eco innovation and firm environmental strategies, in order to clearly define to the reader what the main points of incremental value added are. The survey is also aimed at defining the set of (open) research hypotheses. We subdivide the literature in three parts: first, (i) investigations focusing on eco innovation drivers. We then take a look at contributions focusing on (ii) employments effects of eco innovations and (iii) studies which select firm performance as target indicator, explained by a vector of (environmental) factors.

2.1 The drivers of eco-innovation strategies

One of the first study is the seminal work by Jaffe and Palmer (1997) who study environmental innovation (R&D and patents), at industry level. In a panel framework, they find that higher lagged abatement costs lead to higher R&D expenditures.

US works have been predominant in the nineties. Brunnermeier and Cohen (2003) also employ panel data on manufacturing industries to provide new evidence on the determinants of environmental innovation. They measure innovation by the number of patents and they find, that it responded to

increases in abatement expenditures, while monitoring and enforcement activities associated with regulations do not impact innovative strategies.

The European setting has recently caught up by offering various interesting evidence, though still mainly devoted to manufacturing industries. Frondel *et al.* (2005), 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. Rennings, Ziegler, Ankele, Hoffmann, and 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. The main hypothesis they test is the influence of the «maturity» of EMAS 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. Firms achieving significant learning success with EMAS also show better economic performances.

Horbach (2006) instead 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 form firm strategy to policy related factors. Results show that R&D, environmental regulation, EMS and general organizational changes trigger eco-innovation.

Mazzanti and Zoboli (2005 and 2006) presents evidence for the manufacturing sector at a more contingent district level, focussing on the drivers of different adoptions of innovations. They analyse the effects on innovation of an extended set of drivers (environmental R&D, policy induced costs, EMS, industrial relations, other innovations).

Frondel *et al.*, (2004) also exploit a large set of drivers, ranging from internal firm based strategies to external policy variables, focusing attention on technological process innovation, and 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. Main results are that policy stringency is more relevant for end of pipe innovations, while 'market forces' such as R&D, environmental accounting systems and audits, and cost saving motivations are more relevant for cleaner technologies.

For a recent comprehensive analysis we finally refer to Johnston (2007). Thus, recent evidence seems to suggest that environmental innovations at the technological level are likely to be related to each other: there may be cluster of eco innovative firms, quite separated from other firms. Secondly, environmental organisational innovations arise positively correlated to technological innovations,

though this may depend on which specification of organisational and technological innovation we use. Then, there is some evidence of correlation between eco and non eco innovation.

2.2 Eco-innovation and employment effects

This is another line of research which is ancillary to the level of innovation determinants and is more relevant here. The hypothesis revolves around the employment impact of environmental innovation at firm and industry level, eventually differentiating between direct impacts at firm level and more general equilibrium impacts for the industry or thee economy as a whole. Among others, we refer to papers such as Rennings and Zwick (2001), Rennings *et al.* (2001), Pfeiffer and Rennings (1999)[2]. What is relevant to us is the hypothesis that increasing environmental efficiency by environmental innovations strengthens competitiveness and the firm performance, with or even without a policy stimulus. An ancillary hypothesis is that eco-efficiency investments require higher amount of labour. The hypotheses are that on the one hand product innovation spur employment since it creates new demand while process innovations decrease employment since it is usually labour saving. Some employment compensation may occur by means of indirect price/market driven effects[3]. It is worth stressing that the process is a two stage one: first the firm decides whether or not investing in innovation, and then optimises the volume of labour following the innovation process (Rennings et al., 2001).

The first of the three papers quoted above is based on a sample of eco-innovative firms for 5 EU countries, belonging to the manufacturing and service sector. It is worth noting that this is a rare study where some evidence concerning eco-innovations in the service sector is provided, being absolutely predominant the evidence for manufacturing. The authors analyse the extent to which categories of eco innovation and eco innovation gaols (cost reduction, increase in markets share, environmental motivation) affect employment, controlling for other drivers. Descriptively speaking, it arises that most firms do not change employment as a consequence of innovation, but this may be due to the limited period of observation of the survey. Econometric results show that eco-innovation typologies do not influence the quantity of employment, apart from some effects registered for product innovations, though, as expected (Caroli and van Reenen, 2001), innovations seems to lead to a skill bias effect. Environmentally oriented innovation is skill biased following this evidence. Then, end of pipe innovations are related to a higher probability of job losses, while recycling innovations with a positive probability. As expected, while cost reduction motivations are associated with employment reductions, environmental specific goals are less likely to be associated with job losses.

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

[3] See also Antonucci and Pianta (2002) and Pianta (2000) for a treatment of employment effects of process and product 'normal' innovations.

The second paper exploits an EU base survey in order to investigate the diversified employment effects. The dependant variable is again a discrete employment effect variable. 88% of firms stated that eco innovations do not lead to specific related employment changes (differentiating between total and environmentally related effects), 9% affirm they increase employment, and only 3% state a decrease. Focusing on eco innovators only, conclusions are that process and product innovations tend to increase the probability of a higher labour stock, while, within process innovations, and of pipe technology tend to present a negative effect. The skill bias is confirmed. On a rather descriptive basis, Pfeiffer and Rennings show that the positive, negative or stable effect of eco innovations on employment is possibly heterogeneous by type of innovations. As examples, the fields where the increase is observed higher are end of pipe emission control, waste disposal, process and product integrated innovations.

We note that employment impacts examined by these studies do not shed light on the more relevant labour productivity impact of innovation. The core research question should be if, and by which mechanisms, environmental innovations positively impact on firm productivity, investigating the potentially correlated dynamics concerning different innovations, as presented and discussed in the papers above. Another shortcoming of the aforementioned papers is the intrinsic limited period of observation on which survey studies rely.

Summing up, employment effects represent a key issue. They could be also unevenly distributed, with strong negative effects of environmental strategies/policies for industries intense in low skilled works and, oppositely, potential positive effects on other industries. It could also be argued that product and process eco-innovation strategies may bring about a (potentially negative) net effects on employment, attributable to a destruction of low skilled labour force (administrative staff) and a creation of high skilled positions (R&D).

2.3 Eco-innovation and firm performances[4]

This is together with (ii) a relevant field where our analysis may provide useful incremental food for thought. An interesting paper is Konar and Cohen (2001) who investigated 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 main contribution is to include 'environmental performance' as explanatory variables in estimating intangible assets. Empirical results show that both variables of

[4] We also refer the reader to some papers that cope with the drivers of firm *environmental* performances: among others, the study of Foulon et al. (2002) on Canadian pulp and paper industry, Cole et al. (2004), who exploit UK industry data for industry specific pollution emissions over 1990-2000 merged with industry (i.e. firm average size) and regional characteristics, provides evidence on the forces lying behind pollution intensity at regional level, also taking into account the impact of local policies.

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. 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. 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.

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. 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. Instead, when analysing variation over time or growth rates, the relationship between abatement costs and productivity is statistically insignificant.

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. Evidence 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.

We see that most contributions focus on US experiences and on the relationship between productivity and abatement efforts. What is worth noting is that the literature has increasingly stressed, that intended and unitended effects may potentially disentangled (this is an aim of next CIS that will cover environmental innovation for the first time)[5].

As a final step of the survey, we point the attention to recent, even EU based, studies, that focus the lens to (short term) effects of environmental strategies on stock performances of corporations, by using standard cross section/panel approaches[6] (Ziegler, Schroeder, Rennings, 2007) 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

[5] Much of the current conceptual and empirical research is aimed at disentangling intended and unitended (e.g. merely costs saving in a general meaning) eco-effects stemming from innovations: only those linked to intended "proper" environmental strategies and effects are then classified as eco-innovations. Some may claim that the ecological content could only be assessed ex post examining real environmental impacts, which is in part what we do in this paper. A broad definition of eco-innovations encompasses intentional and unintentional actions (Rennings, 2000).

[6] A recent study on a transition economy worth quoting is Earnhart and Lizal (2007), who exploit a 1996-98 panel for assessing the effects of pollution control on profits.

term lens, claiming from studies analysing such relationship in the medium long run scenario. Although valuable, and grounding on official datasets, we believe that evidence focusing on 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.

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 round the pivotal role of firm productivity.

The extended survey has highlighted and reinforced the main added values of our paper: the focus on the unexplored realm of services, the use of real firm performance indicators, the lagged structure of the dataset the large number of firms, sub divided in innovative and not innovative. Those incremental values should in our eye open the way to further research efforts along those lines.

3. Dataset and methodology

3.1 The dataset

Before describing both our modelling strategy and econometric results, it is worth examining the main characteristics of the dataset and indicators used in the empirical analysis. Our investigation is based on an original longitudinal data-set built up 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 Account (SEA). The resulting sample of this merging 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 a selected number of economic indicators such as employment and turnover for the period 1995-1998 are available.

The statistical representativeness of our sample can be assessed by comparing it with the CIS II population in Table 1. From this table, it can be seen that our sample closely resembles the entire CIS II population in terms of both percentage of innovative firms in total firms and overall structure. The exception is the trade sector, which is slightly underrepresented in our sample. Also, our sample shows a slight bias towards innovative firms. 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
Hotel & 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
Hotel & 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**

In addition, we measure service firms' economic performance using three different indicators: (i) the growth rate of employment at current prices over the period 1995-1998; (ii) the growth rate of turnover at current prices over the period 1995-1998; and, finally, (iii) the growth rate of labour productivity, measured as the ratio between turnover at current prices and the number of employees. As already said these performance indicators are expressed in terms of current prices; thus they may subject to price change effects. In order to account for these price effects, we should need appropriate industry deflators, which unfortunately are not available. However, the use of constant prices is not relevant here, because the time span considered in our empirical investigation is quite short.

Great care was also taken in the empirical identification of the sector and size dummies which were identified on the basis of earlier work on these issues (Cainelli, *et al.* 2006). In particular, 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 of these qualitative variables.

As far as purposes 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 are concerned, we constructed for each of these ten innovative strategies considered in the CIS II questionnaire a dummy variable, assigning value 1 to the following answers (d) averagely relevant, (e) very relevant and (f) crucial, and value 0 to the following other answers (a) not relevant, (b) low relevant and (c) moderately relevant[7].

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

As discussed above, the aim of this investigation is to study firm performance effects of (eco) innovative strategies. The empirical specification we use in this paper can be placed within the established and well developed literature descending from the Gibrat's law hypothesis of proportionate effects. As is known, this hypothesis affirms 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 and 1987b), we adopt a 'growth version' of this model, thus specifying the dependant variable as firm size growth and not as firm size at time *t*. The independent variable remains size at time *t-1*. We test this hypothesis for employment,

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

turnover and labour productivity. Although most studies have focused on employment as size proxy, the literature has also witnessed an (increasing) amount of investigations on other measures of size and performances, from profitability to asset value[8].

According to this literature, it is also relevant coping with the exit/entry flows over the period. The law could be valid for some defined sub samples of firms (younger, innovative, etc..). This calls, from a methodological point of view, for using econometric techniques that tackle sample biases.

Finally, 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 SME grow faster, in an *ex post* 'equilibrium', after the market has cleaned the industry through competition pressures, the law may hold for the core of survival firms. Short run and long run differences in Gibrat's law validity may thus be present, and associated to the exit/entry flows and the evolution of industry towards a core set of firms. It remains that the period of observation is general not so long to detect such aforementioned differences from short to long run. Our study is in any case not primarily focused on the Gibrat's law test. Nevertheless, any result should be interpreted as biased towards the short-medium run. Especially concerning the main focus of the study, the relationship between environmental strategies and performances, we may say that on a market evolutionary basis we should reason around a no mature and not in equilibrium scenario, given that green oriented strategies were in their infancy at the time (some first movers started to emerge) and even today, though more diffuse, are in a still developing path[9].

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

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

where $Y_{i,1998}$ and $Y_{i,1995}$ is the performance indicators of firm *i* in 1998 and 1995, measured either as employment, turnover and labour productivity (measured as the ratio between turnover and

[8] For a recent work that, similarly to us, uses size measures such as real gross output, employment and real value added, see Harris and Trainor (2005), who analyse the 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 richly commented survey of this literature is presented by Santarelli, Klomp and Thurik (2006), to whom we refer the reader. Summing up, they conclude that "only in relation to certain sectors (services) and size classes (the largest firms) the probability of a given proportionate change in size during the relevant period turns out to be the same for all firms. This implies that Gibrat's law cannot be regarded as a law in strict sense, given that heterogeneous patterns of behaviour do emerge across industries and size classes.

[9] We here cannot assess the role of policies as driver of innovation, and consequentially performance. Nevertheless, if we exclude anticipation strategies, the period under observation is one wherein major policies were still not implemented at EU and national level. We may assume thus that such innovation strategies are purely endogenous and depending on firm strategic management. This could partially explain the coherent but reduced number of first mover firms aimed at innovating for environmental purposes.

employees), $Strat_{i,j,1993-1995}$ are a set of dummy variables, capturing the intensity of each innovative strategies, X_i is a vector of controls, and, finally, v_i is the error term with the usual statistical properties.

In order to overcome the potential selection bias of our estimates, we estimated equation (1) using the Heckman two-step procedure[10]. 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 finally 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 (Greene, 2003). This factor accounts for the effects of all unmeasured characteristics which are related to the selection variable. The Inverse Mill's Ratio is then introduced as an extra explanatory variable in the second stage of the Heckman procedure. The second step of the procedure consists in estimating, using Maximum Likelihood estimators, our growth equations (1) 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 affect second stage results. Summing up, the empirical model of reference for the analysis is a model inspired and embedded in the Gibrat's law empirical related literature, with emphasis on innovation-like covariates, which tackles the sample bias regarding innovation by setting a two stages Heckman model, as usual in the commented literature (see Calvo, 2007; Lotti *et al.* 2001 and Evans, 1987 for discussions on this methodological issues).

We here also re-specify the research hypotheses we test. They are mainly two.

1. The first is regarding the effect of (eco) innovation strategies on employment growth [ECO-INNOVATION STRATEGY → FIRM ECONOMIC PERFORMANCES: EMPLOYMENT]. Assigning a specific hypothesis on this link is hard task, being 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 absence of detailed data on the skill content of the workforce, we may expect that value added oriented strategies impact positively while cost reduction ones impact negatively. As far as environmental oriented strategies, the theoretical and empirical literature has highlighted that those depends both on the kind of innovation adopted (mainly product vs process) and on the type of workforce involved. It is the matching between those two

[10] In a similar conceptual environment see Cainelli et al. (2006).

elements that is important for defining eventual net effects. We may say that negative effects on levels and growth rates, relatively speaking, are more likely when process innovations are the key strategy of firms in environmental terms and/or mainly the low skilled workforce is touched.

As a main reference, already quoted above, Pfeiffer and Rennings (2001) provide a taxonomy of possible effects of eco-innovations, embedded in the wider realms of innovation ←→ employment dynamic relationships (Stoneman, 1983), specifying hypotheses for product, process, recycling and organisational innovations. Generally speaking, it is stressed that both positive and negative effects are possible. Main pillars are that on the one hand we could face job losses deriving from increases in work productivity linked to 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 likely to exist: process innovations could impact positively on final performances through higher productive efficiencies. Then, higher market shares could impact on employment. Product innovation impacts tend to impact positively even in secondary stages, though the degree of complementarity between old and new products is not irrelevant to assess employment impacts in equilibrium. According to Pfeiffer and Rennings, and we support this opinion largely, recycling measures and organisational innovations (EMS) should impact positively, given their labour intensive content and, in the latter case, value added creation processes. What matter 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 internalised by firms, evolve and what differences exist along this path concerning employment effects.

2. Regarding the second hypotheses, [ECO-INNOVATION STRATEGY → FIRM ECONOMIC PERFORMANCES: TURNOVER/PRODUCTIVITY][11] we recall from the above discussion, the "substitution hypothesis" which often derives from a usual neoclassic reasoning, which 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 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).

[11] We here bring together turnover and productivity as pure firm performances, compared to employment which is better defined as an effect of innovation, but not a firm performance per se. It is obvious that productivity effects descend from the "merge" of employment and turnover effects.

Even heterodox minded authors (Rennings *et al.*, 2001, p.4) state: "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 may conclude that significant (negative, positive) or insignificant signs may be expected. Positive signs should prevail in a long run scenario, while negative ones in a short run effect. Being our causal structure of short medium run nature, 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 that depend on the sum of cost and turnover impacts, the evaluation of results should take into account 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 specific analyses on sub sectors, given the limited number of data when disaggregating.

Finally, we should observe that the early nineties, and this is emerging from the shares of 'eco-firms', were still characterised by a low commitment towards the environment. A 25% of firms, probably leaders and first movers, may have anticipated the market. If short run effects[12] prevail and we assume that the market was at that time yet not mature to absorb environmental innovation, in terms, say, of higher demand, by final consumers or other firms (suppliers, subcontractors, clients) along vertical and horizontal market relationships, negative effects between the eco-strategy and productivity should be expected with higher probability. Today the picture may be different, considering a stricter role of policy levers, even in services, a more developed markets for eco products at all stages, with a larger share of firms reinforcing the market and the competition on the market on such directions, a higher firm awareness and commitment even in terms of devoted expenses, and finally given that leaders could now exploit past moves by grasping the benefits of strategic innovative choices in the environmental fields.

4. Empirical evidence

Here we summarise the main outcomes of our econometric investigation (see Tables 4-6).

4.1 Employment growth effects

The main result we find is a negative relationship between eco innovation strategy and *firm growth*. In addition larger firms grow less. The latter result is consistent with what found by a seminal paper like

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

Evans (1987a and 1987b), who study manufacturing industries in the framework of Gibrat's law, adopting growth rates as dependent variable[13], and Nelson and Winter (1982) speculations and discussions on empirical results, on the fact that it is plausible that firm growth initially increases with size but then decreases. It is also consistent with new evidence that, on average, tend to reject the law more often with respect earlier studies that tended to confirm it (Lotti, Santarelli and Vivarelli, 2007).

In a 'pure' Gibrat framework specifying size in levels, Calvo (2006), like others, finds that smaller firms have grown larger. This seems the most standard result we may expect. It is worth noting that some claim that the law validity could also depend on 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 also 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 higher. As far as services specifically are concerned, our result, though not based on a completely similar model, is diverging from the evidence provided by Audretsch et al (2002, 2004). We note in any case that besides 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 verified. This is anyhow a general statement in empirical studies. Taken jointly, such outcomes tell us that firm employment growth over 1998-1995 is lower in larger firms and in firms (25% of the total) adopting an environmental oriented innovation strategy. It is worth noting, though ancillary in our analysis, that the innovation strategy aimed at preserving market quotas is associated with a negative coefficient to growth, while firms which try to extend market shares through innovations activities appear to grow more in employment terms. Value added oriented strategy confirm to pay more as far as performances are concerned. We note that here and in other levels of analyses the inclusion in the second stage of size and sector controls do not affect results.

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

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

Nevertheless, and in addition, it would be helpful in future research to disentangle 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 a destruction of low skilled employees and a creation of high skilled ones, as a consequence of increased environmental awareness and strategy. Most environmental strategies (a counter example could be the management of waste) are implemented with a reduction of low skilled workforce and an increase of high qualifications. In terms of numbers, the latter may be impacting less on a net figure, leading to negative impacts.

This is not inconsistent with the (rare) evidence found by other relevant econometric studies. For example, Pfeiffer and Rennings (2001) assess net employment effects of technical progress which can be expected by the ongoing transition from end-of-pipe technologies towards 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 in more firms to a net creation of jobs than end-of-pipe technologies. However, eco-innovations like other innovations tend to require higher qualification. Thus, the demand for skilled and high-skilled labour rises whiles the demand for unskilled labour decreases. The results imply that supporting cleaner production is not in conflict with labour market policy. Thus, technology policy in general and supporting cleaner production in particular can not be expected to give substantial contributions to the solution of mass unemployment in Germany without using additional instruments (e.g. concerning a reduction of labour costs, increasing flexibility of labour markets).

An alternative or complementary interpretation is based on the concept of eco-innovations. We may expect that product innovations are more benign regarding employment effects, sine they are linked to value added creation, while process integrated innovations (and less, end of pipe) may destroy workforce, substituting technological inputs or reducing the layers/steps of the production activity. Rennings *et al.* (2003) explore in fact the determinants of employment changes due to an environmental innovation of an establishment. The data stem from telephone surveys in five European countries. Based on 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[14].

[14] Pfeiffer and Rennings (2001) analyse the effects on the basis of case studies on industries. They also rely on discretely elicited variables, the main limit in our opinion. Nevertheless, results are worth commenting on: 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

Those studies possess a greater detail in terms of innovation adopted, compared to the somewhat crude proxy of innovation strategy we test. On the other side, they rely on subjectively elicited discrete data on employment levels, and exploit a less rich array of innovation strategies of firms, which is the core part of our reasoning. It is also to be remarked that our analysis is carried out in terms of growth rates, not levels: co-innovation strategies tend to reduce the rate of growth of firms in employments terms.

4.2 Turnover growth effects

First, explanatory variables used in the first probit estimation confirm that size, regional and sector factors impact on the innovativeness of firms. Those outcomes are expected and provide a robust framework to the first stage of the analysis.

Regarding impacts on turnover growth, we note some different results. Primarily, environmental strategies are associated with a reduced growth in terms of turnover. This implies that short run effects underlined by the mainstream body of literature could be in action. Leaders may find difficult to reap returns from such strategies, for reasons commented 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 stem 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 not still mature 'market' and institutional environment and to short medium run dynamics, not of equilibrium.

Other worthwhile results are the confirm of a negative highly significant link between size and size growth, and a positive effect of strategy aimed at improving the labour conditions of workers ([10] improve the workforce job related welfare). This is at fist sight an unexpected result. We may interpret it from the perspective and the empirical results of recent studies dealing with techno-organisational innovation, HRM and firm performances. There is mounting evidence that firm performances are driven by HRM and innovation factors[15]. Other works have started to analyse the labour conditions effects of such innovations, with still ambiguos evidence, with negative (stress related) and positive effects emerging (Askenazy and Caroli, 2006; Bain (1997); Gallie (2005)). The interpretation may be that this valued added enhancing effect is strictly related to a higher workforce team and individual productivity, spurred by associated organizational and HRM practices and even by higher job related motivations. Thus, Win win innovation-labour conditions (innovations strategy are in effect aimed at enhancing labour conditions and job satisfaction, say, as examples, HPWP like TQM; teamworking,

[15] Since the mid nineties, many contributions have highlighted the limited short run effects of strategies biased towards organisational (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, 2005).

job rotation etc..) scenarios implemented by firms may be at the heart of our result. We now move to the core of performance indicators, productivity, which synthesises to some extent aforementioned results.

4.3 Productivity growth effects

Specifications that define labour productivity (turnover/employment) as expected confirms previous results. We summarise and note the following primary elements for reasoning. First, there is a confirm that innovation strategies linked to workforce job conditions improvements impact productivity growth, in addition to turnover effects. This is expected on the basis of previous analyses but signals an important point: the core firm performance indicator is spurred by individual and team stronger efforts deriving from higher work satisfaction/quality and/or complementarity between techno-organizational innovations, HRM and job quality/welfare contents. This is plausible, just a bit surprising given that we observe a relatively embryonic period regarding the adoption of HPWP and the diffusion of innovative practices. It is a flag of innovations on the Italian service sector.

Secondly, the drivers we observed significant for employment growth (extending market shares has a positive effect), are not here encountered. It means that such stimulated employment growth (leading to lower productivity ceteris paribus) is not significantly reducing firm performances, probably because it also impact positively on turnover (and in effect, though not significant, the sign is positive for strategy 7). The same is true for the other market oriented strategy that resulted having a negative effect on employment: it does not improve productivity, since it also impact negatively on turnover. Thus, overall, the only strategy that pays is adopting or investing in innovation changes that involve a labour-related content, in terms of higher job satisfaction[16]. If HRM, training and innovation are jointly adopted by firms, it is likely that productivity is enhanced by such complementarity elements that do not undermine or partly compensate, by 'management by stress' effects (Coriat, 1995, 2002), potential productivity gains. This is scope for further research. More specifically, the relationship between eco innovations and job quality elements, intermediated by the links with other innovations and HRM strategies, is a real unexplored area.

Third, and most relevant to us, employment and turnover effects seems to compensate, ending up in an observed insignificant relationship between etc-innovation strategies and productivity. Honestly, this derives from a negative turnover impact. Nevertheless, the main stream approach is not validated, if we take productivity (for comparison with most studies) as leading indicator. Eco-innovations strategies do not show positive links with productivity but do not appear to undermine growth, even in a relatively short term / market immature scenario. Then, in a long run scenario of industry equilibrium adjusting

[16] It may mean monetary and non monetary elements driving higher job quality and satisfaction. They are in any case all linked to innovation changes: higher wages, higher training, and better work environment are among the many factors that could spur form such strategy.

to environmental satrapies, it is not granted that productivity would increase: this depends on the relative strength of eventual employment and turnover rebound growth effects, which we commented above.

5. Conclusions

The paper aims at analysing the role of environmental purposes behind innovative strategies with respect to firm performances. A usual mainstream assumption is that environmental aims, given the public good content of his production and the optimal allocation of resources in the status quo, are in conflict with the pursue of 'core' firm performance goals. Other approaches tend to emphasise the role played by environmental strategies, even in absence of specific policies, at firm level. We study the role of environmentally motivated innovation within the web of innovative dynamics of firms, by analysing the various links between innovation strategies and performances, including environmentally and more usual competitiveness oriented strategies (cost reduction oriented, market oriented, technological, organizational oriented).

We exploit a unique merged database of 773 Italian service firms with 20 or more employees consisting of 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 in the first set of probit regressions, usual controls confirm shared knowledge about the links between firm structural variables and innovation adoptions. Moreover, our investigation show a negative link between environmentally minded motivations and both employment and turnover, while, as a consequence, the effect on labour productivity is not significant. Other innovative strategies impact on performances with expected signs. The effect on employment is partially in line with past evidence and is not unexpected. It may derive from efficiency improvements (dematerialization processes) that also impacts on efficiency through reducing the (rate of growth of the) workforce. Nevertheless, it would be helpful in future research to disentangle effects on low and high skilled workers. It is plausible that the net effect is a possibility among others, deriving from a destruction of low skilled employees and a creation of high skilled ones, as a consequence of increased environmental awareness and strategy. The effect on turnover claims for a negative impact of environmental innovation strategy (the share of firms is 25%, the lowest among innovation aims), 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 to the observed period, wherein environmental strategies where 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 said, Porter-like effects and

virtuous circles between environmentally strategies and performances do not seem to appear in this case study.

As a final relevant point, that opens the way of further research, we point out that the CIS related strategies here exploited are first an expressed motivation behind innovation not an expressed adoption. They may indicate, looking at the results for employment and mostly turnover, relatively more a trade off ex ante rather than ex post, between environmental and economic strategic management of the firm. As commented, unitended effects in environmental performance terms may spur from "economic" innovation strategies (cost reduction, value added enhancement), leading to a complementary ex post between environmental and economic aims.. For such an assessment ex post, economic and environmental indicators (emission, waste, and other impacts) are needed. This is a complementary line of research worth attempting at firm and sector level.

Table 4 – The impact of innovative 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 innovative 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 innovative 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