What Drives Environmental Innovation?

Empirical Evidence for a District-Based Manufacturing System[♦]

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Abstract

Technological innovation is a key factor for achieving a better environmental performance of firms and the economy as a whole, to the extent that helps increasing the material/energy efficiency of production processes and reducing emission/effluents associated to outputs. Environmental innovation may spur from exogenous driving forces, like policy intervention, and/or from endogenous factors associated to firm market and management strategies. Despite the crucial importance of research in this field, empirical evidence at firm microeconomic level, for various reasons, is still scarce. Microeconomic-based analysis is needed in order to assess what forces are lying behind environmental innovation at the level of the firm, where innovative practices emerge and are adopted. The paper exploits information deriving from two surveys conducted on a sample of manufacturing firms in the Emilia Romagna region -Northern Italy- in 2002 and 2004, located in a district-intense local production system. New evidence on the driving forces of environmental-related innovation is provided by testing a set of hypothesis, concerning the influence of: (i) firm structural variables; (ii) environmental R&D; (iii) environmental policy pressure and regulatory costs; (v) networking activities, (vi) other non-environmental techno-organizational innovations and (vii) quality/nature of industrial relations. We estimate various input and output-based environmental innovation reduced form specifications in order to test the set of hypothesis. The applied investigation shows that environmental innovation drivers, both at input and output level, are found within exogenous factors and endogenous elements concerning the firm and its activities/strategies within and outside its natural boundaries. In the present case study, structural firm characteristics appear to matter less than R&D, induced costs networking, organisational flatness and innovative oriented industrial relations. Environmental Policies and environmental voluntary auditing schemes exert some relevant direct and indirect effects on innovation, although evidence is mixed and further research is particularly needed. Although this new empirical evidence is focusing on a specific industrial territory, results concern a large set of hypothesis on potential driving forces of innovation. We thus provide food for discussion on firm environmental innovation strategies, and research suggestions for further empirical works.

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1. Environmental Innovations and environmental policies in industrial settings

1.1 Conceptual framework

Growing evidence suggests that advanced economic systems operate with a decreasing intensity of energy and materials per unit of output. For energy and materials, these trends can be observed over the very long run. In general, the factors behind macro-level decoupling between economic growth and resources can be: (a) market factors, i.e. change in relative prices of basic commodities; (b) technological innovation at the macro and micro level, including structural changes of the sector composition of the economy and 'industry migration'; (c) public policies. The three are dynamically interrelated. Concerning the current European situation, we observe a mounting interest in environmental (less polluting) technologies, partly depending on the contribution they can make to complementarily reach the "Lisbon Objectives" on growth and innovation and the "Gothenburg priorities" on sustainable development (IPTS, 2004)[1].

The issue of environmental innovation in district-oriented local productive system is particularly important given the high density of firms in district industrial devoted areas. This is extremely relevant for some industrialised Italian Regions, like Emilia-Romagna, since cluster or districts of firms may generate critical harmful local "hot spots" in emission and waste production (Montini and Zoboli, 2004). The local relevancy is particularly serious for externalities like river pollution and (urban) landfills. This negative environmental feature could be counterbalanced by the high innovative propensity of district firms that, exploiting networking relationships, knowledge spillovers due to proximity and internal sources, may dynamically increase the environmental efficiency of the district/productive area[2]. The relative rate of growth of externalities and innovation is crucial for determining whether a *Delinking* between growth and environmental externalities is occurring or not. Environmental Innovative capacity, endogenously driven and/or spurred by policies and networking spillovers and agreements, is currently the key issue. Environmental innovations are particularly crucial in industrial local frameworks since they often give rise to a "double externality", providing on the one hand the typical R&D spillover and on the other hand reducing environmental externalities.

Specifically concerning manufacturing, pollutant emissions from the manufacturing industries are main determinants for the general pollution affecting the environment, in Italy and in the European industrial environment. Manufacturing industries apart from the energy production industry, account for a relevant part of total emissions for respective species. They are the principal offenders in the case of methane (CH_4); the transport sector is the most polluting in the case of carbon monoxide (CO), the nitrogen oxides (NO_x) and the non-methane volatile organic compound (NM-VOC). Six air pollutants are considered in the Italian official environmental data. Data refer to air pollution emissions from household consumption (transport, heating and others) and production activities (agriculture, industry and services). Upon examination of the macro sources of emission in Italy it appears that the manufacturing industry is primarily responsible for carbon dioxide pollution and accounts for about 40% in the sulphur oxides emissions too.

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[1] The IPTS report stems from the 2004 Commission communication "Stimulating technologies for sustainable development: an environmental technology action for the EU", which derived from a 2001 European Council that requested the preparation of a report "assessing how environmental technology can promote growth and employment".

[2] Aggeri (1999) calls those informal agreements "innovation-oriented voluntary agreements", where pollution is diffuse, uncertainty is high and innovation becomes the central feature".

1.2 Empirical evidence: the state of the art

We may subdivide the empirical literature in three parts: (i) investigations using environmental Innovation output and/or input indexes as dependant variable, which are the primary interest for our applied analysis, and contributions focusing on (ii) firm/sector pollution indexes, and (iii) firm performances as dependant variables. Since innovation, performances, policy and pollution are intrinsically co-evolving and co-determinant variables at firm level, each contribution may focus on a specific piece of the conceptual "model", depending on both data availability and research aims[3].

It is worth noting that evidence grounding on firm level data possessing richness in details and representativeness is rare relatively to industry-based data since survey based approaches are the only option for data collection (Khanna and Anton, 2002; Lee and Alm, 2004). This also emerges from the above literature review. Jaffe and Palmer point out the need of further applied micro-oriented research (1997, p.618): "given the inconsistency between our findings for R&D and for patents, the highly aggregate nature of the data in this study, and the shortcomings of using compliance expenditures as a measure of regulatory stringency, further research is necessary before these results can be considered conclusive. It is to these topics for future research we now turn. […] Perhaps the best way to overcome the aggregated nature of the data used in this study and to develop a better understanding of the nature of the relationship between regulation and innovation would be to conduct some focused industry study".

We here exploit two survey based investigation on the same firms (in 2002 and 2004), eliciting data respectively on 1998-2001 and 2001-2003 (described in par. 2.1). We aim at providing additional new evidence with detailed firm data covering a full comprehensive set of explanatory factors for innovation. Although specific to the industrial system here studied, our results may allow a generalisation concerning the northern Italian and European industrial situation with respect to the recent trends in environmental innovation. The analysis also opens some new research directions, widening the vector of potential driving forces of environmental innovation in complex and evolving industrial systems.

1.3 Environmental innovation and its drivers: a set of hypothesis

The paper discusses and tests the following hypotheses, mainly assessed by means of econometric analyses[4]:

(1) Policy effect. The role of policies in stimulating innovation is a long debated issue at theoretical and empirical level (Grubb and Ulph, 2002). A good candidate variable for representing indirect policy action (in absence of direct-policy proxies) are the *induced costs* stemming from policy implementation. Expenses seem to be a reasonable proxy for "costs", and most authors use environmental expenditures as a proxy for "policy stringency" (Brunnermeier and Cohen, 2003; Jaffe and Palmer, 1997). However, expenses and costs show different perspectives: expenses are closer to private and public investments, thus representing a close and instrumental consequence of policy action. Instead, costs are referring to all figures of direct, indirect and shadow costs (opportunity costs) associated to policy implementation and compliance with the policy, by both private agents and eventually by society as large (if social market and non-market costs are also accounted for).

[3] We refer the reader to Mazzanti and Zoboli (2005) for a survey of the empirical literature.

[4] We specify in brackets acronyms for explanatory factors used in the econometric section.

Costs can be accounted for as a part for the "achievements" of the policy (although with a possible negative sign) that parallel other achievements on the environmental side. We elicited information on direct environmental costs linked to current expenses, and financial burdens deriving from policies in order to take into account the aforementioned cost-related effect (ENV_COST).

(2) *Eco-Auditing schemes (AUDIT) are positively correlated to environmental innovation.* We include auditing schemes for testing whether voluntary approaches (like EMAS, ISO14000) of environmental management improve, acting as driver, the likelihood of introducing environmental related innovation. Unlike ISO schemes, EMAS requires external communication via an environmental report. We also test the correlation between auditing schemes, which may be defined as part of the environmental organisational innovation strategy of a firm (Rennings et al., 2003), and process/product environmental innovations, by a bivariate probit model. On the link between environmental innovation and auditing schemes we note the recent applied oriented contributions by Horbach (2003) and Frondel et al. (2004), who empirically verify the hypothesis of correlation between environmental process/product innovation and "environmental organisational innovation". Rennings et al. (2003) also analyse the interrelationship between various environmental related innovations, deeply focusing on EMS and associated green organisational corporate strategies innovative from an organisational point of view. Those papers provide preliminary evidence on the links between auditing, as part of a wider environmental organisational innovatory strategy, and environmental technological innovations, suggesting the need of further research on a complex and new issue. From a pure theoretical standpoint, Dosi and Moretto (2001) suggest that eco-labeling, which should enable firms to reap the consumer surplus linked to environmental attributes by identifying "green" products, may induce also perverse effects, such as increased investments in conventional technologies (more polluting with respect to new technologies) before the label is awarded.

(3) *Industrial relations play a role in favouring innovation.* The sign of the relationship cannot be defined ex ante. The mere presence of trade unions is not leading to higher innovative capacity. Different schools of thought tend to see in the presence of unions at the firm level a danger for the efficiency of production processes, or an element of stimulus, pressure, and active interaction with the management. At the empirical level, contrasting results have been reached about the role of unions (Fernie and Metcalf 1995; Addison and Belfield, 2001) and their generalisation would not be granted[5].

Within the economic literature this "industrial relations driver" model opposes to the "management driver" model, and roots on procedures of consultation and handing over of decisional functions, from management to employees. This involvement is activated through the implementation of working groups with operative tasks, and joint commissions by managers, employees and union representatives, which aim at decentralising decisional processes. Union representatives are co-involved for reducing the risks associated to action coordination at a decentralised. This approach may be particularly effective when the aim is to reshape a fordist-taylorist structure.

[5] Valenduc (2001) deals with trade unions as agents of environmental awareness. He stresses, proving anecdotal examples, that the sensitivity to environmental issues is very variable from a branch union to another. Even if there is a long-standing interest of trade unions in taking into account health, safety and environmental issues, it is not always possible to affirm that this is a highest priority. Environmental issues may be either a supplementary tool in order to improve other main areas of bargaining and negotiations (environment is a new dimension), or a specific goal, a new strategic priority, with trade unions acting as stakeholder in environmental policy at regional and local level.

The local production system under investigation is historically highly unionised. Industrial relations quality, in terms of co-operative relationships between management and unions and management and employees, matters for organisational and technological innovation (Antonioli et al, 2004; Mazzanti et al., 2005). We use a vector of synthetic index capturing the quality of industrial relations and unions/employee involvement in management strategies in order to test this link for environmental innovation[6]. To our knowledge the link between industrial relations and environmental innovation strategies has very rarely been tested.

(4) *Complementarity between organisational/technological innovation and environmental innovation*. Exploiting trends for high-performance practices/organisational innovation and process/product innovation in 1998-2001, we test whether environmental innovation is, following possible complementarities relationships[7], positively associated with other innovations. The most recent literature emphasises that the mere introduction of new technologies, without organisational innovation and new human resource management practices, does not seem to support better performances. Bundles of high-performance practices are needed (Arnal et al, 2001). The link between techno-organisational innovation and environmental innovation has rarely been tested to our knowledge.

We use diverse proxies: a total index of organisational innovation practices (INNO_ORG), a dummy for Total quality management (TQM), a synthetic index of technological process and product innovation (INNO_TEC) As training is often considered a high-performance practice linked to organisational innovations (Huselid and Becker, 1996), we include among the set of possible covariates for R&D an index of formal training employee coverage (COV). Finally, another proxy of organisational innovation is the flatness of the organisational structure: it has been argued that flatter organizations perform better in terms of innovative dynamics, compared to Fordist-Taylorist more "centralized" firms (Aoki and Dore, 1994; Womak et al., 1990). Flatter firms should also move easier towards innovation flexibility dynamics rather than defensive strategies (labour cost reduction, labour saving technological process). We capture the element by an index of hierarchical levels on establishment business "functions" (hierarchy ratio): the lower the index, the flatter the firm (HYER).

(5) *Networking activities are (positively) associated to environmental innovation (through environmental R&D).* R&D generally recognised as an important innovation measure and an input for innovation output dynamics (technology invention and adoption) and firm productivity in a second stage. This extends to *Environmental R&D*. this is an indicator seldom available in official statistics: we elicited the value as share of turnover, excluding expenses on workplace safety and environmental security.

The importance of networking relationships, in terms of voluntary agreements and spillovers is high in district industrial areas. Networking activities may partially substitute for size economies of scale in environment characterised by small and medium firms. We elicited data on the source of environmental innovation to test an important hypothesis which recently emerged from the "social capital (SC) literature" (Cainelli et al., 2005;

[6] Our main indicator, ranging between 0 and 1 to represent intensity and quality of management/trade unions/employee relationships concerning firm strategies, is a synthetic index of industrial relations "intensity" concerning high performance practices (IND-REL). It is a comprehensive index enclosing various aspects of the interactions between social parties; it takes into consideration the organisation of mangers/workers joint work groups, employee participation in formal structures with decisional power.

[7] Complementarity may be opposed to the "substitution hypothesis" which derives from a usual neoclassic reasoning. In fact, if the firm is optimizing resource allocation in production before environmental regulations, any additional abatement cost or innovation cost deriving from policy enforcement lead, 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). Substitution dominates under this view.

Glaeser et al., 2002; Durlauf, 2004): the positive relationship between R&D and social capital in an impure public good framework (Cornes and Sandler, 1997), where social capital arises as an intangible assets, defined as firm investments in co-operative/networking agreements.

The necessary joint effort to establish voluntary co-operative schemes characterises most forms of (i) voluntary agreements, (ii) inter-firms infra district cooperation, (iii) inter-firms inter-districts cooperation. The relevance of points (i)-(iii) as engines for innovation and growth at a regional level has increased over the last decades.

Empirically speaking, we use "networking" dummies (presence of cooperation with other firms and cooperation with research institutes in developing innovations for the four identified innovation areas, from emissions to energy: acronyms are NET-suffix) as explanatory variable of R&D in the innovation input regression. We also construct a total networking index ranging from 0 to 1, synthesizing the four dummies (NET-TOT): this represents the networking innovation oriented involvement of firms with other firms and research institutes across environmental realms. To our knowledge the link between environmental-oriented networking strategies (Aggeri, 1999; Aggeri and Hatchuel, 1997) and R&D has never been tested for environmental innovation. The networking effect on innovation is included in R&D using a two-stage estimation procedure, where the hypothesis is networking → R&D → innovation.

Finally, the impact on innovation of *firm structural variables* is assessed by including a vector of control factors. First, economies of scale may spur innovative strategies and reduce the cost burden: either/both largest firms may bear the fixed costs of investing in innovation. We test the hypothesis using the number of employees (including linear and squared terms). The set of covariates also include additional control variables which may act as explanatory factors of innovation. Following the literature on firm innovation, we include the share of revenue in international markets (INT_REV), the share of final market production, complement to subcontracting production (FIN-MKT), the firm sector, using a set of dummies for Machineries (MACH), ceramics (CER) and chemicals (CHEM). Other less innovative and more importantly less environmentally strategic/critical (in terms of polluting outflows) sectors identify the base case. Those dummies also capture a first "district agglomeration effect", as associated to the machineries and ceramic local district agglomerates. Finally, a dummy capturing the membership to national or international industrial groups is also used as control (GROUP).

2. Environmental innovation dynamics in an industrial system

2.1 Data and Context

We ground our applied analysis on a district-based manufacturing local system in Emilia Romagna, Northern Italy. Emilia Romagna is an area of Northern Italy characterised by a high density of industrial districts, it shows a very high level of per capita GDP (around 27.000€ in 2003); and with four millions residents represents the 7% of the Italian population. The industrial system of Reggio Emilia is a complex one, primarily characterised by a high degree of dynamism of the system, with important variations and exceptions to this general feature.

Firms preliminarily included in the universe are those belonging to the manufacturing sector (257 firms, see tab.1a) with at least 50 employees and located in the province of Reggio Emilia in year 2001. The first survey carried out in 2002 was made up of a questionnaire addressed to the Management. The firms responding to the survey were 199. Innovation intensity is high both concerning technological and organisational innovations (Antonioli et al., 2004).

The survey on environmental innovation was carried out by administering a short focused questionnaire to the 199 firms who had joined the first survey. Telephone interviews were made in November 2004. We ended up with 140 out of 197 firms joining the second survey, showing no significant distortion by sector and by size, as shown by tab.1b.

The questionnaire elicited information on (i) process and product technological innovation introduced over 2001-2003, aimed at increasing environmental efficiency in (a) emission production, (b) waste production and management (c) material inputs, (d) energy sources. Then, we asked whether those innovations were (a) produced from within the firm (b) stemming from co-operative agreements with other firms, (c) stemming from co-operative agreements with research institutions, (d) acquired from other firms. Whether innovation was associated to patenting activity was also asked. Further, the adoption of environmental corporate management schemes was elicited. As far as environmental policy is concerned, a question was devoted to whether the firm was subject to policies on (i) emissions and (ii) waste/energy. We asked for how many years the policy had been implemented. Three more questions elicited the expenses on environmental R&D, capital investments and direct costs (current costs plus tax payments, etc..) over 2001-2003. Finally, we asked whether the firm had exploited governmental environmental grants (subsidies) over the past 3 years.

A proof of the good degree of representativeness for the two surveys also comes from the following test (Cochran, 1977) which allows determining, given the universe and the final sample, in addition to a given level of probability, the maximum error we are experimenting.

The formula is:

$n = N/[(N-1)theta^2+1]$;

where n is the sample, N the universe, and theta the error we face (i.e.. 0,05, 0,04).

As far as the first is concerned, n=199 and the universe is 257; the sampling error is equal to 0,046. For the second survey, n=140, so taking N=199 gives barely 0,04, while taking the full universe 0,055. Values of 0,05 or not much distant from that threshold level are generally considered as good.

2.2 Input/output based Environmental Innovation: descriptive analysis

Concerning the specific data on environmental issues, we refer for brevity to descriptive tables in the appendix for a summing up (tab. 2a-c). We here present the extent to which innovation is influenced by size and sector. Concerning output innovations, it does not emerge a clear size effect. Although smaller firms are associated to the lowest (mean) index for all environmental indexes, the percentage of firms involved in environmental innovations is only slightly, if not, increasing by size. The effect is dependant on the environmental realm. Concerning emission-related innovations, firms between 250 and 499 show the highest percentage. Waste innovations are definitely immune from size effects. Energy related innovation instead present an inverted U shape by size: the "innovation peak" is for firms between 500 and 999 employees, the decreasing for the largest ones. When analysing firms that present all four forms of innovations, we note instead a monotonous size effects, from 2%, for smallest firms, to 30%, for largest firms. Looking at the index INNO-TOT (tab.2c), the peak is in association with firms between 500-999 employees.

Environmental auditing is finally presenting a moderate increase by size, though firms with more than 250 employees show a constant percentage index for all classes. Empirical evidence for Germany (Frondel et al., 2004) confirms that ISO typologies dominate EMAS (25% of firms in the German case study, mainly concentrated in the chemical industry), and the latter is more likely to be present above a certain facility size.

By sector, we first note that Textile, as expected (it is historically a low innovation sector), shows the lowest involvement in environmental issues within manufacturing. Concerning the most relevant sectors for numbers of firms, the investigation shows that emission related and material inputs innovations are more likely to characterise the chemical sectors (60% and 50% of firms), while waste management related innovations the ceramic sector (57%). Ceramics has also the highest score (60%) for energy efficiency innovations. All in all, chemical and ceramic sectors confirm to be highly involved in local environmental issues in the Region, and responding with higher innovative efforts.

Turning attention to R&D, investments and environmental costs, elicited as percentage of turnover, once again size effects are not dominating figures. R&D is not associated to any clear size effect. Table 2c shows that both in terms of investments and in terms of firm shares, size cannot be identified as a crucial factor. For capital investments, an inverted U shape arises, with largest firms showing the lowest value. Medium-large sized firms show the highest values. As far as costs are concerned, no size effect emerges, although the highest value is for the largest firms. By sector, we report the highest and lowest observed values: chemical and textile for R&D (1,3% and 0,0%), paper-publishing and textile for capital investments and also for environmental costs (respectively 2,6%/0,0% and 1,7%/0,0%).

To summarize dimensional and sector effects, tab. 2c presents the mean values of output innovations, R&S, Investments and environmental costs for each defined dimensional class and for main sectors. A general conclusion stemming from the descriptive analysis is that sector effects on innovation, as expected, prevail over size effects, on both input and output sides of the innovative process. Environmentally critical sectors like chemical, ceramic and also paper seem to be more involved in innovative dynamics. Medium and medium-large firms emerge overall as the more involved, but the picture is quite heterogeneous by type of innovation and index considered. Although size effects on innovation only weakly emerge from the case study, we should point out that a stringer structural break could have been observed if firms under 50 employees had been included. Firms under that threshold represent the 50% of the productive structure of the area. Size and sector effects will be further investigated in the multivariate analysis that follows, in order to find more robust evidence.

2.3 Methodological issues and innovation modeling

There is no shared theoretical model for studying innovation determinants both at industry and firm level. In effect it is very difficult to specify a theoretically satisfying structural or reduced form equation for both input and output innovation (Jaffe and Palmer, 1997), as, for instance, a "production function" approach. In addition, the set of potential explanatory variables is large, ranging from firm structural characteristics and firm performances, to exogenous factors, like policies, to organisational and technological dynamics, belonging both to the specific environmental arena and to other strategic business areas which nevertheless may exert indirect influence on environmental innovations. One aim of the paper is the attempt to extend the usual core of driving forces which is often restricted to environmental-related factors and some control elements. At a conceptual level, we here extend the usual linear innovative process, which mainly link innovation to R&D as input, towards a richer and more extended "innovation production function". We claim that when studying innovation output and input proxies from an applied perspective, a feasible and plausible way is to define reduced forms which attempt to explain innovation by exploiting a theoretically consistent set of covariates (Cassiman and Veugelers, 2002). This is a usual practice within the technological and organisational innovation oriented literature, which broadly exploits the frame of a "knowledge production function" (Griliches, 1979) and then in the specific sub-realm of environmental innovation[8] (Brunnermeier and Cohen, 2003; Jaffe and Palmer, 1997; Khanna and Anton, 2002; Lee and Alm, 2004).

The "pillars" giving robustness to the study, in absence of a theoretically based reduced form, are sample representativeness, the quality and quantity of firm level data, and the way we cope with endogeneity, omitted variable issues and other potential flaws affecting the analysis.

A preliminary analysis must be carried out for studying the full correlation matrix, concerning all potential covariates, dropping high-correlated potential regressors. This first selection is aimed at reducing collinearity problems, selecting a limited set of covariates for testing each specific hypothesis. The outcome is a matrix of *selected* potential explanatory variables (correlation values for selected regressors are shown in tab.3). Besides few variables indexes, which will be consequentially cautiously introduced, the final correlation matrix shows low figures concerning main independent variables. Concerning regression analysis, a "from general to particular" backward stepwise method is applied.

(a) Innovation output

In order to perform this exercise, we estimate a sort of 'knowledge production function' (Griliches, 1979). The knowledge production function expresses the relationship between innovation output and innovation inputs within the 'conceptual' framework[9] of a production function:

(1) $INN_{i,t} = \beta_0 + \beta_{1,t}(\textit{structural firm features}^{10}) + \beta_{2,t/t-1}(\textit{environmental policy}) + \beta_{3,t}(\textit{environmental R\&D}) + \beta_{4,t}(\textit{environmental direct costs}) + \beta_{5,t-1}(\textit{techno-organisational innovation}) + \beta_{6,t-1}(\textit{industrial relations}) + e_i$

where INN_i represents the environmental innovation output of firm i, and e_i the error term with usual properties. β_0 is the constant term, β_{1-8} the set of coefficients associated to explanatory variables, where (t) stays for 2003-2001 and (t-1) for 2001-1998.

[8] Hansen et al. (2001) present an analysis of case studies regarding environmental innovations in small and medium sized enterprises, for five European countries. The study reveals a great variety in factors driving the process: character of environmental innovation, regulatory setting, firm strategic orientation, network relations, sectoral influence. Innovative capability emerges as the result of the interplay between different driving forces.

[9] Even without assuming the usual neo-classical properties concerning production inputs.

[10] Size, market features (national market share, subcontracting share), sector, district membership, etc...

From the econometric point of view, the estimation poses at least two problems. First, heteroskedasticity, as it is often found when cross sectional data are used, may reduce the efficiency of econometric estimates. Thus, all estimates are carried out adopting a 'robust' estimator which addresses such source of distortion. Secondly, there is a potential endogeneity when investigating the determinants of innovation. Panel dataset may be a better framework to cope with it. Nevertheless, the nature of techno-organisational innovation, intangible assets, networking and policy-related data, all potential drivers of innovations, often prevent the setting up of proper panel dataset given most factors are definable quasi-fixed or slow evolving (Huselid, 1996; Brynolffson et al., 2002). A way to deal with the problem is by introducing a vector of 'lagged' term into the regression (thus specifying an hybrid cross sectional model) for all relevant covariates (for an example see Khanna and Anton, 2002). Exploiting the two survey waves, most of our drivers are temporally preceding innovations (2001-2003). For R&D, we use both the elicited 2001-2003 value and the predicted values stemming from a first stage R&D regression, in order to cope with endogeneity between R&D and innovation. Though the direction of causality is not ambiguous in this case (from R&D to innovation), the use of a two stage procedure may help making estimates more robust (see par.3.2).

When estimating a total innovation index, ranging between 0 and 1, we face a limited but continuous variable. We deal with *fractional variables* (Papke and Woolridge, 1996), continuous but limited. It is possible to affirm that there is not an "optimal" econometric model for studying fractional variables. Although OLS estimates in this case may suffer from the same distortions characterising the use of linear models for binary variables, the often used one limit or two-limits Tobit models are not a panacea. It is possible to verify that estimates deriving from OLS, OLS based on (log) transformations (when this is possible given the observed "0s") and Tobits do not differ significantly as far as coefficient signs and "relative" statistical significances are concerned (Pindyck and Rubinfeld, 1991), although coefficient "levels" are different across models. Since the aim is not (here) the estimation of elasticity, this may be considered a less severe flaw. Thus, OLS corrected for heteroskedasticity is used as econometric tool for estimation.

(b) *R&D Innovation input*

We estimate a simple reduced form equation for R&D investments per employee (Jaffe and Palmer, 1997). The log value is often used as dependant variable. Nevertheless, environmental R&D is not positive for many firms, which report a zero corner value. This is plausible with other evidence (Horbach, 2003). Thus, R&D equations are first estimated by means of OLS corrected for heteroskedasticity: OLS is nevertheless generally inconsistent when facing "corner solution models", both using the entire sample and a subset of it. Those models arise when y takes on the value zero with positive probability but it is a roughly continuous random variable over positive values. As discussed in length by Woolridge (2002, ch.16-17), those models are often wrongly labeled censored regressions, though the issue is not data observability as in censoring and truncation. Corners solutions models refer to a hypothetical economic model where the zero value is the "optimal", and observed, corner solution for most agents. As a consequence, more appropriate Tobit (Type I Tobit model, following Amemya's definition) and two stage heckit/two-tiered models are used and compared. Finally and alternatively, a probit model specifying as "1" firms with positive R&D is also tested.

2.4 Econometric results

We present and comment results for the set of hypothesis formulated above. Different regressions are investigated (tab.4a-b). We examine various environmental-related output innovation equations and environmental R&D equations.

For output innovations, given that data presents simultaneity of innovations, R&D, environmental costs and auditing schemes (all defined as trends over 2001-2003), potential endogeneity should be tested, though, as we remarked above (par. 4.2): (i) emphasis is on trends; this is plausible given the slow-evolving nature of such variables. (ii) The causality nexus is clear in this case, if compared to the innovation-performance link, intrinsically subject to the reverse causality conceptual problem. In fact, R&D is an input, costs are an input and partially policy-driven, auditing schemes may be correlated to but hardly "explained" by innovations. Nevertheless, endogeneity is properly checked by implementing a Wu-Hausman test (Woolridge, 2002, p.118-20), which is a regression-based form of the Hausman test: fitted residuals or predictions estimated from a first stage regression using *all* instruments for the potential endogenous variable (x) are used as covariate in a regression of y on x and all the previous used instrument, including a constant (remember that all exogenous variables are used as instruments for themselves). The usual t test statistic on the targeted variable is a valid test of endogeneity. In other words, if the "object" variable is not significant we may assume its exogenity and IV estimation is not needed. In our case, a significant coefficient emerges only for environmental costs in some of the regressions, and never for R&D and auditing. The outcome confirms ex ante expectations, since costs were, relatively speaking, the most likely factor to present endogeneity problems. We then introduce in those cases the associated fitted values as a further estimation option in this case[11]. Further, R&D and costs are introduced both separately and jointly as explanatory variables, to check whether their positive correlation may lead to distortions in estimates.

2.4.1 Input innovations

We begin commenting the outcomes for the *input innovation* equations, for R&D and environmental investments, following a logical consequential reasoning starting from input and then moving to innovation outputs.

Concerning both input proxies, two analyses are attempted: one using the log-value per employee as dependant variable in a "corner solution/censoring model" and the other, given the high number of "zero", using a probit model where positive values are associated to one. In the first case (continuous R&D variable), Tobit and two-stage procedures are used as estimation tools.

Probit analysis on environmental R&D shows the following outcome. Ceramic and chemical sectoral effects are the only structural features associated to the firm which result to significantly drive R&D. Size-related effect do not emerge. In addition, the share of final market production tends to positively explain the amount of resources devoted to R&D. Other firm related factors affect R&D, all with a positive sign: the quality of industrial relations within the firm (proxied by the index IND-REL, which derive from information on the trade unions involvement in internal labour markets, organisational practices, and participative / consultation

[11] See Woolridge (2002, pp.90-93) for a comprehensive discussion on "two-stage least squares".

processes), the number of hierarchical levels (which represent a proxy of "organisational flatness", read in the opposite way), and to a lesser extent organisational innovation (number of innovative organisational practices).

It is worth noting that the covariate capturing the firm involvement in operative and networking activities specifically devoted to environmental innovation (NET-TOT) exerts a positive effect on R&D, though significant only at 10% level (quite close to the 5% threshold). The index concerning the total networking effect across all environmental innovation realms actually hides possible different links: in fact only networking for emission-related innovation arises highly significant if indexes are separately introduced. All in all, networking effects turn over size effects, highlighting a theoretically defined complementarity between R&D and networking investments as "inputs" of innovative outputs.

When specifying R&D/employees as dependant variable, we note that the OLS estimates perform poorly in terms of overall regression fit and coefficient robustness. The censored nature of the variable may be the underlying reason. We thus use a two stage procedure (hurdle model), finding no evidence of a two-tier process (last column tab.4b). The model fit is nevertheless good. Networking, organisational factors (flatness), industrial relations elements and productivity performances affect R&D as shown in tab.4b. A positive role of training (COV) also emerges, though the coefficient significance depends on the inclusion of other positively correlated "high-performance" practices and industrial relation proxies, thus is not robust. Auditing schemes do not matter. As far as networking is concerned, when dummies for specific environmental realms are included, it emerges that energy-related cooperation is the only and most significant, maybe driving the total networking effect. Summing up for networking, this preliminary evidence highlights the role of cooperation with other firms and research institutes, with specific evidence on emission and energy contexts. The regression including energy-related networking dummy is associated to higher fit measures.

2.4.2 Output Innovations

As far as *output Innovation* proxies are concerned, we observe the following outcomes analysing an index (ranging from 0 to 1)[12] capturing all four realms of innovation (INNO-TOT). OLS robustly corrected estimates show (tab.4a) that (i) R&D and costs are significant while investments are not (regression 4); (ii) Policy drivers, like grants, in addition to policy driven environmental costs (which we may intend as a proxy of indirect effect of policy) are also significant. Auditing schemes are significant (with EMAS dominating over ISO14000). Sectors and size do not influence the adoption of innovation measured in terms of "intensity". Scale economies emerge through the effect of "group membership". Finally, confirming an already mentioned evidence for specific realms, innovative activity is more intense in flatter organizations and in firms where the quality of industrial relations is good in terms of workers and unions participation to decisional processes on high-performance and organisational strategies.

2.4.3 Main outcomes

We sum up the main outcomes. As far as firm structural features are concerned, size effects are significant only when considering innovative inputs. All in all, the effects exerted by group membership and networking

[12] The index takes values 0; 0,25; 0,50; 0,75; 1. As discussed, it may be analysed using different econometric specifications.

activities, two relational dynamics, here represent the "scale economy" driving forces, turning over pure size effects. This evidence is highly interesting even for policy purposes. Market features also do not matter. By sector, effects on innovation are not strong but more evident: the chemical and ceramic sector emerges as moderately important drivers in some cases.

Other firm characteristics instead influence the adoption of innovation more evidently: organisational flatness is generally emerging a driver of innovative output, and the variables concerning industrial relations, mainly the synthetic index IND-REL, exerts overall a positive influence on adoption. Though the correlation between size and this industrial relations index is not extremely high, the positive value may suggest that some size effects are better captured, in our estimates, by industrial relations dynamics occurring in medium-large firms. Nevertheless, more specific variables of employee involvement do not result significant. More research is needed on the role of trade unions and employee participation concerning environmental innovation dynamics.

Environmental costs (current expenses and policy related expenses) instead arise as a core driver for most innovative output specifications. Environmental grants are exploited by a very limited number of firms, thus their positive statistical effect is to be cautiously interpreted.

Turning back to R&D, we observe that it arises as a primary driver for most innovation output realms. It is interesting to note that networking activities with other firms and research institutes are a driver force of R&D and investments. There is some evidence in favor of a causal chain link like: networking/cooperation → R&D → innovations. This link emerges when focusing on the total index of innovation. More research is needed. It is worth noting that the assessment of relevant networking and spillover effect concerning R&D/induced innovation would justify the implementation of specific subsidies and/or even higher Pigovian taxes, with respect to the case of innovation dynamics which are completely internal to the firm (Rosendhal, 2004).

Overall, technological and organisational innovations and high performance practices, including training, seem not to be correlated to environmental innovation[13]. The hypothesis that firms adopting high performance practices and techno-organisational innovations also present higher innovation concerning environmental issues is here not validated. No link between R&D and training, as potential intangible complementary inputs, also arise. Nevertheless, the relative flatness of the firm seems to influence both more innovative environmental strategies and non environmental techno-organisational ones. Thus, though a direct link is not emerging, environmental and non environmental innovation realms may be driven by the same innovative-oriented structural dynamics (flatness, participatory schemes, and good industrial relations) characterizing the firm. Given the scarce evidence on this point, and the complexity of the relationship, further evidence is needed for achieving new and more robust insights.

Within the realm of "organisational innovations", a clear positive association is shown to exist between all output innovations and voluntary auditing schemes. When considering the total innovation index (INNOTOT), EMAS certification emerges as primary factor. This is consistent with the "incremental" nature of EMAS with respect to ISO14000 (though we note that EMAS-certified firms are currently not many).

[13] Instead, training and techno/organisational innovations are positively correlated. This reinforces the present evidence: environmental innovation seems, accordingly to our data, disentangled from other innovation and high-performance practices, at least if we observe their direct relationship.

3. Concluding remarks

The paper provides new empirical evidence on the determinants of environmental-linked innovation at a microeconomic level. We exploit a recent and rich survey based datasets covering market and non market firm features. The focus is on local production system grounding on industrial districts, which is a quite unexplored case in the literature on environmental innovation. The paper adds new insights on the complex analysis concerning the driving forces of environmental performance at firm level, since it explicitly considers the relevancy of networking dynamics, techno-organizational innovations, environmental R&D and industrial relations, as long as the more usual policy-related and structural variables, among the potential driving forces of innovation in district-oriented industrial systems. The investigation has shown that environmental innovation drivers, at both input and output levels, are to be found within (i) exogenous factors, (ii) endogenous dynamics concerning the firm and its activities/strategies within and outside its boundaries, and (iii) both environmental and non environmental structural elements of the firm. Voluntary eco-auditing schemes also appear to play a strong role in favoring innovation output dynamics, even more than input factors as R&D.

Firm size is never significant, while sectoral/district influence is somewhat positive, but impact is weaker with respect to other drivers. More than size, group membership and networking arise as positive innovative drivers, respectively for innovation output and R&D: this means that "horizontal economies of scale" and cooperative agreements/strategies might matter more than internal economies of scale, which are instead more relevant for non environmental techno-organizational innovation dynamics. Those latter are in fact not here correlated to environmental innovations and R&D, validating this statement. This evidence is new and it is possibly representing an added value for understanding innovation environmental dynamics and for orienting policy actions in local systems. Given the high percentage of small-medium sized firms (with less than 100 employees), this may represent good news for environmental performance of the local system: standard economies of scale are not a priority for the environment, although trade offs may emerge with other realms, since size appears relevant for techno-organizational innovation and high-performance practices like training. Another view would instead focus on the role of J-firm characteristic like a less hierarchical structure and a participatory environment in favoring the adoption of both environmental and non environmental innovations. This is the evidence arising from the industrial environment here analyzed. Trade offs could be mitigated under this perspective.

It is then highly important to investigate, for any innovation typology, what the drivers are in terms of "internal" structural firm features and external networking relationships. Our investigation suggests that networking relationships aimed at building up a social capital, instrumental to creating and introducing innovations, and "membership" to a district or a group, are factors as much as important, if not more, than firm structural characteristics. It is worth noting that a three-factor link might emerge: networking "investments" and research-oriented relationships are possibly influencing (and theoretically being complementary to) R&D/environmental investments. Then, and consequently, R&D is one of the inputs driving the adoption of innovative output. Further applied research is suggested on this key new topic to provide some generalization. Further research is also needed towards the understanding of the interaction effect on innovation of environmental and technology policies.

Summing up, the "innovative driver box" may consist of the following main factors: (i) firm involvement in groups and networking activities, (ii) "innovative oriented" industrial relations and a less hierarchical organization. These driving factors contribute to drive environmental innovations, together with environmental (policy related) costs, R&D and, final but not less important, voluntary environmental schemes. External-oriented firm behavior, environmental specific R&D, the reshaping of organization structures and management-employees relationships along more flexible and innovative scenarios, and policy-related elements all may induce innovations impacting firm strategies and firm behavior. Although specific to districts and to the industrial system here studied, our results may represent a first attempt to assess a comprehensive framework of innovation drivers in the environmental arena. The analysis also opens some new research directions, widening the vector of potential driving forces of environmental innovation when dealing with complex and evolving industrial systems.

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Tab.1a: Total firm population

Sector	no. of employees						
	50-99	100-249	250-499	500-999	> 999	Total (%)	*Total (Absolute value)*
Food	0,78%	1,95%	1,17%	0,78%	0,78%	5,45	14
Other Industries	0,78%	0,00%	0,00%	0,00%	0,00%	0,78	2
Paper-Publishing	1,56%	0,00%	1,17%	0,00%	0,00%	2,72	7
Chemical	3,11%	2,72%	0,78%	0,00%	0,39%	7,00	18
Wood	0,00%	0,78%	0,00%	0,00%	0,00%	0,78	2
Machineries	28,02%	15,95%	5,06%	2,72%	3,50%	55,25	142
Non-Metal Minerals (Ceramic)	9,73%	6,61%	1,95%	2,72%	0,78%	21,79	56
Textile	1,56%	1,56%	2,72%	0,00%	0,39%	6,23	16
Total (%)	45,53	29,57	12,84	6,23	5,84	100,00	
Total (absolute value)	117	76	33	16	15		257

Tab.1b: Interviewed firms (2004 survey)

Sector	no. of employees						
	50-99	100-249	250-499	500-999	> 999	Total (%)	*Total (Absolute value)*
Food	0,00%	0,00%	1,43%	1,43%	0,71%	3,57	5
Other Industries	0,71%	0,00%	0,00%	0,00%	0,00%	0,71	1
Paper-Publishing	2,14%	0,00%	2,14%	0,00%	0,00%	4,29	6
Chemical	3,57%	2,86%	0,00%	0,00%	0,71%	7,14	10
Wood	0,00%	0,00%	0,00%	0,00%	0,00%	0,00	0
Machineries	27,14%	17,14%	4,29%	2,86%	5,00%	56,43	79
Non-Metal Minerals (Ceramic)	10,00%	8,57%	2,86%	1,43%	0,71%	23,57	33
Textile	2,14%	1,43%	0,71%	0,00%	0,00%	4,29	6
Total (%)	45,71	30,00	11,43	5,71	7,14	100,00	
Total (absolute value)	64	42	16	8	10		140

Tab. 2a- Environmental innovation, R&D and environmental costs (acronyms defined above)

Indicators	Inno	Inno-em	Inno-wa	Inno-en	Inno-tot	R&D	Inv-env	Env-Costs	Environmental Patents	Auditing voluntary certification Schemes
Range	Dichotomous 0/1	Dichotomous 0/1	Dichotomous 0/1	Dichotomous 0/1	between 0-1	% turnover, all firms*	% turnover, all firms*	% turnover, all firms*	Dichotomous 0/1	Dichotomous 0/1
Mean value	0,79	0,49	0,42	0,46	0,41	0,55%	0,78%	0,67%	0,02	0,26

*including all firms, with positive and zero values.

Tab. 2b- Core Variables and time period of reference

Variables	Time period
Environmental innovations, R&D, environmental costs and investments	2001-2003
Techno-organisational innovations, industrial relations, other organisational practices and production dynamics	1998-2001

Tab. 2c- Dimensional and sectoral effects: descriptive summary (mean values)

	Innovation (at least one form)	emissions	waste	energy	material	Four innovations index (0-1)	R&S*	R&S>0	Investments*	Investments>0	Costs*	Networking index (0-1)
<100 employees	71,88%	39,06%	34,38%	37,50%	25,00%	0,340	0,71%	37,50%	0,70%	42,19%	0,47%	0,152
100-249	80,95%	47,62%	50,00%	42,86%	21,43%	0,405	0,32%	45,24%	0,75%	61,90%	0,90%	0,208
250-499	**93,75%**	**75,00%**	50,00%	68,75%	31,25%	**0,563**	0,42%	**56,25%**	0,85%	**68,75%**	0,42%	0,172
500-999	87,50%	62,50%	37,50%	**87,50%**	**50,00%**	**0,594**	**0,73%**	37,50%	**2,15%**	62,50%	0,19%	**0,281**
> 999	80,00%	60,00%	50,00%	50,00%	**50,00%**	0,525	0,56%	60,00%	0,23%	30,00%	**1,81%**	0,225
Chemical	80,00%	**60,00%**	50,00%	50,00%	50,00%	**0,525**	**1,30%**	60,00%	**1,36%**	40,00%	0,58%	**0,350**
Machinery	79,75%	49,37%	35,44%	44,30%	29,11%	0,396	0,48%	40,51%	0,44%	49,37%	0,47%	0,184
Ceramic	81,82%	42,42%	**57,58%**	**60,61%**	21,21%	0,455	0,64%	60,61%	1,29%	66,67%	**1,20%**	0,182

* % firm turnover, all firms included; the first five columns report the share of firms adopting such innovations.

Tab. 3- Correlation matrix- independent variables

		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25
1	NETW-TOT	1,00																								
2	AUDIT	0,21	1,00																							
3	POL-WAS	0,16	0,00	1,00																						
4	POL-EM	0,20	-0,01	0,56	1,00																					
5	R&D	0,03	-0,06	0,03	0,17	1,00																				
6	ENV-INV	0,05	0,09	0,11	0,15	0,36	1,00																			
7	ENV-COST	0,02	0,01	0,09	0,08	0,35	0,37	1,00																		
8	GRANT	0,20	-0,06	0,02	0,15	-0,02	0,16	0,07	1,00																	
9	SIZE	0,06	0,26	-0,04	-0,05	-0,07	-0,01	-0,03	-0,09	1,00																
10	CHEM	0,19	0,03	0,02	0,06	0,08	0,08	0,02	0,19	-0,02	1,00															
11	MACHIN	0,02	0,01	-0,11	-0,07	-0,04	-0,16	-0,22	0,01	-0,04	-0,30	1,00														
12	CERAM	0,00	0,02	0,07	0,03	0,04	0,08	0,21	-0,13	0,00	-0,15	-0,61	1,00													
13	INT-REV	0,02	0,01	-0,07	-0,01	0,00	0,04	0,03	0,22	-0,06	0,17	-0,25	-0,04	1,00												
14	FIN-MKT	-0,01	0,02	0,02	-0,04	0,07	0,09	0,09	-0,21	-0,06	-0,01	-0,08	0,18	-0,29	1,00											
15	GROUP	0,05	0,14	0,05	0,10	0,00	-0,13	0,08	-0,08	0,43	-0,06	0,02	-0,04	-0,02	-0,04	1,00										
16	LIVGER	-0,04	-0,06	0,13	0,09	0,17	0,14	0,14	0,14	-0,11	-0,06	0,06	0,04	0,11	-0,16	-0,12	1,00									
17	%DIP-FORM	0,06	0,20	0,20	0,11	-0,02	-0,18	0,06	-0,01	0,10	0,07	0,00	-0,16	0,07	0,00	0,24	-0,14	1,00								
18	INNO-ORG	-0,06	0,02	0,04	0,08	-0,01	0,01	-0,04	0,11	0,03	-0,04	0,13	-0,17	-0,07	0,08	0,11	-0,20	0,23	1,00							
19	INNO-TEC	0,01	0,16	0,04	-0,04	-0,05	-0,09	0,11	-0,03	0,05	-0,04	-0,05	-0,04	-0,11	0,03	0,11	-0,11	0,11	-0,01	1,00						
20	MAN-vs-EMP	0,04	0,05	-0,14	-0,16	0,11	0,05	0,16	0,00	0,10	0,10	0,04	-0,14	0,15	0,09	0,21	-0,06	0,31	0,23	0,05	1,00					
21	PART	0,01	-0,02	-0,14	-0,01	0,05	0,10	0,00	0,15	0,07	0,01	0,10	-0,12	0,08	-0,15	0,05	0,03	-0,05	0,08	-0,02	0,20	1,00				
22	IND-REL	0,05	0,22	0,07	0,12	-0,08	-0,11	-0,12	-0,09	0,27	-0,19	0,00	0,11	0,01	-0,02	0,23	-0,16	0,01	0,03	0,07	-0,04	0,19	1,00			
23	PROF_95-00	-0,06	0,13	0,09	0,12	0,06	0,18	0,00	0,09	-0,12	0,04	0,20	-0,09	-0,07	0,14	-0,11	-0,03	0,21	0,25	0,05	0,05	0,03	-0,02	1,00		
24	PROD-95-00	-0,13	0,20	0,06	0,08	0,20	0,33	0,12	0,03	0,10	-0,02	0,04	-0,06	-0,03	0,23	0,05	-0,08	0,21	0,22	-0,02	0,16	0,02	0,03	0,65	1,00	
25	INV_N-95-00	-0,04	0,25	0,15	0,17	0,15	0,29	0,08	-0,04	0,37	0,02	-0,30	0,18	0,01	0,12	0,23	-0,12	0,15	0,06	-0,02	0,02	0,03	0,32	0,16	0,54	1,00

The table presents the complete set of potential covariates.

Tab. 4a- Econometric regressions (output innovation)

Dependant variable	INNO-TOT	INNO-TOT	INNO-TOT
Regression	1	2	3
Covariates/Methodology	OLS corrected for heteroskedasticity	OLS corrected for heteroskedasticity	OLS corrected for heteroskedasticity
Constant	0,941	0,135	0,083
Log-Size	0,416	0,196	0,272
CHEM	1,668*	1,778*	1,579
MACH	0,619	0,720	0,547
CERAM	1,186	1,223	1,318
GROUP	1,515	1,758*	1,982**
HYER	-1,892*	-1,831*	-1,786*
IND_REL	2,477**	2,492**	2,293**
POL-WA/EM			
POL- WA/EM (YRS)			
Grant	3,707***	3,194***	3,670***
ENV-INV	-0,975		
ENV-COST	2,794***	2,397**	
ENV-COST (pred values)		Not highly significant when included	
R&D	2,131**		2,535**
R&D dummy			
AUDIT	3,076***	2,951***	3,038***
EMAS	EMAS significant at *** when included separately		
ISO_{14000}			
McFadden pseudo R^2			
Estrella fit			
Adj R^2	0,192	0,200	0,194
Log-L			
Chi-squared LR test (prob chisq>value)			
F test (prob)	3,21 (0,0002)	4,17 (0,0000)	4,05 (0,0000)
Correct prediction: actual 1s and 0s correctly predicted			
N	140	140	140

Notes on regressions

1. EMAS drives the significance of AUDIT
2. fitted values of environmental costs not highly significant when included

Tab.4 presents t ratios (only covariates emerging as significant in final form specifications are shown).
We emphasise coefficients which arise significant at 10%, 5% and 1% (*, **, ***).

Tab. 4b- Econometric regressions (Input Innovation)

Dependant variable	R&D	Ln(R&D)	Ln(R&D)
Methodology	Probit	Two-stage procedure	Two-stage procedure
Constant	-4,22***	-2,42**	-2,694**
Log-Size	1,10	-1,37	-1,259
CHEM	2,24**	-0,53	-1,10
MACH	0,99	-1,39	-2,146**
CERAM	2,10**	-0,19	-0,471
FIN-MKT	2,68***		
HYER	2,78***	1,74*	2,188**
IND-REL	2,03**		
MAN-EMP		1,24	
INNO-ORG	1,64		
COV		0,77	2,325**
NET-TOT	1,83*	1,87*	3,972*** (NET-EN)
PROD9800		3,016***	3,418***
GRANT		-2,03**	-1,514
IMR		1,06	0,985
McFadden pseudo R^2	0,157		
Estrella fit	0,209		
Adj R^2		0,192	0,32
Log-L	-80,74	-93,66	-89,34
Chi-squared LR test (prob chisq>value)	30,26 (0,0003)	38,74 (0,0001)	47,37 (0,0000)
F test		2,30 (0,02)	3,91 (0,0006)
Correct prediction: actual 1s and 0s correctly predicted	66%		
N	140	61	61

Tab.4 presents t ratios. We emphasise coefficients which arise significant at 10%, 5% and 1% (*, **, ***).