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Sustainability and Competitiveness in Evolutionary Perspectives. Environmental Innovations, Structural Change and Economic Dynamics in the EU

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Sustainability and competitiveness in evolutionary perspectives. Environmental Innovations, structural change and economic dynamics in the EU

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Abstract

We take a sector based perspective to investigate the EU economic, environmental and innovation performances. We correlate the various sector performances taking into account the role of changing specialization. In addition, we examine sector environmental performances related factors through *shift-share* decomposition analysis.

We show that vivid divergences in environmental, economic and innovation performances exist between EU countries. The leading role of Germany emerges, with strong underpinnings in its economic specialization rooted on manufacturing. France excels in some services, while Italy suffers. Germany and Sweden more than others present win win economic-environmental sector performances.

On the basis of our investigation economic and environmental performances are effectively potentially interrelated. Examples of integrated innovation-economic-environmental performances appear. Nevertheless, the sector view highlights that the underpinnings of macro performance rely on various structural change and innovation elements. Further research could investigate how composition effects and innovation changes correlate towards the achievement of sustainable economic development.

Keywords: Environmental innovation, economic performance, decomposition, meso economics

JEL Classification: Q53, Q55

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1. Introduction

The main aim of the work is to draw a picture of the EU countries performances at the sector level in terms of eco-innovation (EI), economic specialization, economic productivity and environmental efficiency (Kemp, 2000). The question is in a nutshell whether the EU economy has moved towards sectors that lead the way in terms of EI, and primarily whether there is a correlation between innovation (adoption), economic and environmental performances at a meso level of analysis (sectors).

We exploit the rich information stemming from the CIS (Community Innovation Survey) 2008 that covers all innovation adoptions by EU firms over 2006-2008, and for the first time includes EI along various types: CO_2 reduction, energy efficiency, material and waste reduction, emission reductions, EMS/ISO adoptions among others.

The development and application of EI is the key issue around which the all reasoning on the green economy may revolve, and it is becoming the conceptual reference point for many regional and international public policies and management strategies. One of the most recent definitions of eco-innovation defines it as the production, application or use of a product, service, production process or management system new to the firm adopting or developing it, and which implies a reduction in environmental impact and resource use (including energy) throughout its life-cycle. This definition includes innovations whose environmental effects are not intentional. A relevant distinction can be made between end-of-pipe technologies and clean technologies integrated in the production process (for more insights around this definition see Kemp, 2010; Kemp and Pontoglio, 2011).

The wide dataset and array of information on EI allows describing in depth EI and its links with major factors that characterize the EU competitiveness and innovation potential. We aim at integrating the EUROSTAT sector based CIS2008 data for EI with data on environmental performance by sector on waste and emissions and economic productivity, namely labour productivity as main indicator of economic performance (WIOD sources). Similar to Montalvo and Moghayer (2012), which analyse innovation performances at sectorial and country level, we take a meso economics perspective, in line with the evolutionary thinking on innovation. Micro and meso levels are key to the understanding of innovation and economic-environmental performances (Dopfer, 2011). The meso level is conceptually robust to analyse the diffusion of innovation and furthermore allows an easier comparison across sectors and countries, similar to that characterizing patent based analyses.

The empirical analysis is aimed at comparatively shedding light on the performances of EU sectors over the last decade. We first compare EI performances for key EU countries (Germany, Italy, France, and Netherlands, Sweden) that represent diverse economic and institutional settings. Leader and laggards are drawn out for the overall economy. It is of interest to associate EI diffusion performances with economic and environmental trends that characterize the EU economy in the way to possible changing specializations (within services and industry). We consequently focus and analyses main sectors in terms of value added, and the most dynamic sectors, namely those that have greatly increased and diminished their value share over the recent past. We can have thus a look at both static and dynamic photos of the EU economic system.

The integrated analysis aims at shedding light mainly on:

- Whether and how 'EI adoption intensity' (by sector, by country) matches country environmental performances.
- Whether and how 'EI adoption intensity' matches country (changing) specialization, namely as example whether a country is specialized (ing) in sectors which shows high/low intensity of EI.

The analysis takes into account industry and services on the view of the structural/composition changes that are occurring in the EU economy. Finally, we propose a decomposition of countries environmental performance differentials through the use of a shift-share analysis. This final exercise seeks to investigate if infra-countries environmental differentials are more related to different market structures (for instance specialisations in greener sectors) or depend on sectorial emission efficiency. Future analyses, in addition to extending the picture to all EU countries, might well test whether EI and other typologies of 'normal' innovations are integrated or not, namely whether they are jointly adopted / positively correlated in major EU sectors. Finally, the productivity and employment effects of EI and joint innovations can be ascertained by more refined quantitative models. We here offer a robust preliminary overview that sketches main factors and offers food for thought to policy makers and innovation practitioners. The last two sections propose two additional exercises aimed at providing a clearer picture of intra country differential in both sectorial environmental and innovative performances.

In the following, Section 2 develops the conceptual background, Section 3 presents the results of the main analysis, Section 4 reports evidence for the shift-share decomposition exercise and Section 5 concludes.

2. Conceptual background

The generation of new Input Output (I-O) tables at European Union (EU) level in recent EU FP7 projects, such as EXIOPOL and WIOD, is a good development towards more effective production and analysis of hybrid economic-environmental accounts, as well as the excellent releases by EUROSTAT of a first National Accounting Matrix including Environmental Accounts (NAMEA) for EU in 2011 (Costantini et al. 2011). Efforts in economic-environmental accounting offer rich extensions and potential links to many fields, such as innovation studies, but also mounting studies on international trade effects on the environment according to both consumption and production sustainability.

The dynamic framework is intrinsically related to on-going transformations of the economic and environmental systems, with innovation and policy as main levers of changes. Analysis of such a constantly transformed environment is what makes broad and hybrid approaches different from static, very narrow fields. The real challenge today is a deeper analysis and broader understanding of the dynamic world that presents many methodological, theoretical and empirical challenges. After consolidation of static environmental economics theory, dynamic thinking has increasingly emerged since the mid '90s.

A few more words on sector analyses and innovation should be added. Specific sector performances (innovative, environmental, and economic) are crucial to the future competitiveness and achievement of environmental targets in the EU. Then, given the relevance of sector interdependencies, the manufacturing sector cannot be the only focus of analysis when looking at innovation effects in open innovation systems. The increasing role of vertical integration makes it necessary to look at both industry and service industry innovation dynamics. The increasing role of vertical integration makes necessary to look at both within industry and industry-service innovation dynamics, especially for the case of 'producer services', in the standard OECD classification (sectors from 50 to 74 in ISIC, especially financial, communication and business services, which also highlight the role of ICT in relation to environmental performances). Moreover, the effects of environmental policy on the innovation system should take into account that increasing share of imported intermediate inputs implies that emissions associated to domestic output are partly leaked abroad through trade. By itself this can improve sectorial direct resource efficiency (RE) indicators. The 'technology effect' in this trade related perspective is important since it makes necessary to

study both sides of the coin: how emissions are relocated abroad, but also how trade drives technology shifts/spillovers and how green technology can enhance the competitiveness of the EU.

A multi-sector country based specific perspective is thus needed to discover weakness and strengths under the overall macroeconomic performance and strengthen future innovation trajectories in the EU. A meso/micro level perspective goes directly into the center of innovation generation, diffusion, including the relevant technological spillovers occurring within industry, between services and industry, between innovators and adopters located in different sectors/countries. The heterogeneity of national policies, associated with the economic and technological interdependencies occurring between actors in various countries, also emphasizes the possibility of other ways of inter country policy transmissions.

3. Environmental Innovation, economic and environmental performances in the EU

We use available data at sectorial level from both European Community Innovation Survey and WIOD database, to compare the economic and eco-innovative performance of five main European countries, namely Italy, Germany, France, Netherlands and Sweden. We begin with major countries that represent different economic-institutional features to offer food for thought for further analyses. WIOD database allows to use data on value added, employment and CO_2 and SOx emission; CIS data concern here three environmental innovation indicators out of the complete set: increasing energy efficiency, emissions reduction and waste reduction. The World Input Output Database (WIOD), is a results from a European Commission funded project as part of the seventh Framework Programme and has been developed to analyse the effects of globalization on socio-economic variables and trade, in a wide range of countries (the 27 EU Member States and other 13 major counties in the world, from 1995 to 2009). WIOD is made up of four different accounts (World Tables, National Tables, Socio Economic Accounts and Environmental Accounts) For the purpose of this work, we used Socio-Economic and Environmental Accounts, both providing a wide range of economic variables such as value added and environmental variables as CO_2 and SOx emission[1].

Community Innovation Survey (CIS) are a series of surveys produced by the national statistical offices of the 27 European Union member states, also covering the European Free Trade Association countries and the EU candidate countries. The surveys have been implemented since 1993, on a two-yearly basis and are designed to obtain information on innovation activities of enterprises, including various aspects of innovation process, as innovation effects, cost and sources of information used. Data are collected at micro level, using a standardized questionnaire developed in cooperation with the EU Member States to ensure the comparability across countries. The sixth CIS (2006-2008) collects data on environmental innovation for the first time[2]. Though it is a cross section dataset, it captures a 3 years time span of EI and is the first CIS survey that has included EI at EU level ever. Community Innovation statistics based data are the main data source for measuring innovation in Europe and are used in academic research as in Horbach et al. (2012) and Borghesi et al. (2012), Veugelers (2012) which exploit data for Germany, Italy, Belgium. Micro and meso aggregation are available. From a conceptual point of view, we refer to the integrated concepts of sectoral and national systems of innovation which have consolidated in the innovation oriented evolutionary theory (Malerba, 2004).

We specifically capture in the following analysis economic sector performances by labour productivity (the economic productivity, labour units per value added) and environmental performance by the ratio of emissions on value added. The environmental performance is namely

[1] The WIOD Database is available at: http://www.wiod.org/database/index.htm

[2] Information taken from Eurostat website (http://epp.eurostat.ec.europa.eu/portal/page/portal/microdata/cis).

'economic' in nature, and differs from other proxy indicators such as emissions per employee or emissions themselves. Analyses with those indicators are scope for possible further research.

3.1 Environmental Innovation adoption: comparing major economies in a meso perspective

Table 1 exhibits the ranking of the five main countries (Germany, France, Italy, Sweden, Netherlands, the selection of which depends upon relevancy, heterogeneity, data availability) by percentage of adoption of environmental innovation. To provide various insights, we sketch some general economic categories and more specific ones such as some key services, utility sectors that are important insofar they manage natural resources, and heavy industrial sectors that for that reason are under the EU ETS policy aimed at cutting CO_2 (potentially inducing innovation). If we look at the three main eco-innovation indicators we mentioned, it is clear that leaders are Germany and France. Italy achieves the worst performance in most sectors, except some ETS sector (manufacture of metal products, manufacture of paper, air transport) and a few services sector (financial services, services for the business economy).

Table A12 on the impact of innovation shows that services are plagued even in the EI realm by lower innovation intensity (the well known 'cost' disease linked to lower productivity). This is relevant both for analyzing sustainability performances along the economy restructure towards services, and for understanding the extent to which increasing vertical integration affects innovation adoption on both sides. The key issue is that mere composition effects, due to innovation weaknesses in some branches and complex transmission of EI across sectors, does not automatically lead to lighter environmental impacts. Marin et al. (2012) show that the total (indirect + direct) emission of services might be close or equal to that of manufacturing.

Table 1. Adoption of environmental innovation over 2006-2008. Ranking of five countries.

		leader CO_2 Innov	leader emission innov	leader waste reduc inn
General	Manufacturing	Germany	Germany	Germany
General	All Core NACE activities related to innovation activities	Germany	Germany	Germany
General	Industry (except construction)	Germany	Germany	Germany
Services	Financial and insurance activities	Netherlands	France	France
Services	Financial service activities, except insurance and pension funding	France	France	France
Services	Services of the business economy	Sweden	France	France
Services	Innovation core services activities	Germany	Germany	France
Services	Insurance, reinsurance and pension funding, except compulsory social security	Sweden	Netherlands	France
ETS	Manufacture of basic metals	Germany	Germany	Germany
ETS	Manufacture of basic metals and fabricated metal products, except machinery and equipment	Germany	Germany	Germany
ETS	Manufacture of chemicals and chemical products	Germany	Germany	Germany
ETS	Manufacture of coke and refined petroleum products	Germany	Germany	Germany
ETS	Manufacture of fabricated metal products, except machinery and equipment	Germany	Germany	Germany
ETS	Manufacture of other non-metallic mineral products	Germany	Germany	France
ETS	Manufacture of paper and paper products	Germany	Germany	Germany
ETS	Air transport	Germany	Germany	France
Utility	Sewerage	France	Germany	Germany
Utility	Sewerage, waste management, remediation activities	Sweden	Germany	France
Utility	Waste collection, treatment and disposal activities; materials recovery	Germany	Germany	France
Utility	Water collection, treatment and supply	Germany	France	France
Utility	Water supply; sewerage, waste management and remediation activities	Sweden	Germany	France

Source: CIS Data extracted from Eurostat on line database (in May 2012)

Table 1 shows the expected dominance of Germany in EI adoption, which adds to its highest position in the ranking related to green patents. Germany leadership is driven by the superiority of its industrial core sectors.

The evidence for services is more mixed. Germany does not lead. France is on average the country which presents the best performance, with Sweden and Netherlands also appearing leaders in some cases. In services that are more integrated with industry Germany nevertheless appear to lead in some cases, thus showing the relevance of vertical integration. Though Italy presents a consistent gap concerning CO_2 innovation, its role is not negligible in waste technological adoption. The role of packaging waste systems that have been effectively implemented by firms through covenants and schemes that fund recycling and recovery might be investigated in the future.

A final look at 'utility' related sectors shows that while the Germany strength is plausibly confirmed in (highly regulated) areas such as waste management and collection, France plays a major force as well. The gap between France and Italy in this field, where big utilities and public-private company are important players in the production of mixed public services, is worth being further investigated. The role of the (typology of) 'decentralization' of public services (higher in

Italy in general terms) and related policies is a possible key issue. Its relationships with environmental innovations have been an overlooked fact.

Results of this ranking prove a relative weakness of Italy in adoption of environmental innovation. The lens with a focus on Italy is relevant insofar it presents one element behind the current problematic unbalances in the EU. The 'debt crisis' is largely a problem of diverging economic productivities. Being Italy a big player in the EU, and second industrial country after Germany, we might state that this productivity gap, which certainly has as one of the main driving element a gap in extensive innovation adoption.

3.2 Sector composition and joint performances

The following tables show economic, environmental[3] and eco-innovative performances of (i) main economic sectors (§ 3.2.1), (ii) expanding and (iii) shrinking sectors (§ 3.2.2). The rationale is to offer a dynamic perspective. We thus focus on main sectors and the most changing/dynamic ones to offer a 'structural change and dynamics' perspective of the EU economy.

Selected variables for this analysis are labor productivity (Value Added in 1995 US Dollars / Numbers of employees), CO_2 and SOx emissions per unit of Value Added[4], Energy Intensity (Total consumption of sectorial energy inputs) (taken from WIOD), and the three eco-innovation adoption indicators (increasing energy efficiency, emissions reduction and waste reduction, taken from the CIS). The following tables summarize the sectorial values of the above mentioned variables for each countries; we compared the country's performance with the European average and filled the cell in grey when the country performance was above the average (e.g., in the first row of Table 2, Italy's labor productivity value for the Real Estate sector is above the European average for the same sector)[5]. White cells denote country sectorial performance below the average (e.g., in the last row of Table 2, the German labor productivity in the financial sector is beneath the European level).

3.2.1 Main sectors performances

Tables from 2 to 9 refer to the five major countries we drew out (tables 2-4 for main sectors, tables 5-9 for expanding and shrinking sectors). The appendix shows summary values for all countries (Table A3).

Generally speaking, the analysis of figures shows that economic and environmental 'productivities', value per labor and emissions per value, are likely to positively correlate in a dynamic perspective[6]. We do observe that a positive correlation does not assure sustainability itself. This really depends upon the pace of the decrease. In the cases where value increases more than emissions, we achieve relative decoupling. Only if emissions decrease while the economy (or a sector) grows we reach absolute decoupling. In both cases emissions per value decrease. A descending emissions / value path thus only assure that decoupling is present. Absolute decoupling

[3] That capture 'economic efficiency', thus indicators of emissions per unit of value added.
[4] CO_2 emissions are measured in 1000 tonnes while SOx is measured in tonnes.
[5] The European mean value is calculated as the un-weighted average of the different variable of interest, at sectorial level for EU27 countries. Other analyses might compare sectors to more specific average benchmarks (e.g. West EU, Euro area, etc..). Preliminary assessments have shown that results are somewhat robust to such sensitivity tests.
[6] In other terms, this means that we expect sectors characterised by an high economic productivity (Value added per unit of labour) are also characterised by a low level of emissions (emission per unit of value added). This is a possibility over dynamic scenarios (Mazzanti and Zoboli, 2009), with innovation at the core and behind the correlation.

necessitates emissions to shrink. Radical inventions, innovation diffusion and structural decomposition are needed for this to come by.

The 'Main' sector are picked out considering the generated sectorial value added in 2008 (Source: WIOD). Top expanding and top shrinking sectors are chosen by considering the variation of the generated sectorial value added over 2000 – 2008. The first criterion allows analyzing the country's industrial structure (before the 2009 recession), while the second allows identifying the ongoing transformation in the same economic structure. Table 2 first exhibits main sectors in Italy and Germany, two main industrial players[7]. Both countries are logically mainly composed by services sector, though Germany interestingly presents a still strong and possibly increasing manufacturing sector, that highlights the 'heaviness' of its competitive advantage (which is compensated by higher EI intensity). Particularly in Italy the larger share of the value added is generated by real estate, which has a higher productivity than Europe and performs better for CO_2 and SOX emissions too: this is an example of 'joint' performances. Though not over the average in Europe, we must highlight that the sector is not performing bad in EI terms. A large share of value added is held also by the construction sector, which performances are generally above the European average. Significant areas are also credit and insurance and wholesale trade. The columns showing the environmental innovation indicators, corroborate the conclusion we drawn from table 1 about the weakness in the introduction of environmental innovation in Italy, which is weaker than the EU average.

The German industrial structure is composed mostly by areas related to services but has a large proportion of value added generated by a manufacturing sector, namely the manufacture of computer and electrical machinery which, as we will see later, turns out to be one of the growing sectors in German economy. It is clear that the adoption of technologies for energy efficiency and reduction of waste generation is widespread in all sectors and above the European average in most cases.

Tables 3 and 4 report the sectorial composition of the economies of France, The Netherlands and Sweden for additional insights. While the French and the Dutch industrial structure are constituted mainly by services sectors and construction, Sweden shows a great importance of manufacturing sectors as witnessed by computers and electrical machinery in the first row of Table 4. Even if Swedish environmental innovation performances are somewhat unexpectedly below the European average in many cases[8], Sweden confirms to be a case where win win economic environmental performances may jointly appear. Though some more in depth investigations of the EI evidence related to CIS is needed, this is certainly a case where the policy-innovation-performance chain might emerge even at macro scale (Costantini and Mazzanti, 2012, 2013). We recall that Sweden presents one of the highest environmental taxation share worldwide and an historically high carbon tax. On the contrary, the productivity of the French main five sectors is lower than the average. The adoption of eco-innovation is widely above the European average (with the exception of the "renting, R&D and other business activities sector), confirming the French leadership among the selected countries, as it was evident from Table 1. Similarly to the French ones, the Dutch sectors obtain better productivity, energy intensity and emissions performance than

[7] In terms of share within EU27, Germany is at 20% in both 2008 and 2011, while Italy shrinks from 13 to 12%. They account for 1/3 of GDP in the extended EU. France share rose from 15 to 16%, while Sweden and The Netherlands are respectively at 3 and 5%. The 5 countries we consider quantitatively amount at more than 50% of EU27 GDP.

[8] This is partly due to some missing observation in the CIS data for this country.

Europe. In innovation terms, Real estate and renting, R&D and other business activity are above the average.

To sum up, the majority of the value added in the considered economies is produced by the services sector and by construction, as clearly expected. An interesting exception is Germany, which has a large proportion of its value added generated by manufacturing. The electrical machinery sector shows a very good overall performance. Besides the penalization in terms of 'productivity', which partially depends upon some outliers, if we link table 1 and 2 the signal is that joint innovation-economic-environmental performance are feasible even at macroeconomic scale. Nevertheless, the German productivity is positive and moreover correlated with very good performance for emission, and CO_2 abatement. This case is anecdotal of the EU core specialization in export oriented industry branches. For the green economy to spread over the EU, those leading examples are to be imitated and followed by laggards.

The same comment applies on the leading performances of real estate in France and The Netherlands, and finally construction in France. An even better picture is being highlighted by the service branch 'rent, R&D' and 'credit and insurance' in Sweden, that matches positive trends over the average for economic, environmental and innovation factors. In the small group of five countries, Germany and France are confirmed leaders in the introduction of environmental innovation, reaching over the European average. Italy not only obtains lower results in economic-environmental performances in most sector branches, but shows an overall weakness in the introduction of environmental innovation compared to the other countries and the European average.

Further analyses are necessary to investigate (i) key eastern emerging players that are on the transition phase, (ii) more micro based data through specific focuses on sectors/countries.

Table 2. Main sectors. Based on the Share of value added (2008). Italy and Germany: sector performances

Italy - Main Sectors							
Sector	VA/L	Sox/VA	CO_2/VA	EN.INT	CIS EN.EFF	CIS CO_2	CIS WASTE
70	1203.432	0.000	0.005	0.299	0.116	0.061	0.160
7174	30.290	0.001	0.069	1.336	0.268	0.138	0.404
J	107.608	0.000	0.015	0.411	0.190	0.107	0.273
51	55.111	0.002	0.120	0.835	Not available	Not available	Not available
F	33.381	0.004	0.058	2.088	0.091	0.063	0.080
Germany - Main Sectors							
70	832.470	0.005	0.021	0.099	Not available	Not available	Not available
7174	62.797	0.006	0.039	0.804	0.258	0.168	0.24924
51	118.362	0.005	0.034	0.605	Not available	Not available	Not available
3033	131.925	0.004	0.016	0.451	0.587	0.415	0.526
J	94.088	0.010	0.022	0.488	0.249	0.122	0.2101

Sector: 70 (Real Estate); 7174 (Renting, R&D and other business activities); J (Credit and Insurance); 51 (Wholesale trade); F (Construction); 3033 (Electrical machinery)

Table 3. Main sectors. Share of value added (2008). France and Netherlands

France - Main Sectors							
Sector	VA/L	Sox/VA	CO_2/VA	EN.INT	CIS EN.EFF	CIS CO_2	CIS WASTE
7174	75.611	0.003	0.019	0.566	0.138	0.154	0.250
70	773.431	0.001	0.003	0.213	0.344	0.191	0.312
51	56.882	0.024	0.068	1.909	0.246	0.241	0.544
J	99.903	0.029	0.048	1.058	0.314	0.213	0.339
F	27.766	0.411	0.279	5.471	0.402	0.273	0.509
Netherlands - Main Sectors							
7174	43.053	0.000	0.058	0.885	0.079	0.088	0.079
51	106.443	0.000	0.029	3.177	0.060	0.132	0.283
J	143.114	0.000	0.020	0.309	0.147	0.199	0.160
70	401.942	0.000	0.006	0.075	0.264	0.268	0.151
F	50.182	0.021	0.107	1.358	0.175	0.128	0.309

Sector: 7174 (Renting, R&D, other business activities); 70 (Real Estate); 51 (Wholesale trade); J (Credit and Insurance); F (Construction)

Table 4. Main sectors. Share of value added (2008). Sweden.

Sweden - Main Sectors							
Sector	VA/L	Sox/VA	CO_2/VA	EN.INT	CIS EN.EFF	CIS CO_2	CIS WASTE
3033	799.828	0.000	0.001	0.079	0.323	0.213	0.218
7174	54.505	0.000	0.035	0.546	0.060	0.045	0.043
70	381.757	0.001	0.013	1.263	Not available	Not available	Not available
51	86.273	Not available	Not available	0.591	Not available	Not available	Not available
J	171.672	0.000	0.005	0.335	0.175	0.128	0.309

Sector: 3033 (Electrical machinery); 7174 (Renting; R&D; other business activities); 70 (Real Estate); 51 (Wholesale trade); J (Credit and Insurance)

3.2.2 Expanding and shrinking sectors performances

Tables 5 and 6 present results for the top 5 *expanding and the top 5 shrinking* sectors at country level. They have been defined according to the increase (or decrease, if shrinking sectors are concerned) in their share of sectorial VA on total VA between 2000 and 2008. This procedure helps pointing out the ongoing transformation in the economic structure of the five European counties.

In Italy (table 5) the major growing industry in the time span considered is telecommunication, followed by credit and insurance, electricity supply and real estate, each showing better labour productivity, energy intensity and emission performances than Europe. Looking at the columns showing the environmental innovation indicators, we see that once again, Italy is below the European average in every sector. Focusing on the top shrinking sectors, we can see they are mostly related to the manufacturing industry and that the productivity performance and emission have not been very brilliant when compared to the European one. If we hold attention to the shrinking sectors, it is crystal clear that economic-environmental-innovation deficient performances go hand in hand. Failing to address the challenges of environmental policy and the necessary changes posed by the greening of the economy is one of the possible causes of decline. Even historical sectors can in fact reposition themselves in international markets by greening their strategies and processes through innovation investments.

Germany (Table 6), has witnessed a great expansion of water transport sector, which can boast higher productivity than Europe and a lower level of CO_2 and SOx emissions; eco-innovation performances too are very good when compared to the EU average, as previously noted in the comparison with major countries. More broadly, transport activities have increased over time and have performed well in the adoption of environmental innovation, as we may see in the fourth row of the upper part of table 6. Among the expanding sectors we find in the second row computer and electrical equipment; we can conclude that Germany's industrial structure differs from other countries since manufacturing not only hold a large amount of value added but is increasing its share over time. Among the shrinking sector we can count manufacturing of wood products, construction, air transport and petroleum products. Even if these sectors have progressively reduced their share within the German economy, the adoption of environmental innovation is widespread and up above the European average. The structural re-composition of the economy shows almost a full integration of good innovation-economic and environmental performances. Innovation is a key issue in the strategy associated to the sectors that are more exposed to the challenges of competitiveness by emerging countries. Their share can shrink due to somewhat natural economic changes, but productivity and wages can be sustained through innovation efforts. Germany is thus emerging out of the EU average regarding both major and more dynamic sectors. This outstanding performance we know all is part of the EU problem, in the sense that the consequential current account surplus is paradoxically too high at the moment, larger than the Chinese one. Notwithstanding the fact that Germany should probably compensate

Table 5. Top expanding and top shrinking sectors. 2000-2008. Italy

Italy - Top Expanding Sectors							
Sector	VA/L	Sox/VA	CO_2/VA	EN.INT	CIS EN.EFF	CIS CO_2	CIS WASTE
64	159.513	0.000	0.024	1.061	0.111	0.105	0.116
J	107.608	0.000	0.015	0.411	0.085	0.052	0.179
E	215.517	2.457	4.745	93.352	Not available	Not available	Not available
70	1203.432	0.000	0.005	0.299	0.116	0.061	0.160
Italy - Top Shrinking Sectors							
1718	35.115	0.091	0.368	3.504	0.096	0.097	0.257
19	28.793	0.047	0.165	1.973	0.081	0.073	0.124
62	60.082	1.582	5.580	142.802	0.241	0.207	0.310
25	64.608	44.479	15.372	2565.267	0.333	0.360	0.373

Sector: 64 (Telecommunication); J (Credit and Insurance); E (Electricity); 70 (Real Estate); 1718 (Textile); 19 (Leather); 62 (Air transport); 25 (Rubber and Plastic)

Table 6. Top expanding and top shrinking sectors. 2000-2008. Germany

Germany - Top Expanding Sectors							
Sector	VA/L	Sox/VA	CO_2/VA	EN.INT	CIS EN.EFF	CIS CO_2	CIS WASTE
61	962.712	1.294	0.121	1.531	0.390	0.2527	0.352
3033	131.925	0.004	0.016	0.451	0.587	0.415	0.526
64	184.985	0.005	0.076963	0.974	0.409	0.052	0.019
63	70.799	0.002	0.269162	3.319	0.518	0.609	0.357
Germany - Top Shrinking Sectors							
20	59.445	0.059	0.124	8.057	0.394	0.359	0.441
F	47.315	0.016	0.079	2.047	Not available	Not available	Not available
62	84.460	0.746	6.154	83.475	0.2414	0.524	0
23	18.799	122.868	50.662	14889.480	0.544	0.544	0.565

Sector: 61 (Water transport); 3033 (Electrical machinery); 64 (Telecommunication); 63 (Auxiliary transport activities); 20 (Wood); F (Construction); 62 (Air transport); 23 (Petroleum products)

The French situation is shown in table 7: expanding sectors are telecommunication, air transport, R&D and other business activities and rubber and plastics. Labour productivity and emission performances are above the European average, even if EI adoption appears to be lower than in Europe, particularly in expanding sectors. Sectors decreasing the generated value added over time belongs to the manufacturing sector (furniture, leather, textiles); despite that, adoption of environmental innovation is higher than European average, particularly for waste reduction. With respect to manufacturing of electrical apparatus and manufacturing of petroleum products, innovation has been introduced for increasing energy efficiency and CO_2 abatement.

If we link this picture to the past economic performance of France, it can be said that the real strength of Germany is really the high value added export oriented manufacturing. On average, manufacturing produces higher value added per employee with respect to most services. Despite the problematic macro performance of France over the recent years, its strength in services seems a strong pillar of the future EU economic development.

In addition, we note that the adoption of EI is not an isolated phenomenon, but something that is intrinsically integrated with technological development and organizational change in a broad meaning. The future economic power of the EU and the possibility to effectively integrate

economic and environmental for a green sustainable economy depends upon the diffusion of EI in firms and sectors as key assets that complement other techno-organizational innovations, not just end of pipe technologies.

Table 7. Top expanding and top shrinking sectors. 2000-2008. France

France - Top Expanding Sectors							
Sector	VA/L	Sox/VA	CO_2/VA	EN.INT	CIS EN.EFF	CIS CO_2	CIS WASTE
64	139.192	0.001	0.006	1.239	0.179	0.097	0.216
62	104.143	0.606	1.910	17.672	0.500	0.200	0.400
7174	75.611	0.003	0.019	0.566	0.138	0.154	0.250
25	107.059	0.023	0.080	2.616	0.286	0.180	0.478
France - Top Shrinking Sectors							
61	49.961	14.258	3.318	95.916	0.525	0.475	0.450
1718	84.843	0.031	0.109	1.946	0.218	0.122	0.419
3637	53.090	0.185	0.592	2.635	0.140	0.160	0.333
19	45.900	0.062	0.112	2.128	0.073	0.073	0.391

Sector: 64 (Telecommunication); 62 (Air transport); 7174 (Renting; R&D; other business activities); 25 (Rubber and plastics); 61 (Water transport); 1718 (Textile); 3637 (Furniture); 19 (Leather)

The Netherlands has seen a greater expansion of services sector (telecommunication, wholesale trade, credit and insurance) as it can be seen in table 8. Manufacture is also present, with petroleum products. Expanding and shrinking sector performances are generally below the EU average in terms of eco-innovation adoption. The only exception is credit and insurance, which exhibits an above than average level of CO_2 reduction innovation. Despite that, labour productivity and general environmental performances (SOx/VA; CO_2/VA) are well above the EU27 level. Overall, The Netherlands performance seems relatively weaker than that of the two major countries Germany and France. We do not observe cases of full economic-environmental-innovation joint performances.

Table 9 shows the Swedish situation: as it can be seen, both top expanding and top shrinking sectors are generally better than Europe in terms of productivity and emission. As in Germany, Sweden is experiencing a growing importance of some manufacturing sectors (petroleum products and electrical machinery) followed by water transport and textiles. Among the shrinking sectors, we count land transport, pulp and paper, air transport and textiles. Generally speaking, all sectors have introduced some type of eco-innovation with the exception of telecommunication, which performs worse than the EU average as regarding EI. Among shrinking sectors, for instance, 'land transport' presents a very good integrated performance, and similarly to Germany, many shrinking sectors appear to position themselves in competitive niches.

Table 8. Top expanding and top shrinking sectors. 2000-2008. Netherlands

Netherlands - Top Expanding Sectors							
Sector	VA/L	Sox/VA	CO_2/VA	EN.INT	CIS EN.EFF	CIS CO_2	CIS WASTE
64	215.536	0.000	0.010	0.511	0.175	0.128	0.309
23	186.051	20.825	9.882	2077.889	0.190	0.190	0.269
51	106.443	0.000	0.029	3.177	0.060	0.132	0.283
J	143.114	0.000	0.020	0.309	0.147	0.199	0.160
Netherlands - Top Shrinking Sectors							
2122	82.265	0.004	0.153	6.582	0.348	0.202	0.388
19	79.753	Not available	Not available	1.799	0.226	0.000	0.000
3033	83.571	0.064	0.052	0.872	0.314	0.108	0.186
1718	70.048	0.001	0.151	3.258	0.303	0.174	0.248

Sector: 64 (Telecommunication); 23 (Petroleum products); 51 (Wholesale trade); J (Credit and Insurance); 2122 (Paper); 19 (Leather); 3033 (Electrical Machinery); 1718 (Textile)

Table 9. Top expanding and top shrinking sectors. 2000-2008. Sweden

Sweden - Top Expanding Sectors							
Sector	VA/L	Sox/VA	CO_2/VA	EN.INT	CIS EN.EFF	CIS CO_2	CIS WASTE
23	1067.875	0.289	0.762	236.837	0.424	0.255	0.373
3033	799.828	0.000	0.001	0.079	0.323	0.213	0.218
61	136.061	26.865	3.812	37.012	0.600	0.840	0.480
64	178.615	Not available	0.014	0.670	0.207	0.103	0.000
Sweden - Top Shrinking Sectors							
60	56.469	0.001	0.446	11.283	0.369	0.605	0.310
2122	115.061	0.752	0.176	31.563	0.446	0.297	0.277
62	143.727	0.953	3.126	55.530	0.381	0.476	0.238
1718	52.249	0.037	0.104	3.977	0.167	0.200	0.200

Sector: 23 (Petroleum products); 3033 (Electrical machinery); 61 (Water transport); 64 (Telecommunication); 60 (Land transport); 2122 (Paper); 62 (Air transport); 1718 (Textile)

In summary, in the selected countries, manufacturing industry has been expectedly shrinking while the services have risen. As we have seen, this general trend is not completely followed by Germany, which sees an expansion in some manufacturing sector, namely the manufacture of machinery and electronic apparatus. It is important to notice that these expanding manufacturing sectors are a case where win win economic-environmental performances appear achievable through the adoption of innovation. Sweden also shows cases in non-manufacturing expanding sectors and in manufacturing shrinking sectors where win win performances are likely to emerge if EI is strongly diffused. Moreover, Netherlands and Sweden are bounded to the industry of petroleum products, which increased over time and adopted a significantly share of environmental regulations. Though the less pronounced manufacturing role of France is possibly now penalizing the economy for GDP growth, the good economic-environmental-innovation performance of its services sectors are good signs for the EU, in light of a stronger integration and of a future EU overall competitiveness based on the country's natural and established sector specializations. For what concerns Italy, both economic, environmental and eco-innovative performances are weak; this is true for both major, top expanding and shrinking sectors. The relative weaker performance is perceivable even if looking at tables in the appendix. Though the ratio GHG/ value had decreased

(we recall decreases, thus improvements of economic efficiency, are driven by cut in emissions and/or increases in economic value), the improvement is lower than that we observe for other countries. The productivity weakness matches the difficulty of cutting emissions. This is another point for stressing that sustainable paths towards a greener economy are better achievable if economic and environmental productivities dynamically correlate with the action of (process and product) innovation diffusion behind the scene.

4. Decomposition of environmental performance differentials: a shift-share analysis.

The evidence proposed in the previous tables, shows how the selected countries tend to be more environmental efficient than the EU27 average, with respect to the chosen indicators (namely Energy intensity; CO_2/VA and SOx/VA). However, this narrative evidence do not account for the overall environmental efficiency differential between each countries and the European average, which will be addressed here thanks to a shift-share decomposition analysis[9]. One of the main advantage of such a technique, which has a long history in growth and urban economics (see among others, Dunn, 1960, Garcia-Mila and Mc Guire, 1993 and Esteban, 2000), relates to its ability to decompose the factors characterizing different growth differential between a single region (or a single) country and a benchmark (for instance the country in which the region is contained or, as in our case, the EU27). In these traditional studies the essential idea was to decompose the growth differential between each regional and the national average, in its two main factors: the region performing generally better than average or a regional specialisation in fast growing sectors. Starting from this approach, we adopt the shift-share analysis to decompose the total emission efficiency differentials in three components, generally called structural (μ), differential (π) and allocative (α) (Costantini et al., 2011).

If, for example, we consider as indicator of emission intensity E/VA for EU27 (our benchmark), and E_{DE}/VA_{DE} for Germany, the total indicator can be decomposed as the sum of $(E^S/VA^S)*(VA^S/VA)$, where E^S is sectorial emission level and VA^S/VA is the share of sectorial Value Added on Total Value Added for sectors s, where s range from 1 to j (j are the number of sector included in the WIOD accounts, see table 10 in the appendix for the full list of sectors included in the analysis). Finally, in the following equations, we use the following notation:

- X is the emission intensity index (where X=E/VA for EU27 and $X_{DE}=E_{DE}/VA_{DE}$ for Germany[10]), and X^S is the sectorial emission intensity. In other term $X = \sum_s P^S X^S$; $X_{DE} = \sum_s P^S_{DE} X^S_{DE}$.
- P^S is the sectorial value added and is define as $P^S=VA^S/VA$.

On this basis, we can decompose the emission efficiency differential between Germany and the EU27 average, which can be written as X_{DE}-X, in three different components:

1. The structural factor (μ) or industry mix, which indicates the environmental efficiency share attributable to the particular industry mix of the country with respect to the EU average. This effect is given by:

$$\mu_{DE} = \sum_S X^S (P^S_{DE} - P^S)$$

[9] Shift share analysis can also be conducted on single sectors, but we prefer here to have an aggregate index of the overall country performances.

[10] We use here Germany as reference, the same principles apply to all other countries.

and assume positive (negative) value if the region is specialised in more (less) polluting sectors (according to the chosen indicator).

2. The differential factor (π), which measure that part of differential due to the country being more efficient in abating emissions than the EU average, which is derived as:

$$\pi_{DE} = \sum_{S} (X_{DE}^{S} - X^{S}) P^{S}$$

And assume on positive (negative) values when the country is less (more) efficient in terms of emissions, under the assumption that the country industry mix coincides with the EU one.

3. Finally, the last factor, called allocative (α), is given by the covariance between the previous two components, and represent the contribution to a country energy efficiency given by its specialisation in greener than average countries. It is calculated as:

$$\alpha_{DE} = \sum_{S} (X_{DE}^{S} - X^{S})(P_{DE}^{S} - P^{S})$$

A positive (negative) value of the α_{DE} factor would mean that Germany is specialised in more (less) polluting sectors, in which is less (more) efficient respectively to the EU average.

Interestingly, the sum of these three factors give the exact emission efficiency differential, or in other term X_{DE}-X= $\mu_{DE}+\pi_{DE}+\alpha_{DE}$, which provide an interesting complement to the analysis presented in the previous chapter, enriching the sectorial evidence with a broader analysis. The results of this decomposition are presented in the following table, which report the emission differential x_i-x and its decomposition for the five analysed countries.

Table 10: Shift-Share analysis regarding all productive branches.

Country	Pollutant	X_i-X	M	Π	α	Share of the Primary factor	Primary factor (%)
Germany	ET	-3.287	-3.856	42.817	-42.248	48%	Π
	Co_2	-0.073	-0.037	**0.109**	-0.145	50%	A
	SOx	-0.524	**0.015**	-0.147	-0.392	71%	A
France	ET	-1.753	-0.524	-0.438	-0.791	45%	A
	Co_2	-0.206	-0.048	-0.169	**0.012**	74%	Π
	SOx	-0.498	-0.204	-0.392	**0.098**	56%	Π
Italy	ET	**0.689**	-1.402	**4.480**	-2.390	54%	Π
	Co_2	**0.037**	**0.015**	**0.072**	-0.050	53%	Π
	SOx	-0.333	-0.091	-0.032	-0.211	63%	A
Netherlands	ET	**3.698**	-1.006	**3.781**	**0.923**	66%	Π
	Co_2	-0.027	-0.042	**0.014**	**0.001**	73%	M
	SOx	-0.478	-0.131	-0.463	**0.115**	65%	Π
Sweden	ET	-0.753	**10.424**	-1.456	-9.720	48%	M
	Co_2	-0.217	-0.016	-0.186	-0.016	86%	Π
	SOx	-0.458	**0.110**	-0.447	-0.121	66%	Π

If we first consider the aggregate country environmental differential Xi-X the countries we selected tend to perform better than the EU27 average, as it is highlighted by the negative sign of most coefficients[11]. There are however some interesting exceptions. Netherlands and Italy, in fact, both present an aggregate environmental performance below the EU27 average, respectively for Energy Intensity (NL) and Energy Intensity and CO_2/VA (IT). The Italian evidence coherently remarks the results we commented on in section 3.This result, as confirmed by the other columns of the shift-share analysis, is due to a mix of different factors. For what concerns Emission Intensity, both countries are less efficient than EU average, as confirmed by the π factor, that account for the 66% of Netherlands differentials and the 54% of the Italian one. Similarly, is a mix of the π and μ factors that, accounting for the 53% and 10% of the total differential, caused the lower than average performances of the Italian CO_2/VA indicator. Italy is strikingly showing that its gloomy CO_2 performance is based on both heavy specialization and low efficiency. The latter is highly correlated to its low performance in CO_2 abatement technologies.

If, on the other hand, we analyse the results for the industry mix factor (μ), Germany and Sweden appear to be slightly more oriented towards SOx intense sectors, as shown by the positive coefficient associated to this value. The magnitude of this element accounts only for the 2% of the German differential, and the 16% of the Swedish one. More relevant is the case of Swedish Emission intensity, which despite being on average more efficient than the benchmark, show and high specialisation in polluting sectors. Finally, despite the generally very positive performance of

[11] All the shift-share indicators are very simple to interpret. A negative sign always means a better than average performance, and a positive sign a worse than average performance

Germany, the π factor shows as the Country tend to be less efficient than EU average for what concern CO_2 efficiency. A similar result is found in Netherlands[12].

5. Conclusions

The analyses in this work attempt to investigate the static and dynamic performance of EU sectors, with the aim of understanding whether economic, environmental and environmental innovation performances are correlated. We assess the presence of win win scenarios on the basis of a sector based scrutiny of main 5 EU countries which show cross heterogeneity in the economic structure and accounts for more than 50% of EU27 GDP.

We analyse the role of EI diffusion and its relationships with economic and environmental productivities, descriptively analysing performances for major sectors, top expanding and top shrinking branches. The idea is to provide a general but integrated assessment of how Europe has changed over the past, what performances sectors have shown, and finally whether the recent evolution of the economy is coherent (or not) with a greener, competitive, sustainable economy.

First, we note on the basis of our investigation that economic and environmental performances are effectively potentially interrelated. Examples of integrated innovation-economic-environmental performances appear.

The current EU crisis is not a debt crisis per se, but a crisis that originates from a lack of convergence in relation to innovation and economic productivity performances. We claim and see that environmental performances are far from being detached from the above performances. They are strictly integrated in what may be defined an 'overall competitiveness'. Natural sector specialization of the economy matters in explaining competitiveness, but also industrial, innovation and environmental policies are part of the picture (as drivers of the integrated competitiveness). We have shown how countries have specialized in quite different sectors – within the natural movement towards a service based economy. Though expanding and more competitive sectors show a relative higher likelihood of integrated performances, we note that even in shrinking sectors (typically manufacturing, thus directly more polluting) joint performances are present.

More specifically, some emerging sectors appear those that show the most fruitful amalgamation of economic and environmental dynamics. Innovation confirms to be often a key correlated factor. This is evident for the interesting case of electrical machinery in Germany, a manufacturing sector that has expanded in the EU, and for some cases in services in Germany and France (such as air transport) as well as Sweden (land transport).

It is also worth noting how the overall performance of Germany and France, among others, is relatively better than that of countries plagued by structural productivity and environmental performance gaps due to a fiercer resistance of shrinking sectors to the challenges of international competition. In those countries even a sector such as textile appears to defend itself through the adoption of innovation.

[12] These final results for CO_2 and SOX confirms the evidence reported in table 2, which highlights that Germany and Sweden are the only two countries with a strong specialisation in manufacturing sectors (electrical machinery), while the other countries are more specialised in Services. We remark that though Germany is highly industrialised (the most industrialised within EU15), the manufacturing share is lower with regard to some East EU countries. This is to be considered when analysing these outcomes which refer to EU27. We here adhere to a full EU27 perspective.

Expanding sectors lead the current and future recomposition of the economy, but shrinking sectors can produce economic and environmental value even at smaller shares. The importance of integrating economic and environmental performances on both sides of the structural recomposition of the EU economies is then clear for a comprehensive achievement of sustainability and competiveness.

References

Costantini V. Mazzanti M. (2012), On the Green side of trade competitiveness? Evidence from the EU, *Research Policy*, 41.

Costantini V. Mazzanti M. (2013), *The dynamics of economic and environmental systems*, Springer.

Costantini, V., Mazzanti, M. & Montini, A. (2011). *Hybrid Economic Environmental Accounts*. London: Routledge.

Dopfer, K. (2012). The origins of meso economics. *Journal of Evolutionary Economics*, 22, 133-160.

Dunn E.S., (1960), A statistical and analytical technique for regional analysis. *Papers and Proceedings of the Regional Science Association* 6, 97–112.

Esteban J., (2000), Regional convergence in Europe and the industry mix: a shift-share analysis, *Regional Science and Urban Economics*, 30, 3, Pages 353-364.

Garcia-Milà T., McGuire T.J., (1993), Industrial mix as a factor in the growth and variability of states' economies, *Regional Science and Urban Economics*, 23, 6, 731-748.

Horbach J. Rennings K. Rammer C. (2012), Determinants of eco-innovations by type of environmental impact The role of regulatory push/pull, technology push and market pull *Ecological economics*, 78, 112-122.

Kemp R. (2000), Technology and Environmental Policy-Innovation effects of past policies and suggestions for improvement, *OECD proceedings Innovation and the Environment*, OECD, Paris, 35-61

Kemp R., S. Pontoglio (2011) The innovation effects of environmental policy instruments. A typical case of the blind men and the elephant, *Ecological Economics*, 72, 28-36.

Malerba F. (Ed.) (2004), *Sectoral Systems of Innovation: Concepts, Issues and Analysis of six Major Sectors in Europe,* Cambridge University Press: Cambridge

Marin G., Mazzanti M., (2012), The evolution of environmental and labour productivity dynamics, *Journal of Evolutionary Economics* (in press, i-first).

Mazzanti M., Montini A., Marin G., (2012), Aggregation biases in environmental extended input output: evidence from Italy and Spain, *Ecological Economics*, January.

Mazzanti M., Zoboli R., (2009), Environmental efficiency and labour productivity: trade-off or joint dynamics?, *Ecological Economics*, 68, 4, 1182-94.

Montalvo C., Moghayer S., (2012), State of an innovation system: theoretical and empirical advance towards an innovation efficiency index. Paper presented at the DRUID 2012, CBS, Copenhagen, Denmark.

OECD (2011), Inventions and transfer of Environmental technologies, OECD, Paris.

Veugelers R., (2012), Which Policy instruments to induce clean innovating? *Research Policy,* (in press).

Appendix

Table A1. Acronyms

	Acronim	Description
Sector	1516	Food products, beverage, tobacco
	1718	Textiles and wearing apparel
	19	Leather, luggage and handbags
	20	Wood and products of wood and cork
	2122	Pulp, paper and paper products
	23	Coke, refined petroleum products and nuclear fuel
	24	Chemicals and chemical products
	25	Rubber and plastic product
	26	Other non metallic mineral products
	2728	Basic metals; fabricated metal products, except machinery and equipment
	29	Machinery and equipment n.e.c.
	3033	Office machinery and computers; electrical machinery and apparatus n.e.c.; communication equipment
	3435	Motor vehicles
	3637	Furniture, manufactiring n.e.c.; recycling
	50	Sale, maintenance and repair of motor vehicles and motorcycles
	51	Wholesale trade and commission trade except of motor vehicles and motorcycles
	52	Retail trade, except of motorveichles and motorcycles; repair of personal and household goods
	60	Land transport; transport via pipelines
	61	Water transport
	62	Air transport
	63	Supporting and auxiliary transport activities; activities of travel agencies
	64	Post and telecommunication
	70	Real estate activities
	7174	Renting of machinery and equipment; computer and related activities; research and development; other business activities
	AB	Agricolture and fishing
	C	Mining and quarrying
	E	Electricity, gas and water supply
	F	Construction
	H	Hotels and restaurants
	J	Credit institution and insurance
	L	Public administration and defence; compulsory and social security
	M	Education
	N	Health and social work
	O	Other community, social and personal service activities
	P	Private households with employed persons
	VA/L	Labour productivity
Environmental performance	SOx/VA	Sulphur oxide emission on value added
	CO_2/VA	Carbon dioxide emission on vale added
	EN.INT	Energy Intensity
EI (% of firms)	CIS EN.EFF	Reduced energy use per unit of output
	CIS CO_2	Reduced CO_2 emission (Innovation)
	CIS WASTE	Recycled waste, water, or materials

Table A2. Average values for the EU sectors

Labour Productivity (VA/L)						CO_2/Va					SOx/Va				
Sector	**Min**		**Max**		**EU Average**	**Min**		**Max**		**EU Average**	**Min**		**Max**		**EU Average**
Textiles	3.201	ROU	165.877	LUX	39.726	0.009	MLT	0.476	LTU	0.176	0.001	NLD	1.518	EST	0.316
Leather	2.003	ROU	179.434	IRL	37.345	0.016	AUT	0.933	EST	0.244	0.000	AUT	6.618	EST	0.530
Wood	0.755	BGR	94.134	LUX	36.520	0.042	MLT	3.399	BGR	0.338	0.001	SVK	16.638	BGR	1.010
Pulp and Paper	3.290	BGR	240.055	IRL	61.958	0.006	MLT	2.941	BGR	0.420	0.002	LVA	44.916	BGR	2.448
Petroleum Products	0.000	LVA	1067.875	SWE	179.373	0.017	ROU	50.662	DEU	10.695	0.037	CYP	247.898	CZE	41.938
Rubber and Plastics	3.705	BGR	132.122	BEL	51.508	0.009	MLT	1.232	BGR	0.198	0.000	NLD	2.130	EST	0.246
Machinery and Equipment n.e.c.	5.083	ROU	101.460	FRA	50.534	0.004	FIN	3.090	CYP	0.273	0.000	NLD	5.798	EST	0.495
Computer and Electrical Machinery	3.342	BGR	799.828	SWE	105.309	0.000	FIN	6.538	CYP	0.523	0.000	FIN	74.514	ROU	3.079
Other Transport Equipment	5.178	ROU	122.023	AUT	54.935	0.011	PRT	7.639	CYP	0.580	0.000	PRT	5.152	EST	0.551
Wholesale Trade	2.630	BGR	223.962	LUX	56.882	0.006	HUN	0.459	LVA	0.068	0.000	NLD	0.166	LTU	0.024
Water Transport	3.616	SVK	962.712	DEU	113.238	0.018	CYP	31.056	DNK	3.987	0.000	CYP	290.383	DNK	26.014
Air Transport	5.470	HUN	330.889	BEL	93.830	0.004	CYP	27.610	HUN	4.267	0.000	CYP	7.842	EST	0.855
Other Transport Activities	8.001	ROU	121.294	FIN	48.500	0.008	FRA	0.730	ROU	0.146	0.000	NLD	1.234	LTU	0.098
Telecommunication	10.668	ROU	362.828	LUX	110.120	0.003	CYP	0.279	ROU	0.047	0.000	NLD	0.114	HUN	0.015
Real Estate	12.294	BGR	1906.357	GRC	407.760	0.001	AUT	0.232	CZE	0.035	0.000	ITA	0.472	CZE	0.031
Renting, R&D and other Activities	5.897	LTU	80.182	GBR	36.128	0.004	ESP	0.569	BGR	0.101	0.000	SWE	0.260	POL	0.025
Electicity supply	6.108	ROU	363.950	GBR	154.755	0.994	FRA	118.925	EST	15.132	0.263	AUT	607.049	EST	79.531
Construction	2.275	BGR	65.651	BEL	27.766	0.014	GRC	1.799	BGR	0.279	0.002	ESP	4.320	BGR	0.411
Credit and Insurance	10.803	SVK	213.860	DNK	99.903	0.001	PRT	0.503		0.048	0.000	PRT	0.595	BGR	0.029

Source: WIOD, extraction in May 2012.

Table A3. Summary of environmental innovation adotion in the EU. Share of firms (value range between 0 and 1).

Sector	Efficiency in Material Use	Energy Efficiency	CO_2 Abatement	SOx Abatement	Waste Reduction and Recycling
Industry (except construction)	0.316	0.341	0.224	0.315	0.350
Manufacturing	0.321	0.338	0.216	0.306	0.344
Electricity, Gas and Air conditioning supply	0.270	0.412	0.474	0.452	0.299
Construction	0.241	0.299	0.221	0.306	0.378
Services of the Business Economy	0.158	0.186	0.142	0.165	0.219
Total average (all sectors)	0.263	0.301	0.228	0.291	0.326

Source: Eurostat (May 2012)