Exploring the patterns of Eco-Innovation index and Competitiveness index in Europe

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Exploring Feedback Loops between Performance Measures. Energy and Environmental Efficiency under heterogeneous Eco-Innovation groups

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Abstract

By following a two-stage analysis, we explore whether resource efficiency measures are interconnected through feedback loops under heterogeneous eco-innovation regimes. In the first stage we adopt the bootstrap Data Envelopment Analysis and a Directional Distance Function approach to estimate productive performance, energy and environmental efficiency of each country under a metafrontier total factor productivity framework accounting for technological heterogeneity and input complementarities. In the second, we employ the potential of the identification through heteroskedasticity estimator to tackle endogeneity concerns surrounding performance measures, we seek the drivers of resource efficiency measures. We comprise a unique balanced panel for the EU-28 from 2010 through 2014 including the eco-innovation index and hand-collected data on the global competitiveness index. Findings indicate that resource efficiency measures despite those are interconnected through feedback loops, they act either as closely related measures i.e. *blood brothers* or as loosely related ones i.e. *distant relatives*. This is particularly relevant for policy design. In this line, findings indicate that there is not a one-size-fits-all policy as the eco-innovation group each country belongs to should be considered as well since the latter respond in an asymmetric manner to candidate drivers.

Keywords: Resource Efficiency, Environmental & Energy Efficiency, Productive Performance, Eco-Innovation Index, Sustainability, Metafrontier & Heterogeneity, Feedback loop

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The usual disclaimer applies.

Table of Contents

List of Tables

Table of Figures

1. Introduction

Over the last decade, EU has devoted significant efforts to build a coherent framework to promote resource efficiency to protect the environmental, preserve its quality and organize a defending strategy against the ever-present threat of climate change. In this line, the economic and environmental policy, has been materialized through specialized directives such as the Thematic Strategy for the Sustainable Use of Natural Resources (2005) and theResource Efficiency Flagship Initiative (2011) as one of the seven initiatives under the Europe 2020 strategy. The Roadmap to a Resource Efficient Europe (COM, 2011 571) is an integral pillar of the Flagship initiative providing a framework for design and implementation of long-term actions. The goal is to improve the use of natural resources and reduce carbon dependency though a more efficient plan of action leading to a prosperous and sustainable Europe.

Recently (December 2019), the European Commission launched its 2050 long-term strategy with carbon neutrality being the main block (European Commission, COM (2018) 773) aligned with the Paris Agreements (COP21, 2015) and the recent report of the Intergovernmental Panel on Climate Change (IPCC, 2018) for a climate-neutral economy structure through the use of more efficient technology to mobilize all levels of the chain from citizens to countries to shift to low carbon action plan adoption to build a sustainable economy. Even more recently, the European Green Deal as a package of measures serves as the instrument to promote the Commission's strategy to a smooth transition to sustainability. Thus, resource efficiency is found in the center of attention at a worldwide scale with agencies and institutions supporting policy guidance to establish resource efficient economies linking the latter to sustainability through the recent initiative of the Sustainable Development Goals (OECD, 2015; UN Environment; 2015).

Bringing together the above, the 2021-2030 directive of EU to the member states is to develop an integrated strategy about energy efficiency, climate action to align with the obligations from the Paris Declaration (ICCP, 2015) and research, innovation and competitiveness among others. In this line, the Resource Efficiency initiative sets the scene for further productivity improvement. Focusing on resource efficiency and policy making, one needs to consider that measures capturing resource efficiency such as environmental and energy efficiency, may affect each other and augmenting this argument, policy design to improve resource efficiency needs to dig deeper in this direction.

In this sense and considering the fact that performance measures are part of the same family, the question about how close are the relationships among them becomes apparent. In other words, the need to investigate whether the measures evolve through distinct channels and could be characterized as *distant relatives* or those are related closely to each other to be characterized as *blood brothers* comes naturally to the forefront. It should also be mentioned that as those measures belong to the same family thus are derived as well as affected by common factors which raises endogeneity concerns in the framework of performance evaluation (Tsekouras et al., 2016). Therefore, *the main research question examined herein the whether energy and environmental efficiency at the European level are interconnected through feedback loops*.

The term resource efficiency is meant to capture the responsible and sustainable use of the scarce natural resources to produce greater output with less input. Implicitly, such a definition, although valid, is only partial as it neglects input complementarities. Therefore, a total factor productivity framework would be more adequate to measure the extent of efficient resource usage. Additionally, the way resources are combined to produce output depends on the access economies have to technological achievements. It is thus important to consider the technology heterogeneity and asymmetry affecting the extent of resource efficiency, as the challenge is how to use the existing endowment level in the most efficient way so as to create more value using less raw resources to mitigate the negative effects of the production process.

Moreover, the merit of national competitiveness should also be taken into consideration in boosting the prosperity and welfare of the country economies (World Economic Forum). Although there is a component for innovation in the global competitiveness, in order to monitor and evaluate progress of the member states, many indicators have been constructed which can be found in the resource efficiency scoreboard[1]. Within the abovementioned policy framework, the eco-innovation index which has been recently offered by the European Commission in the framework of the Eco-innovation action plan, is related to resource efficiency promoting growth and prosperity.

All in all, this paper is the first attempt to study the relationship between resource efficiency measures such as the environmental and energy efficiency through an heterogeneity framework acknowledging for endogeneity in the content of the Resource Efficiency Flagship Initiative embracing the Eco-Innovation index to explore the patterns of performance measures. To the best of our knowledge, no other studies have surfaced yet to explore such a question, and therefore it remains a void to be filled.

This paper unfolds as follows. The next section offers a brief review of the relevant literature, Section 3 presents the methods adopted and research hypotheses, Section 4 presents the data, Section 5 is dedicated to the results and policy implications while Section 6 concludes the paper.

2. Brief Literature Endeavours

The contributions to the literature of energy as well as environmental efficiency have been proliferated over the years in an exponential manner. This has resulted in a quite vivid in terms of applications, aggregation level, methods, results and policy implications stock of knowledge for both resource efficiency measures (e.g. Zhang et al., 2011l; Stern, 2012). This section however, does not aim to be exhaustive in terms of presentation but to set the scene in which the present paper aims to contribute at.

Given the recent European initiatives towards the transition to a more sustainable society e.g. Europe 2020 Strategy, The European Green Deal, becomes apparent that resource efficiency measures are pillars of the same policy agenda and thus the relationships between environmental efficiency, energy efficiency, productive performance or eco-innovation should be studied under the same framework.

At an industry level, productivity indicators have been proposed (Beltrán-Esteve & Picazo-Tadeo, 2015) however only a few studies acknowledge cross-country technological heterogeneity by applying the concept of metafrontier to find that policy directives should target to boost green technologies in EU-28 (Beltrán-Esteve et al., 2019). Eco-efficiency and eco-innovation have also been explored for the OECD countries using two-stage network DEA analysis and big data in an attempt to find the leaders of each measure (Mavi et al.,

[1] Provided by Eurostat's official database.

2019). Recent studies explore the links between eco-innovation and performance at an industry level focusing on specific countries (Cheng et al., 2014). As Cheng et al. (2014) argue there is not a single type of eco-innovation.

Another strand has focused on the eco-innovation of the enterprises. More precisely, the measurement of eco-innovation and its drivers has attracted significant amount of interest both for the case of European countries as a total (Triguero et al., 2013) but also for individual cases (Kesidou & Demirel, 2012). Rennings (2000) however, put eco-innovation in another perspective in a way that the concept is related to technology, energy efficiency, regulation and market characteristics.

At a country level, there have been attempts to study the effect of policy-mix on eco-innovation patterns so as to boost energy efficient technologies (Costantini et al., 2017). However, the interest has not been placed on resource efficiency measures explicitly. Liu et al. (2018) focusing mostly on the examination of feedback loops between the global value chain with energy efficiency and environmental efficiency, however possible feedback loops between resource efficiency measures and the role of productive performance have been neglected. Chatzistamoulou et al. (2019) put in perspective the relationship between measures of performance by investigating energy efficiency patterns under heterogeneous competitiveness regimes considering productive performance as a driver of energy efficiency, reversing the crystalized perception that the latter is a function of the former. In the same line, Chatzistamoulou and Kounetas (2019, wp) explore environmental efficiency patterns in Europe under technological heterogeneity to find that productive performance negatively affects environmental efficiency and that competitiveness is a necessary but not sufficient condition for performance enhancement. However, a systematic attempt to relate those performance measures under a unified framework has not been surfaced yet.

However, in this paper, we explore whether energy and environmental efficiency are related through feedback loops for the case of EU-28 considering productive performance and eco-innovation index, inter alia, in the context of resource efficiency improvement toward sustainability.

3. Methodological and theoretical considerations

3.1 Revealing heterogeneous Eco-Innovation regimes

Figure 1 below presents the empirical distribution of the eco-innovation index for the period of study. It is noticeable that the distribution is bimodal indicating that two heterogeneous groups co-exist. In order to group the country economies that form each group, we apply the *k*-means clustering procedure to construct the two eco-innovation regimes as in Chatzistamoulou et al. (2019). Thus, we create the Eco-Innovation leaders (onwards EIL) and followers (onwards EIF) cluster respectively. Therefore, there is empirical evidence, as well as theoretical justification based on the work of Dyson et al. (2001) who argue that a limited number of entities in a group during the performance evaluation results in a higher but deceiving number of fully efficient entities. Thus, in the context of benchmarking the scenario of having two groups can be supported despite the fact that the EU member states have been classified into three groups based on the eco-innovation scoreboard (leader, average, catch-up) by the DG Environment.

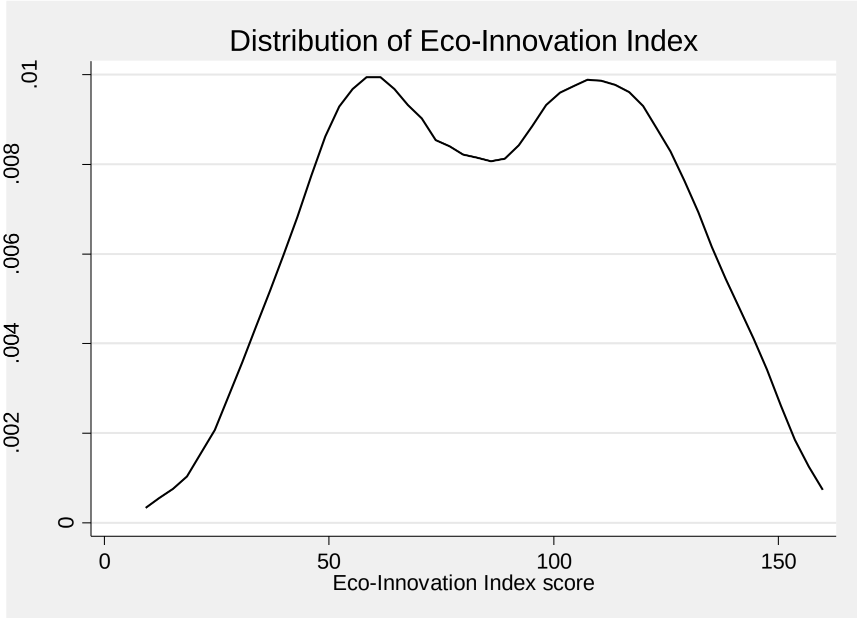

Figure 1. Distribution of the Eco-Innovation Index, 2010-2014.
Source: Own construction.

3.2 Performance assessment under technology heterogeneity

Consider a country economy $i = 1,2, \dots, n$ as an entity transforming inputs $x = (x_{1i}, x_{2i}, , \dots, x_{Ni},) \in \Re_+^N$ into outputs $y = (y_{1i}, y_{2i}, , \dots, y_{Mi},) \in \Re_+^M$ under a technology set S defined as $S \equiv \{(x, y): x\ can\ produce\ y\}$. For the input-oriented productive performance scores, the technology is represented by its production possibility set $L(y) = \{x \in \Re_+^N: (x, y) \in S\}$, while for measuring productive performance we use the input distance function defined as $D_I(x, y) = sup\{\theta > 0: x/\theta \in L(y)\}$. Given the two eco-innovation regimes (technology structures) T^{EIL}, T^{EIF} exist, the European metatechnology set, denoted as T^M, can be defined as the convex hull of the jointure of the two represented as $T^M = \{(x, y: x \geq 0, y \geq 0)\ x\ can\ produce\ at\ least\ one\ of\ T^{EIF}, T^{EIL}\}$ (Batesse et al., 2004). Each individual technology set can be defined similarly.

A two-stage analysis is employed. In the first stage, by adopting the metafrontier framework (onwards European technology) as introduced by Hayami (1969) and Hayami and Ruttan (1970) and further developed by O'Donnell et al., (2008), and employing the bootstrap version of the input-oriented Data Envelopment Analysis (DEA) technique under variable returns to scale (Bogetof & Otto, 2010) to account for size effects (Halkos & Tzeremes, 2009), we calculate the bias corrected productive performance (*MTEff*) of each country economy with respect to the european technology using the following formula[2]:

$$MTEff_i \equiv \hat{\theta}(x, y) = \min\{\theta | \theta > 0, y \leq \textstyle\sum_{i=1}^{n} \gamma_i y_i; \theta x \geq \sum_{i=1}^{n} \gamma_i x_i \text{ for } \gamma_i$$
(1)

such that

$$\textstyle\sum_{i=1}^{n} \gamma_i = 1;\ \gamma_i \geq 0, i = 1,2, \dots, K\} \tag{1}$$

The meta-technology ratio (*MTR*) is calculated for each country economy on an annual basis, using the formula below:

$$MTR_i(x, y) = \frac{MTEff_i(x,y)}{ProdPerf_i(x,y)} \tag{2}$$

The technology gap is defined as the distance of the individual frontier to the universal technology (O'Donnell et al., 2008) whereas as Chatzistamoulou et al. (2019) argue, it represents the opportunity cost of the unexploited potential to improve performance while at the same time conveys information regarding the technological spillover generated at the European level diffused towards the group frontiers i.e. incoming spillovers.

Then, following Hu and Wang (2006), we calculate the *slack-based energy efficiency*[3] of the *i-th* country economy, at year *t* (Equation 4), using the input slacks associated with each country provided by the DEA (Coelli et al., 2005) for the case of the European metatechnology, as below:

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[2] The productive performance (*ProdPerf*) of each country economy within each cluster is calculated by employing Eq. (1)

[3] It has been also used under a productivity framework (Førsund, F. R., & Kittelsen, 1998; Wei et al., 2010) with the criticism to focus on the use of only radial adjustments (Honma & Hu, 2008).

$$EnergyEfficiency_{it} = \frac{(Target\ Energy\ Input)_{it}}{(Actual\ Energy\ Input)_{it}} = 1 - \frac{(Energy\ slack + Radial\ adjustment)_{it}}{(Actual\ Energy\ input)_{it}} \quad (3)$$

The next step is to calculate the environmental efficiency of each country economy at the European level, by following closely the works of Chambers et al., (1996), Chung et al., (1997) and Fare and Grosskopf (2000). However, in this case, two kinds of outputs may be discerned, the desirable output $y = (y_1, y_2 \dots, y_k) \in \Re_+^K$ and the undesirable output $b = (b_1, b_2 \dots, b_l) \in \Re_+^L$ respectively[4] (Kumar and Khanna, 2009). The underlying production process is constrained by the technology set[5] T defined as $T(x) = \{(y, b): x\ can\ produce\ (y, b)\}$ (Dervaux et al. 2009).

The directional distance function (DDF) is a representation of a multi-input, multi-output distance function. Following Chambers et al., (1998) and Picazo-Tadeo et al., (2005) the DDF on technology T is defined as:

$$\overrightarrow{D_T}(x, y, b; g_y, g_b) = max\{\beta^*: (x, y + \beta^* g_y, b - \beta^* g_b) \in T(x, y, b)\} \quad (4)$$

Indeed, the DDF projects the input-output vector (x, y) onto the technology frontier in the $(g_y, -g_b)$ direction allowing desirable outputs to be proportionally increased, whereas bad output(s) to be proportionally decreased. More precisely, it seeks the maximum attainable expansion of desirable outputs in direction (g_y) and the largest feasible contraction of the undesirable outputs in direction$(-g_b)$. Considering that the technology set has been restricted only to the production of good output[6], the environmental efficiency at the European technology level i.e. metafrontier, $EnvEff^{MF}$, may be defined as follows:

$$EnvEff^{MF} = \frac{\left(1 + \overrightarrow{D_T^{MF}}(x, y, b; g_y, g_b)\right)}{\left(1 + \overrightarrow{D_T^{MF}}(x, y, b; g_y)\right)}, \quad (5)$$

with the environmental efficiency for the individual production frontiers to be defined in an analogous manner.

The environmental efficiency index $(EnvEff^{MF})$ aims to capture the contraction in increasing outputs by each industry under the potential ability of the production process convention from free disposability to costly disposal of CO_2 taking values between zero and one. Conceptually, for an industry with environmental efficiency score equal to one, the cost of transforming their production from strong disposability to weak for CO_2 should be zero while values lower than one denote a significant opportunity cost for this transformation

[4] Note that the two different output sets are actually sub-vectors of the $y^* \in \Re_+^M$ output set.

[5] The technology set corresponds to all technologically feasible relationships between inputs and outputs while at the same time it satisfies a set of axioms discussed in Shepard (1953; 1970) and Luenberger (1992; 1995) that is (i) inactivity is allowed, (ii)"free lunch" is not allowed (Kumar, 2006), (iii) technology is convex, bounded and closed (Chambers et al., 1996), (iv) good outputs are "null-joint" with the bad outputs and (v) free availability of inputs and outputs (see Zhou et al., 2012 for a further discussion).

[6] $\overrightarrow{D_T}(x, y, b; g_y)$ is defined as $\overrightarrow{D_T}(x, y, b; g_y) = \max\{\beta^*: (x, y + \beta^* g_y) \in T(x, y)\}$.

(Kumar & Khanna, 2009). Furthermore, environmental efficiency has been defined as the ratio of two distance functions assuming strong and weak disposability of CO_2 emissions. Since the frontier, which was constructed assuming weak disposability of pollutants, envelops the data more closely than the frontier constructed assuming strong disposability, the ratio of those two distances leads to values very close or equal to one (Zaim & Taskin 2000).

3.3 Econometric Strategy and Hypotheses Testing

3.3.1. Identification through heteroscedasticity

In the quest to explore whether resource efficiency measures are related, the absence of a structural model adds an extra layer of complexity to an already tangled issue. Although the metafrontier accommodates for heterogeneity (O'Donnell et al., 2008; Tsekouras et al., 2016), reinforces endogeneity suspicions as measures of performance occur within the same technology set. This makes them more prone to common unobserved factors and omitted variables bias. Even if the countries under examination belong to the same group e.g. European Union, a latent aspect in the form of structural shocks, latent policy decisions and turbulence across countries over time is ever present, as the degree of resilience to random events is not symmetric. Due to the intrinsic difficulty to be quantified, those are included in the disturbance term provoking heteroskedasticity.

The above discussion brings to the forefront endogeneity concerns as well. Therefore, with the main assumptions of the linear model to be violated the need for a tool capable to cope with the lack of valid instruments becomes apparent. A plausible choice to this direction proves to be the *identification through heteroskedasticity estimator* proposed by Lewbel (2012) and implemented by Baum and Schaffer (2017) which is based on the heteroskedasticity of the structural shocks e.g. unobserved differences across countries, when no external source of variation is available.

This estimator proves to be the appropriate strategy in this context as it may be used when no external instruments and repeated measurements are available or standard identification assumptions cannot be justified (Ebbes et al., 2009; Lewbel, 2012). The method is based on higher moments and especially the third moment i.e. skewness of the data to achieve identification which is also a point of criticism compared to standard identification techniques. Nevertheless it is a legitimate estimation strategy lack of other options (Lewbel, 2012). A basic assumption of this method is that identification is achieved by restricting the correlations of the product of the heteroskedastic errors with the exogenous regressors in the model.

Thus, the method generates instruments using the residuals from the auxiliary regression (including a constant term) multiplied by the model's exogenous variables establishing zero covariance with each of the mean-centered generated instruments. Moreover, this method provides the opportunity to augment the instruments list by including external instruments to identify the model.

3.3.2. Seeking the drivers of resource efficiency measures

In the second stage, we seek to explore the drivers of resource efficiency measures though empirical models whereas we turn the spotlight on the possible feedback loop between the two performance measures. Therefore, we specify and estimate the following models for the metafrontier i.e. European level technology, by employing the identification through heteroskedasticity estimator:

$$EnvEff_{it}^{MF} = a_0 + \beta_1 EnergyEff_{it} + \beta_2 ProdPerf_{it} + \beta_3 GCI_{it-1} + +\beta_4 EcoInnovIndex_{it} + \beta_5 FraserIndex_{it} + \beta_6 EconStruIndex_{it} + \beta_7 \boldsymbol{TimeTrend} + u_{it} \quad (6)$$

$$EnergyEff_{it}^{MF} = a_1 + \gamma_1 EnvEff_{it} + \gamma_2 ProdPerf_{it} + \gamma_3 GCI_{it-1} + +\gamma_4 EcoInnovIndex_{it} + \gamma_5 FraserIndex_{it} + \gamma_6 EconStruIndex_{it} + \gamma_7 \boldsymbol{TimeTrend} + v_{it} \quad (7)$$

where $EnvEff_{it}^{MF}$ and $EnergyEff_{it}^{MF}$ are the environmental and energy efficiency the *i-country* in year *t* with respect to the European technology.

The feedback loop captured by the $EnergyEff_{it}$ *and* $EnvEff_{it}$ has been included to investigate whether resource efficiency measures are interconnected. In the context of the European Green Deal and the on-going agenda of sustainable development through green growth this becomes particularly relevant for policy implications. Formally stated, the main research hypothesis examined herein could be stated as follows:

> H_1: *Resource efficiency measures occur contemporaneously and thus are closely related affecting each other via feedback loops.*

In other words, environmental and energy efficiency are a driver of each other not only because they are derived by the same production technology set but also because those are affected by the same policy directives. Thus, the feedback loop could act as an indication of a direct effect between resource efficiency measures. The literature has acknowledged causal relationship between measures of performance (e.g. Chatzistamoulou et al., 2019), however this is the first time that this is investigated in the context of resource efficiency measures in the framework of a European Initiative such as the Flagship initiative. In a nutshell, rejecting the null would indicate that despite being part of the broad family of performance measures there are no tight bonds i.e. they could act as *distant relatives* whereas evidence in favor of the null would be an indication of a strong relationship i.e. resource efficiency measures could be characterized as *blood brothers*.

$ProdPerf_{it}$ is the productive performance of each country with respect to the European level of technology and it is considered the most fundamental measure of performance of an entity. The literature has acknowledged its effect on energy efficiency (Chatzistamoulou et al., 2019) and other performance measures such as technology gap (Tsekouras et al., 2016) with asymmetric effects on distinct performance groups however. Thus, we formulate and test the following research question:

> H_2: *Productive performance exerts a positive and significance influence on resource efficiency measures despite the existence of heterogeneity groups.*

By rejecting the null, we are inclined to think that there is a sort of inefficiency in the resource allocation when the strategic orientation is to increase productive performance within a limited time window. Moreover, rejecting the null would indicate that technological heterogeneity does not have a distorting effect on resource efficiency measures as there is no differentiating effect of productive performance on the former.

The role of competitiveness has been acknowledged by the literature (Tsekouras et al., 2016; 2017; Chatzistamoulou et al., 2019; Gkypali et al., 2019) and in this content it is captured by the GCI which is country-specific and time-varying. Lagged values of competitiveness capture the absorptive capacity levels of each country indicating the ability to transform technological achievements into improved performance (Cohen and Levinthal, 1990) while it reinforces the ability and potentiality to absorb accumulated knowledge generated across aspects of the economy. This can be formally stated in the form of a hypothesis as:

> H_3: *The level of absorptive capacity of EU member states facilitates the resource efficiency performance both at the European as well as at the eco-innovation regimes each member state belongs to.*

By rejecting the null would imply that low technological opportunities and assimilation ability affect negatively the resource efficiency measures.

$EcoInnovIndex_{it}$ captures the overall performance of each country on the recently developed Eco-innovation index in the context of the EU Flagship Initiative and it is used for the first time in the empirical analysis in order to explain resource efficiency patterns. $FraserIndex_{it}, and\ EconStruIndex_{it}$ have been included to capture the overall performance to the Fraser Index and the economy structure index which has been created by combining[7] the share of industry, manufacturing and services on the national product capturing the production environment of each country into a common index. Thus this is a country-specific time varying variable setting the foundation for resource efficiency enhancement. Rec_{it} is the share of renewable energy consumption at the country level capturing the use resource-saving and environmentally aware technologies and $TimeTrend_{it}$ captures the time heterogeneity while u_{it} and v_{it}, are the disturbance terms. The parameters to be estimated are $a, \boldsymbol{\beta}, \boldsymbol{\gamma}, u_{it}$ and v_{it}.

[7] This has been done by employing the Principal Components Analysis (varimax rotation) to decrease the number of dimensions due to the small number of observations in the panel.

4. Data & variables

We devise a unique dataset by co-ordinating, matching and harmonising several complementary publicly available official sources covering twenty-eight European Union member states[8] over a five-year period, from 2010 through 2014. The dataset's contribution is elevated using data on the eco-innovation index. The index measures the eco-innovation performance facilitating comparisons across the member states showing how well those perform in economic, environment and social dimension while simultaneously presenting strengths and challenges of each national economy. Moreover, the dataset is benefited by detailed hand-collected data on the global competitiveness index (onwards GCI) for all country economies[9] included. Therefore, the panel consists of 140 observations.

We collect data on two outputs and three inputs. The outputs are captured by the desired output that is gross domestic product (GDP) of each country economy (measured in million US $) and the undesired that is the carbon dioxide emissions (CO_2) stemming from the production processes in each member state (measures in kt). Inputs are captured by the capital stock (K) (measured in mil. US$), labour proxied by the number of persons engaged (measured in mil.) and the energy captured by the energy use (measured in kt of oil equivalent). All monetary values are in constant 2011 prices. Although extending the dataset to cover more years appears to be technically possible, series of particular importance to the analysis such as energy use and CO_2 emissions have been not been updated yet and constructing data would compromise the validity of the results. Therefore, the dataset's coverage has been determined by the last known figure of those variables.

Data on the eco-innovation index were collected through the Eco-innovation Scoreboard of the DG Environment Eco-Innovation Action Plan published by the Eco-Innovation Observatory. The potential of such detailed data is employed for the first time in performance evaluation, to the best of our knowledge. Furthermore, data describing the structure economy proxied by the contribution of the industry, manufacturing, services, shares of renewable energy use and foreign direct investments (to the GDP) respectively have been collected as well. Moreover, data was collected on the Economic Freedom index (Fraser Index) measuring the functionality of each economy affecting its performance.

As far as the rest of the variables is concerned, official data sources were co-ordinated to compile the dataset as mentioned. Data on Gross Domestic Product, Capital stock, Labour was collected through the Groningen Growth and Development Centre (GGDC), World Penn Tables 9.1. Data on CO_2, Energy use, Renewable energy use, Industry, Manufacturing & Services contribution and foreign direct investments have been collected through the World Bank database. Data on GCI has been hand-collected through various editions of the Global Competitiveness Report published by the World Economic Forum annually while data on the Economic Freedom index was collected through the Fraser Institute official site. Tables A1 and A2 in the Appendix illustrate the descriptives of the main variables and brief description of the dataset respectively.

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8 Austria, Belgium, Bulgaria, Croatia, Cyprus, Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, Netherlands, Poland, Portugal, Romania, Slovakia, Slovenia, Spain, Sweden, United Kingdom.

9 Pillars include Institutions, Infrastructure, Macroeconomic Environment, Health and Primary Education, Higher Education and Training, Goods market efficiency, Financial market development, technological readiness, market size, business sophistication and innovation.

5. Results, discussion & policy suggestions

5.1 Exploring the patterns of Eco-Innovation index

Figure 1 below presents the mean values of the Eco-Innovation (EI) index across the member states of European Union for the period 2010-2014. We notice that there is a significant amount of heterogeneity among the member states and this could be attributed to differences in the resource endowments, ability to internalize and benefit from technological advancements at the European level as well as to the strategic orientation and political decisions taken at the national level.

The European average for the period of study is 87.96. More precisely, among the top 3 performing countries, we find Denmark (136.8), Germany and Sweden achieving the same score on average (132) while Spain (119) follows. The bottom 3 countries are Bulgaria (36.00), Poland (40.4) and Slovak Rep. (49.00).

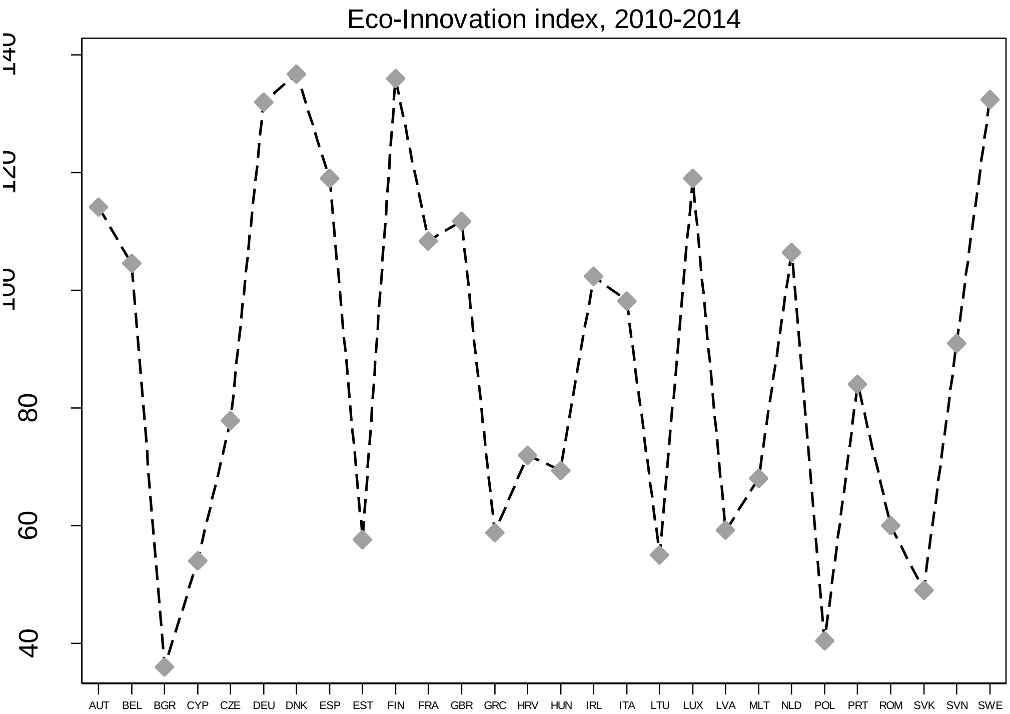

Figure 2. Eco-Innovation index, EU-28, 2010-2014.
Source: Own construction.

As the EI index encapsulates thematic areas and indicators that are related to the performance and technology level of each country, it is not meaningless to explore possible associations with the main measures of efficiency examined herein. It is noticeable that the correlations with the specific measures of performance remain quite low. This could potentially be attributed the fact that those measures are total factor productivity measures in the sense that the techniques adopted to calculate them (DEA, DDFs) have taken into consideration input complementarities (Hu & Wang, 2006; Honma & Hu, 2008; Zhang et al, 2011) and the level of the European technology accessible to all the members. It therefore becomes apparent that the relationship of the EI index with each measure of performance passes through a different channel which requires further investigation. This is attempted in the next section.

Table 1. Correlations of Eco-Innovation index with measures of performance

	Eco-Innovation index	Productive performance	Energy efficiency	Environmental efficiency
Eco-Innovation index	1.000			
Productive performance	.176	1.000		
Energy efficiency	-.212	.631	1.000	
Environmental efficiency	-.126	-.051	.426	1.000

The merit of the group based on the performance on the EI index each country belong to, should also been considered in the investigation of the relationship between the measures of performance under heterogeneous EI regimes, because as Table 2 below indicates, EI leaders outperform followers only in productive performance. This situation is reversed for both the energy and environmental efficiency though. The reasons for this shift require further investigation.

Table 2. Eco-Innovation regimes and measures of performance

	Productive performance	Energy efficiency	Environmental efficiency
Eco-Innovation Leaders	.844	.764	.831
	(.079)	(.239)	(.351)
Eco-Innovation Followers	.792	.826	.942
	(.102)	(.163)	(.183)

Table 3 below presents a transition probability matrix which captures how likely it is for a given member state to switch from being the group of EI leaders to that of the EI followers and vice versa. As far as transition probability matrices are concerned, the rule of thumb mentions that the matrix is considered as significant when the elements of the main diagonal are above 33.33 percent. In this case, the matrix is significant as the main diagonal shows.

More precisely, the rows correspond to the initial state whereas the columns to the represent the final. Each period, 91.53% of the EI followers in the dataset remained followers in the next period as well, while the rest 8.47% became EI leaders. Nevertheless, EI followers had an 8.47% chance of switching status in each year, the EI leaders had only 3.77% chance of becoming or return to the status of the follower. The same rational applies to the case of EI leaders, that is each period 96.23% of the EI leaders, maintained their status in the next year.

Thus, it appears that there is a significant persistence in the group in the beginning of the study period and therefore it seems that switches do not take place within the particular time window the sample is explored.

Table 3. Transitions between Eco-Innovation regimes for the period of study

	EI followers	EI leaders
EI followers	**91.53**	8.47
EI leaders	3.77	**96.23**

5.2 Measures of performance; blood brothers or distant relatives?

Table 4 below presents the estimation results using the *identification through heteroskedasticity estimator* (Lewbel, 1997, Baum et al., 2012) for the generated instruments case. For each dependent variable, two models have been estimated, with the feedback loop included (*Models 2 & 4*) and without (*Model 1 & 3*) it. Thus, the table presents the estimation results from four models.

Regarding Model 1, a negative and significant relationship arises between productive performance and environmental efficiency (H_2 is partially rejected) as indicated in other studies (Chatzistamoulou & Kounetas, 2020 WP). Such a relationship could be attributed to the fact that productive performance, as the most fundamental measure of performance, requires a reallocation of resources with the underlying possibility of an inefficient use of inputs given technology level, in order to be enhanced. The absorptive capacity of the country does not seem to play a crucial role in this specification (H_3 is rejected). The use of renewable energy however seems to have a positive and significant impact on environmental efficiency. Variables capturing production environment and institutions do not seem to exhibit remarkable effect on environmental efficiency in this case. The Eco-Innovation index seems to exert limited influence as well under this specification. This finding pinpoints towards the importance of actions and policies to promote any of the five dimensions of the index as it will boost the overall index as well.

However, when the energy efficiency is included in the model (Model 2) a different story is revealed. It is apparent that the inclusion of a feedback loop between the two performance measures triggers all the compartments of the model. This finding is supported by other studies (Liu et al., 2018), however, the suspected endogenous relationship between the measures of performance is acknowledged for the first time in this setting (H1 is not rejected). More precisely, the significance of productive performance remains unchanged (H_2 is partially rejected), the volume of the effect has been increased though. The fact that productive performance remains significant under alternative specifications could be considered as an indication that it is a driver of environmental efficiency after all and pinpoints towards supporting the idea that measures of performance are interlinked. Absorptive capacity exerts a positive and significant effect on environmental efficiency (H_3 is not rejected) now while it seems that *the feedback loop activates the eco-innovation index as well and enhances the effect of renewable energy use on environmental efficiency.*

Shifting the attention to Model 3, productive performance does not seem to exert a significant effect on energy efficiency as well (H_2 is not accepted), at the European technology level. This finding is in line with the study of Chatzistamoulou et al. (2019) who study a similar effect considering 77 countries across the globe from 2002 through 2011. In this case, the situation is quite different as the same set of candidate drivers does not seem to have the same effect on energy efficiency. This is useful in terms of policy design as given a pre-specified set of tools and instruments, there is a high chance that those will not have a horizontal effect as measures of performance appear to respond differently even though the latter are inter-connected.

Taking into account the feedback loop in Model 4, we notice that the situation is changed. The effect of productive performance becomes stronger while the effect of absorptive capacity exerts a negative influence on energy efficiency (H_3 is partially rejected). In this case, a strong positive and significant feedback loop between energy efficiency an environmental efficiency surfaces as well (H1 is not rejected). Moreover, it should be noted that the effect of environmental efficiency on energy efficiency is smaller compared to the opposite case. The latter in conjunction to the positive influence of productive performance and negative influence of past competitiveness level, indicate that the two performance measures besides the fact communicate through the feedback loop, evolve quite differently. This is particularly relevant for policy design as well (See next section).

Last but not least, the lower part of the table illustrates some model information. The test about the suspected endogeneity between the measures of performance pinpoints towards the rejection of the null, meaning that the suspected endogenous relationship is rather weak. *In other words*, productive performance and each of the resource efficiency measures can be treated as exogenous. It is useful to notice that the significance of the endogeneity test for them models including the feedback loop (Model 2 & 4).

Specifically, environmental efficiency and productive performance appear to be attached to loosen ties compared to the energy efficiency and productive performance which seem to be developing a closer relationship. The latter provides and extent of affinity between the two performance measures. Such being the case, despite the fact that measures of performance belong to the same family of measures, given the above we are inclined to think that not all members of this family share a common degree of closeness. From another perspective and focusing on the feedback loop, the effect of energy efficiency on environmental efficiency is greater than that in the reverse case. This indicates that in the former case the loop is tighter and it is more likely that a more appropriate strategy for policies towards boosting environmental efficiency would be to associate the directives with energy efficiency levels.

From the one hand, a weak endogenous relationship emerges for the case of Model 2 indicating that energy efficiency and environmental efficiency operate through different channels but those are not entirely detached indicating that when environmental efficiency is under the spot light, the two measures act as *distant relatives*. On the other, shifting the attention on energy efficiency the two measures appear to be quite attached pinpointing that when focusing on energy efficiency, the two measures act as *blood brothers*.

Therefore, we are inclined to think that besides any associations or interlinks between measures of performance those are detached from each other operating through different channels (Chatzistamoulou et al., 2019). Such finding might be attributed to the direction of one-sized-fits all policies at the European level without taking into account the heterogeneity among the member states. Thus, the idea of a one-size fits-all policy may not be the appropriate strategy rather, a tailored designed oriented to each measure should be pursued instead. Nevertheless, at this point we need to acknowledge the fact that the results of this paper would be benefited by the inclusion of more data as the limited number of observations is a weakness. Unfortunately, for the time being this is the more complete dataset we could compile as the Eco-innovation index launched in 2010. Thus, this the main contribution of this paper as it explores the effect of the index on the resource efficiency measures in the context of the Resource Efficiency Flagship initiative broader framework.

Table 5 presents the estimation results for the case which we augment the set of instruments with the lagged share of foreign direct investments (FDI) in order to enhance the validity of the results. Conceptually, the use foreign direct investments are justified as it has meaningful correlation with the independent variables and it is outside the control of each country, at least directly as well. However, the literature on the effect of FDI on performance is quite mix and this is depicted from the *C* statistic. In general lines, both specifications reveal the same pattern. Small differences are found for the case of energy efficiency when the feedback loop is included. That energy efficiency and environmental efficiency exert a significant influence on each other, but environmental efficiency and could be considered as *blood brothers* only in the case where the focus in on energy efficiency.

Table 4. Estimation results; the Lewbel's estimator with generated instruments only.

Generated instruments only	**Environmental Efficiency**		**Energy Efficiency**	
	Model 1	**Model 2**	**Model 3**	**Model 4**
Performance measures				
Productive performance	-1.483**	-1.402***	.157	1.062***
	(.668)	(.367)	(.403)	(.165)
Absorptive capacity	-.065	.199**	-.191	-.169***
	(.105)	(.072)	(.063)	(.035)
Feedback Loops				
Energy Efficiency	-	1.396***	-	-
		(.156)		
Environmental Efficiency	-	-	-	.383***
				(.042)
Economy & institutions				
Frazer index	.061	-.109	.113	.077
	(.120)	(.074)	(.072)	(.039)
Economy structure index	.023	.007	.014	.008
	(.030)	(.019)	(.018)	(.010)
Eco-innovation index	-.000+	-.002*	.001	.001
	(.002)	(.001)	(.001)	(.001)
Renewable energy consumption	.006*	.011***	-.004**	-.005
	(.003)	(.002)	(.002)	(.001)
Time effect	Yes	Yes	Yes	Yes
Model information				
Obs	110	110	110	110
Underidentification test	.000	.000	.000	.000
Sargan statistic	.348	.004	.635	.000
Endogeneity test	.000	.063	.000	.002
Model p-value	.005	.000	.005	.000

Notes: (i) all models include constants, (ii) standard Errors of the two-step GMM procedure are reported in parentheses, (iii) stars indicate statistical significance * 10%, ** 5% and * ** 1%.

Table 5. Estimation results; the Lewbel's estimator with augmented instruments.

Augmented instruments	**Environmental Efficiency**		**Energy Efficiency**	
	Model 1	**Model 2**	**Model 1**	**Model 2**
Performance measures				
Productive performance	-1.129*	-1.408***	.440	1.080***
	(.607)	(.366)	9.352)	(.164)
Absorptive capacity	-.068	.199**	-.194**	-.169***
	(.100)	(.072)	(.058)	(.035)
Feedback Loops				
Energy Efficiency	-	1.397***	-	-
		(.156)		
Environmental Efficiency	-	-	-	.384***
				(.041)
Economy & institutions				
Fraser index	.047	-.109	.102	.076*
	(.113)	(.074)	(.066)	(.039)
Economy structure index	.027	.007	.017	.009
	(.028)	(.019)	(.016)	(.010)
Eco-innovation index	-.000+	-.002	.001	.001
	(.001)	(.001)	(.001)	(.001)
Renewable energy consumption	.006**	.011***	-.003**	-.005***
	(.003)	(.002)	(.002)	(.001)
Time effect	Yes	Yes	Yes	Yes
Model information				
Obs	110	110	110	110
Underidentification test	.000	.000	.000	.000
Sargan statistic	.110	.007	.064	.000
Endogeneity test	.001	.068	.000	.004
C statistic (exogeneity of FDI_{t-1})	.043	.802	.005	.178
Model p-value	.004	.000	.000	.000

Notes: (i) all models include constants, (ii) standard Errors of the two-step GMM procedure are reported in parentheses, (iii) stars indicate statistical significance * 10%, ** 5% and * ** 1%.

5.3 Policy implications

In this section, we investigate whether the main relationship of interest holds for the eco-innovation groups at the European level. Table 6 below presents the estimation results for each eco-innovation group defined in previous section.

Regarding the environmental efficiency of the followers, it seems that the energy efficiency exerts a positive and significant effect. Productive performance does not seem to be a driver for the environmental performance of the eco-innovation followers. The use of renewables has a positive impact on the environmental performance of the followers indicating the importance of promoting clean energy in the production. Limited progress on improving the aspects included in the fraser index, negatively affect the resource efficiency. For the case of leaders, productive performance affects environmental performance negatively and significantly as in the main model. Competitiveness appears to be a crucial driver and so is the use of renewables indicating that sustainability plays a crucial role in improving resource efficiency outcomes. The feedback loop in this case is a main driver as well which confirms the main research hypothesis.

Shifting the attention on the energy efficiency, a rather differentiated picture is depicted for both groups. The influence of productive performance is now positive and significant with a greater effect on the followers as small changes have a greater impact, while competitiveness does not have a horizontal effect on the groups. The significance of the feedback loop is only active for the case of the leaders. A counterintuitive finding is that the use of renewables has a very small but negative and significant effect on energy efficiency. This might be attributed to the energy paradox in the form of a rebound effect, as increasing the renewable energy use, given technology level, will increase the demand for energy which leads to a reallocation of resources with a negative effect on energy efficiency.

Following up on the above discussion, it becomes apparent that the orientation of the policy is of great importance. More precisely, based on the target outcome and heterogeneity group different implications arise as the latter have distinctive mechanisms to absorb (Cohen & Levinthal, 1990) and internalize changes. Policies oriented towards energy efficiency should consider the influence of productive performance; irrespective of eco-innovation level. It is also noticeable that despite the intrinsic differences between the resource efficiency measures, the latter are quite responsive to the feedback loop, an indication that this could act as a means of more sophisticated policy design in the sense that it manifests the effects on each other. Such finding becomes more prominent under the European Green Deal which aims at promoting sustainable growth through resource efficiency.

Table 6. Estimation results based on eco-innovation groups.

	Environmental Efficiency		Energy Efficiency	
	Followers of Eco-Innovation	**Leaders of Eco-Innovation**	**Followers of Eco-Innovation**	**Leaders of Eco-Innovation**
Performance measures				
Productive performance	-.279	-1.498***	1.506***	1.399***
	(.283)	(.337)	(.088)	(.152)
Competitiveness	.285	.183**	.013	-.185***
	(.096)	(.081)	(.052)	(.048)
Feedback Loops				
Energy Efficiency	.361*	1.410***	-	-
	(.204)	(.133)		
Environmental Efficiency	-	-	.048	.415***
			(.037)	(.051)
Economy & institutions				
Fraser index	-.230**	-.063	-.033	.085
	(.104)	(.121)	(.023)	(.063)
Economy structure index	.042	-.018	.009	.030*
	(.030)	(.024)	(.006)	(.017)
Renewables	.006*	.013***	-.002**	-.005***
	(.002)	(.002)	(.001)	(.001)
Time effect	Yes	Yes	Yes	Yes
Model information				
Obs	68	69	68	69
Model p-value	.019	.000	.000	.000

Notes: (i) All models include constants, (ii) robust standard errors in parentheses, (iii) stars indicate statistical significance * 10%, ** 5% and * ** 1%.

6. Concluding Remarks

Energy and environmental efficiency dipole has been put in the center of attention both for the research community as well as the policy maker (e.g. Resource Efficiency Flagship Initiative, European Green Deal) as resource efficiency is a necessary condition, if not an integral part, toward sustainable development. The idea of resource efficiency as well as the field of efficiency analysis heavily relies on the relative scarcity of resources to define the level of efficiency of each unit under examination.

In this line and by constructing a unique dataset including 28 European countries from 2010 through 2014, we seek to investigate whether energy and environmental efficiency measures are related through feedback loops under alternative eco-innovation regimes. The latter are constructed based on the Eco-innovation index provided by the European Commission.

By employing the non-parametric methods of bootstrap Data Envelopment Analysis and Directional Distance Functions under a metafrontier framework in the first stage analysis, we calculate the productive performance, energy and environmental efficiency on an annual basis for each of the countries in the dataset and a second stage identification through heteroskedasticity estimator to tackle endogeneity concerns surrounding performance measures, as those are part of the same family, in the absence of an established theoretical background. Findings indicate that resource efficiency measures are linked via the feedback loops however the extend of the relationship differs substantially. This is particularly relevant for policy design. We also find that the effect of productive performance on resource efficiency measures differs across the latter and this is also the case for the country competitiveness. Findings also pinpoint toward a rebound effect from the use of renewables on resource efficiency measures. The eco-innovation regime each country belongs to should also be taken into consideration as leaders and followers of each resource efficiency measure respond differently to the set of candidate drivers. This is particularly relevant for the transition to a green sustainable future.

To the best of our knowledge this is the first attempt to study such effects under a technology heterogeneity framework. Attempts to study the links between resource efficiency measures using the eco-innovation index as a partitioning factor of the overall technology to draw policy implications have not been surfaced yet to the best of our knowledge. However, we need to acknowledge that this analysis could be benefited by a broader time window but for the time being more data has not become readily available.

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Appendix
A1. Tables

Table A1. Descriptive statistics of the variables

	European Technology	Eco-Innovation leaders	Eco-Innovation followers
Gross Domestic Product (GDP)	623,100	1,014,732	225,709
	(884,384)	(1,071,460)	(322,839)
Carbon Dioxide Emissions (CO_2)	126,842	189,624	63,137
	(172,203)	(209,459)	(86,529)
Capital stock (K)	3,012,157	4,961,365	1,034,284
	(4,213,526)	(5,025,390)	(1,588,364)
Energy use (E)	3,382	4,146	2,606
	(1,425)	(1,501)	(792.09)
Labour (L)	8.170	12.198	4.082
	(10.586)	(12.990)	(4.749)
Overall GCI score	4.72	5.09	4.33
	(.49)	(.39)	(.18)
Eco-Innovation Index	87.96	115.87	59.65
	(32.26)	(15.52)	(15.87)
REC	17.91	18.20	17.61
	(11.64)	(13.62)	(9.31)
Foreign direct investments	9.66	10.82	8.49
	(31.15)	(32.44)	(29.98)
Economic Freedom Index	7.47	7.55	7.38
	(.29)	(.27)	(.29)

Table A2. Variables, units of measurement and sources

	Brief description	**Units of measurement**	**Sources**
Gross Domestic Product (GDP)	Real Gross Domestic Product, national prices	million US $	GGDC
Carbon Dioxide Emissions (CO_2)	Anthropogenic carbon dioxide emissions	kiloton (kt)	World Bank
Capital stock (K)	Capital stock, national prices	million US $	GGDC
Energy use (E)	Energy use	kg of oil equivalent per capita	GGDC
Labour (L)	Number of persons engaged	millions	GGDC
Overall GCI score	Overall Global Competitiveness Index score	Pure number	World Economic Forum
Eco-Innovation Index	Illustrates eco-innovation performance across the EU Member States by applying 16 indicators grouped into 5 dimensions	Pure number	European Commission, DG Environment
Industry	Industry including construction, value added % of GDP		
Manufacturing	Manufacturing value added (% of GDP)	Percentage	World Bank
Services	Services value added (% of GDP)		
Foreign direct investments	Net inflows foreign investors as % of GDP		
REC	Renewable energy consumption, % of total final energy consumption	Percentage	World Bank, Sustainable Energy for All database

Table A3. Descriptive statistics of the main variables by country

	GDP	*CO2*	*K*	*E*	*L*
Austria	354,698	63,199	1,753,999	3,908	4.203
	(5,858)	(3,291)	(33,653)	(102.713)	(.071)
Belgium	424,978	99,239	2,416,328	5,032	4.551
	(5,272)	(6,921)	(56,529)	(318.532)	(.034)
Bulgaria	112,062	44,037	315,515	2,471	3.485
	(1,697)	(3,569)	(17,494)	(107.550)	(.082)
Croatia	85,158	18,474	458,300	2,034	1.570
	(1,353)	(1,450)	(5,333)	(101.022)	(.065)
Cyprus	22,353	6,813	138,372	1,932	.330
	(1,062)	(791.719)	(1,696)	(228.167)	(.017)
Czech Rep.	283,315	102,933	1,866,891	4,055	5.118
	(3,520)	(6,205)	(21,608)	(120.152)	(.027)
Denmark	250,381	39,149	1,271,776	3,166	2.789
	(3,803)	(4,952)	(11,276)	(232.538)	(.012)
Estonia	30,802	18,750	158,468	4,370	.601
	(1,917)	(949.892)	(6,401)	(218.606)	(.024)
Finland	207,188	52,511	1,030,890	6,394	2.513
	(2,358)	(6,646)	(22,973)	(288.719)	(.019)
France	2,414,983	331,088	1.19E+07	3,839	27.262
	(35,701)	(17,813)	(259,532)	(126.667)	(.165)
Germany	3,478,871	741,683	14,900,000	3,893	41.604
	(84,233)	(16,600)	(210,458)	(81.674)	(.654)
Greece	257,702	76,109	1,731,240	2,309	4.405
	(22,893)	(7,256)	(21,667)	(170.015)	(.302)
Hungary	212,280	45,375	1,079,874	2,404	4.007
	(5,459)	(3,588)	(12,682)	(125.909)	(.106)
Ireland	229,339	36,040	933,500	2,885	1.922
	(11,156)	(2,334)	(29,324)	(156.659)	(.023)
Italy	2,083,304	367,711	12,500,000	2,692	24.541
	(44,825)	(35,624)	(81,349)	(203.413)	(.534)
Latvia	39,947	7,297	280,835	2,144	.878
	(2,251)	(450.108)	(2,988)	(44.553)	(.018)
Lithuania	65,524	13,313	250,046	2,380	1.295
	(4,166)	(547.110)	(6,173)	(71.484)	(.029)
Luxemburg	28,642	10,456	174,939	7,656	.378
	(1,122)	(578.240)	(8,184)	(584.885)	(.014)
Malta	10,206	2,494	39,802	1,936	.173
	(690.285)	(147.343)	(1,380)	(136.428)	(.008)
Netherlands	743,443	173,618	3,477,764	4,647	8.806
	(5,934)	(5,922)	(44,758)	(249.385)	(.062)
Poland	871,254	304,242	1,937,071	2,580	15.390
	(35,504)	(12,961)	(117,389)	(72.049)	(.137)
Portugal	259,113	46,451	1,958,526	2,104	4.698
	(8,106)	(1,361)	(4,701)	(84.928)	(.182)
Romania	362,539	77,393	1,507,554	1,687	8.149
	(14,157)	(6,616)	(66,027)	(87.093)	(.295)
Slovak Rep.	128,056	33,460	487,226	3,135	2.221
	(4,148)	(2,075)	(11,943)	(137.390)	(.021)
Slovenia	53,600	14,434	309,884	3,428	.945
	(851.635)	(1,009)	(1,108)	(148.844)	(.012)
Spain	1433270	255450	8522299	2619	18.417
	34425	18400	144819	122.206	0.773
Sweden	401,861	47,815	1,750,262	5,217	4.631
	(8,948)	(3,930)	(26,834)	(171.985)	(.087)
United Kingdom	2,279,624	457,536	9,717,525	3,002	29.931
	(71,249)	(26,979)	(179,614)	(162.577)	(.582)
Total	**611,589**	**124,538**	**2,957,361**	**3,354**	**8.029**
	(878,265)	**(171,050)**	**(4,184,344)**	**(1,422)**	**(10.515)**