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2011

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Abstract

Due to the fact that norms govern individual behavior, which in turn it is related to the environmental behaviour, this study tries to establish a link between human behavior (in terms of cultural values) and the environment. With the use of robust frontiers this paper constructs countries' environmental efficiency ratios. Then it conditions these ratios with countries' cultural values in order to capture their effect on the calculated environmental efficiency measures. The empirical results of the conditional and unconditional robust nonparametric frontiers of a sample of 17 OECD countries (for the census years of 1980, 1990 and 2000) reveal that countries' national culture values have changed over the years from a neutral posture towards the enhancement of countries' environmental efficiency. In addition, the results indicate that there is still much work to be done from countries' environmental policy makers for the enhancement of an efficient environmental culture.

Keywords: National culture; environmental efficiency; robust estimators.

JEL Classification: C6, C67, Q00, Q50

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1. Introduction

The role of culture and generally ethics has been suppressed by mainstream economics. For ecological economists the relation between ethics and environmental economics is not perfectly clear (Eriksson, 2005). Furthermore, Eriksson (2005) suggests that ethical considerations in ecological economics are even more important than for standard economics due to the fact that ethics (values) and economics (rationality) get mixed both in the short and in the long run. Mohr (1994) argues that environmental economics rarely touches on environmental norms, which in economic analysis it is still remaining a missing link between human behaviour and the environment. Nassauer (1995) emphasizes the fact that scientists and scholars have felt the necessity of binding social and cultural insights to ecological knowledge due to the fact that human perceptions, cognitions and values directly affect the environment. Nightingale (2003) suggests that cultural practices and their effect on ecological change has been examined illustrated by studies investigating how capitalist development influence land management regimes at different scales.

According to Nassauer (1995) culture structures landscapes which in turn have a direct effect on countries environment. Furthermore, Ohl et al. (2007) suggest that human activity affects ecosystem through the extraction, transport and transformation of resources which are driven by societal and economic pressures. Redman et al. (2004) suggest land use, land cover, production, consumption and disposal are the main human activities which are influencing countries' environment. Culture in addition contains the ways of living which are built up by a group of human beings and transmitted from and generation to another. Accordingly, Hofstede (1980) suggests that culture is a collective mental programming which is difficult to change; if it changes at all, it does so slowly. This study tries to capture the existence of an environmental commune. Since environmental norms appear to be on the advance everywhere this study tries to investigate empirically if the role of norms (i.e. national cultures) is to ensure the survival of the commune (i.e. countries' environmental performances). Since this study investigates the link between cultural values and environmental efficiency it is hoped to provide evidence that the neoclassical model of human behaviour (*Homo economicus*) can be a valid part of a solution to human-made ecological problems. The main question in hand is if countries' environmental norms which are embedded in their national cultures effect countries' environmental efficiency. We assume that environmental norms shape humans' behaviour towards an environment commune which in turn has a direct impact on countries' environmental efficiency.

2. Literature Review

Weak disposability was originally proposed by Färe et al. (1989) and was on the first models proposed in order to measure environmental performance based on the fact that reducing pollutants involves a cost that can be measured either as increased quantities of inputs or decreased production of desirable outputs. In addition Färe et al. (1996) based on the production theory measured countries' environmental performance by constructing environmental performance indexes (EPIs) in a macro level using aggregated data. Later Tyceta (1997) has introduced another EPI based on the same principles as Färe et al. (1989) but with different assumptions (a restricted technology which is not account for inputs). Since those to similar approaches to the construction of EPIs have been introduced several papers have been appeared incorporating them into their analysis (Zaim and Taskin 2000; Zofio and Prieto 2001; Zaim, 2004; Zhou et al. 2006; Picazo-Tadeo and García-Reche, 2007; Camarero et al.

2008). In addition to those DEA based studies some other group a research stream has used DEA-based weighting method for the aggregation of various indicators, which differ from the usual inputs and outputs (Cherchye, 2001; Cherchye et al., 2004, 2007; Cherchye and Kuosmanen, 2006; Zhou et al., 2007; Kortelainen, 2008). In addition to those studies Halkos and Tzeremes (2009a) calculated environmental efficiency by using a variation of the traditional DEA approach introduced by Charnes et al. (1978) in order to be able to handle panel data (DEA window analysis). Based on Färe et al. (1999) they measured countries' environmental efficiency by constructing an efficiency ratio of good to bad environmental efficiency measure. The environmental efficiency of a country will be a ratio of good efficiency performance (using a good output) to a bad efficiency measure (using a bad output). In addition to the other studies Halkos and Tzeremes (2009a) have based on free disposability of all inputs and outputs as has been indicated by Coelli et al. (1998) and Haynes et al. (1993) we construct the efficiency ratio by employing DEA window analysis having in our formulation the ‘good’ output and then employing (with the same inputs as previously) the DEA formulation using the ‘bad’ output.

In addition to those studies Liu (2001) suggested that there is a need of studies to be able to integrate human behavior and economic/ environmental factors in a framework of new approaches. However few studies have implemented different disciplines. Mainly they incorporated ecological and social factors (An et al. 2001; Cramer and Portier 2001; McDonald et al. 2001; Weber et al. 2001; Wang and Zhang 2001). Berry and Annis (1974) have introduced a model which examined interrelationships among ecological settings, cultural adaptation and psychological differentiation emphasizing that different cultures have different impact on the environment. Mohr (1994) suggests that individual behaviour relates to the environment and in addition environmental norms are natural object of investigation in environmental economics. This study attempts to do so by trying to measure and analyze countries' environmental efficiency based on the effect of their national cultural values. Our measurement of environmental efficiency is based on the construction of an environmental efficiency ratio using a good efficiency measure (using a 'good output') to a bad efficiency measure (using a 'bad output') as has been introduced by Färe et al. (1999) and Halkos and Tzeremes (2009a). Furthermore, we are based our analysis on the free disposability assumption, however the paper uses completely different DEA methodology in order to overcome traditional DEA-based problems. Zhou et al. (2008) suggests that in order to overcome traditional problems associated with DEA deterministic other approaches such as bootstrap techniques (Simar and Wilson 1998) must be combined. In addition our paper uses for the first time robust DEA estimators in order to measure environmental efficiency in an aggregate level by avoiding the traditional DEA based problems. The full nonparametric models (DEA-Data Envelopment Analysis and FDH-Free Disposal Hull) suffer from different problems such as extreme values/outliers (which provide them with the property of deterministic nature) and the curse of dimensionality (Daraio and Simar, 2007a, pp. 78). Therefore in order to avoid those problems we apply partial nonparametric frontiers (order-m frontiers) as has been introduced by Cazals et al. (2002), which will enable us to avoid the main problems when using full nonparametric frontiers. Florens and Simar (2005) suggest that using the robust version of the nonparametric estimators can provide us with properties of $\sqrt{n}$-consistency and asymptotic normality. Daraio and Simar (2007a, p.96) suggest that "the measurement of productive efficiency is only a first step of an efficiency analysis. A natural complement is the investigation on explanatory variables of the distribution of efficiency scores". Therefore, as a second stage of our analysis we capturing the effect of countries' national culture on obtained countries' environmental efficiencies. The use of conditional robust frontiers (conditional order-m frontiers) is able to show the impact of external factors even if some extreme observations may mask it when using full frontier estimations. Lovell (1993, p.53) distinguishes the inputs/outputs of the production process as "variables under the control of the decision maker during the time period under consideration", from explanatory variables that are "variables over which the decision maker has no control during the time period under consideration". As such we use the methodology proposed by Daraio and Simar (2005) by introducing Hofstede's cultural dimensions (Hofstede, 1980) as external/environmental variables. Hofstede is the most widely cited author in the field with the most methodologically supported quantification of cultural characteristics (Swierczek, 1994). Given this fact we adopt in our study Hofstede's cultural dimensions having in mind the critique made by several authors regarding the methodology and the diachronically validity of those cultural dimensions (Shackleton & Ali, 1990; Sondergaard, 1994; Triandis, 1982). However, in contrast with the critique of the usage of Hofstede's cultural measures recently Merritt (2000) has confirmed the validity of those measures.

2. Data and Methodology

2.1 Data

Using census data for 1980, 1990 and 2000 we construct and evaluate environmental efficiency ratios of each for the 17 randomly chosen OECD countries into consideration. Following Färe et al. (1999) and Halkos and Tzeremes (2009a) firstly we construct countries' 'good' efficiency (θ_m^G) using the order-m model. For this formulation we use a desirable aggregate output measured by real GDP[1]. However the second order-m model uses an undesirable output measured by sulphur emissions per capita (in tons of sulphur) by allowing us to measure countries' 'bad' efficiency (θ_m^B). A large dataset on sulphur emissions is used here (A.S.L. and Associates, 1997). The data include sulphur emissions from various fuels (hard coal, brown coal, and petroleum) as well as sulphur emissions from mining and smelting activities for most of the countries from 1980 to 2002. In addition, the two inputs used in both models are aggregated labour input measured by total capital stock (trillion US$) and total employment (millions workers) obtained from OECD (2008). In order to capture the effect of culture on countries' environmental efficiency we use the four cultural dimensions as introduced by Hofstede (1980):

(1) Power distance (PDI, Z1): ''the extent to which the less powerful members of institutions and organizations within a country expect and accept that power is distributed unequally'' (p. 28).

(2) Individualism versus collectivism (IDV, Z2): ranges from ''societies in which the ties between individuals are loose'' to ''societies in which people from birth onwards are integrated into strong, cohesive in-groups'' (p. 51).

(3) Masculinity versus femininity (MAS, Z3): ranges from ''societies in which social gender roles are clearly distinct'' to ''societies in which social gender roles overlap'' (p. 82).

(4) Uncertainty avoidance (UAI, Z4): ''the extent to which the members of a culture feel threatened by uncertain or unknown situations'' (p. 113).

2.2 Probabilistic approach to efficiency measurement

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[1] The 'good' efficiency measures measure countries' economic efficiency based on the production process (see Halkos and Tzeremes 2009b, 2009c, 2009d)

Daraio and Simar (2005) extending the ideas of robust measurements introduced by Cazals et al. (2002) introduced a probabilistic approach of production process. The production set Ψ is defined as a set of *p* inputs and *q* outputs in a Euclidean space R_{+}^{p+q} as:

$$\Psi = \left\{ (x, y) \middle| x \in R_{+}^{p}, y \in R_{+}^{q}, (x, y) \quad is \quad feasible \right\} \tag{1}$$

where *x* is the input and *y* the output vectors. Next the production process can be described by the joint probability measure of *(X,Y)* on $R_{+}^{p} x R_{+}^{q}$. Then the knowledge of the probability function $H_{XY}(.,.)$ can be defined as:

$$H_{XY}(x, y) = \Pr ob(X \leq x, Y \geq y) \tag{2}$$

For the input oriented case the efficiency scores $\theta(x, y)$ for $(x, y) \in \Psi$ can be defined as:

$$\theta(x, y) = \inf \left\{ \theta \middle| F_{X|Y}(\theta x | y) > 0 \right\} = \inf \left\{ \theta \middle| H_{X|Y}(\theta x, y) > 0 \right\} \tag{3}$$

A nonparametric estimator can be classified by replacing $F_{X|Y}(x|y)$ by its empirical version:

$$\hat{F}_{X|Y,n}(x|y) = \frac{\sum_{i=1}^{n} \Im(X_i \leq x, Y_i \geq y)}{\sum_{i=1}^{n} \Im(Y_i \geq y)} \tag{4}$$

where $\Im$ is the indicator function. Under the free disposal assumption (FDH) the estimator of $\theta(x, y)$ developed by Deprins et al. (1984) coincides with the input efficiency score for a given point *(x,y)* (Cazals et al., 2002):

$$\hat{\theta}_{FDH}(x, y) = \inf \left\{ \theta \middle| (\theta x, y) \in \hat{\Psi}_{FDH} \right\} = \inf \left\{ \theta \middle| \hat{F}_{X|Y,n}(\theta x | y) > 0 \right\} \tag{5}$$

2.3 The formulation of Order-m frontiers

Following Cazals et al. (2002) for an input orientation the order-m frontier can be introduced as follows. Having a fixed integer $m > 1$ for a given level of output *y* we obtain the random production set of the order-m units producing more than *y* as:

$$\Psi_m(y) = \left\{(x, y') \in R_+^{p+q} \middle| x \geq X_i, y' \geq y, i = 1,...,m\right\} \tag{6}$$

In addition for any *x* we can define $\tilde{\theta}_m(x, y) = \inf\left\{\theta \middle| (\theta x, y) \in \Psi_m(y)\right\}$ (7).

The order-m input efficiency measurement can be defined as:

$$\begin{aligned} \theta_m(x, y) &= E\left(\tilde{\theta}_m(x, y) \middle| Y \geq y\right) = \int_0^\infty (1 - F_{X|Y}(ux|y))^m du = \\ &= \theta(x, y) + \int_{\theta(x,y)}^\infty (1 - F_{X|Y}(ux|y))^m du \end{aligned} \tag{8}$$

Next the nonparametric estimator can be calculated as:

$$\begin{aligned} \hat{\theta}_{m,n}(x, y) &= \hat{E}\left(\tilde{\theta}_m(x, y) \middle| Y \geq y\right) = \int_0^\infty (1 - \hat{F}_{X|Y,n}(ux|y))^m du = \\ &= \hat{\theta}_n(x, y) + \int_{\hat{\theta}_n(x,y)}^\infty (1 - F_{X|Y,n}(ux|y))^m du \end{aligned} \tag{9}$$

According to Daraio and Simar (2007a) the order-m efficiency score is the expectation of the input efficiency score of the country (x,y) when compared to *m* (in our case 5 countries)[2] countries randomly drawn from the population of countries producing more outputs than the level y. The efficiency scores computed under the order-m formulation can take values greater than one. When the estimator has a value greater than one indicates that the country operating at the level (x,y) is more efficient than the average of *m* peers. In a input oriented case when a country has an efficiency score of 0.8, means that the country uses 20% more inputs than the expected value of

[2] For larger values of *m* the results converged very quickly to the full-frontier results (similar to FDH results).

the minimum input level of m other country drawn from the population of countries producing a level of output $\geq y$. Finally, when $m \rightarrow \infty$ then $\hat{\theta}_{m,n}(x, y) \rightarrow \hat{\theta}_{FDH}(x, y)$.

For our purpose we construct in the same way both $\hat{\theta}^{G}_{m,n}(x, y)$ and $\hat{\theta}^{B}_{m,n}(x, y)$. Following the idea of environmental performance ratio proposed by Färe et al. (1999) we calculate countries' environmental efficiency following the assumption of free disposability of all inputs and outputs as:

$$EF = \frac{\hat{\theta}^{G}_{m,n}(x, y)}{\hat{\theta}^{B}_{m,n}(x, y)} \tag{10}$$

As has been described by Daraio and Simar (2005) different variables (exogenous to the production process) $Z \in \Re^r$ can be used to explain the efficiency variations of the production process. The idea is to condition the production process to a given value of $Z = z$. The joint distribution *(X,Y)* conditional on $Z = z$ defines the production process if $Z = z$. Then a nonparametric estimator $\theta_m(x, y|z)$ is provided by plugging the non parametric estimator:

$$\hat{F}_{X|Y,Z,n}(x|y, z) = \frac{\sum_{i=1}^{n} \Im(x_i \leq x, y_i \geq y) K((z - z_i)/h)}{\sum_{i=1}^{n} \Im(y_i \geq y) K((z - z_i)/h)} \tag{11}$$

where K(.) is the kernel and h is the bandwidth of appropriate size. The density of Z has been calculated based into the two stage approach proposed by Daraio and Simar (2006). In the first stage we used the likelihood cross validation criterion, using a k-NN (nearest-neighbor) method (Silverman, 1986). Then in the second step the local bandwidths obtained are expanded by a factor $1 + n^{-1/(p+q)}$ in order to take into account the dimensionality of x and y, and the sparsity of points in larger dimensional spaces[3]. Thus a conditional order-m nonparametric estimator can be obtained as:

[3] See also Bădin et al. (2009) for a data driven approach of bandwidth selection based on least squares cross validation procedure.

$$\hat{\theta}_m(x, y|z) = \hat{E}_{X|Y,Z}(\hat{\theta}_m^z(x, y)|y, z) = \int_0^\infty (1 - \hat{F}_{X|Y,Z,n}(ux|y, z))^m du \quad (12)$$

Then our conditional environmental efficiency ratio is calculated as:

$$EF|z = \frac{\hat{\theta}_{m,n}^G(x, y|z)}{\hat{\theta}_{m,n}^B(x, y|z)} \quad (13)$$

According to Daraio and Simar (2007a, b) the global influence of Z on the production process can be obtained by comparing the conditional *order-m* and frontier to their unconditional equivalents. In a univariate case of Z a scatter-plot of the ratios

$$\frac{EF|Z}{EF} = \left(\hat{\theta}_{m,n}^G(x, y|z) / \hat{\theta}_{m,n}^B(x, y|z)\right) / \left(\hat{\theta}_{m,n}^G(x, y) / \hat{\theta}_{m,n}^B(x, y)\right) \quad (14)$$

against Z and its smoothed nonparametric regression line would indicate the global effect of Z on the production process. If the smoothed nonparametric regression is increasing it indicates that Z is unfavourable to environmental efficiency and when this regression is decreasing then is favourable to country's environmental efficiency. For this purpose we use the nonparametric regression estimator introduced by Nadaraya (1964) and Watson (1964) as:

$$\hat{g}(z) = \frac{\sum_{i=1}^n K(\frac{z - Z_i}{h})\left(\frac{EF|Z}{EF}\right)}{\sum_{i=1}^n K(\frac{z - Z_i}{h})} \quad (15).$$

3. Empirical results

The results obtained[4] from the construction of $\hat{\theta}_{m,n}^G(x, y)$, $\hat{\theta}_{m,n}^B(x, y)$ and EF scores are presented in table 1. In most of the cases it seems that 'bad' efficiency increases over the years whereas 'good' efficiency doesn't. This is reflected on

[4] Due to the enormous quantity of results obtained it is difficult to be presented here. However all results are available upon request.

countries' EF values. When looking the $\hat{\theta}^{G}_{m,n}(x, y)$ index we realize that best performers for the three census years are reported to be: the United States, United Kindow, Japan, Portugal, France and Germany. However, when looking the $\hat{\theta}^{B}_{m,n}(x, y)$ index (i.e. producing a bad output) it appears that Australia, Canada, France, Germany, Italy, Netherlands, Japan, Sweden and the United States appear to produce more bad output relative to the other countries. Finally, the last three columns represent the environmental efficiency indexes for those countries (see equation 10). It appears that Finland, Greece, Portugal and the United States have higher environmental efficiencies scores compare to the other countries. The interesting point regarding this finding is that those countries come from different cultural backgrounds and thus different environmental norms and values. Therefore it would be interesting to quantify the effect of those different values over the three census years over countries' environmental efficiencies.

Table 1 about here

Table 2 provides descriptive statistics of the conditional measures obtained. As can be realised cultural values have a direct effect on countries environmental efficiencies' over the years examined. For instance when looking the effect of power distance (z1) on the $\theta^{G}_{m}(x, y|z_1)$ index we realize that the average value of the standard deviations among the efficiencies over the three census years is 0.22 [(0.2+0.21+0.27)/3]. In addition for the $\theta^{B}_{m}(x, y|z_1)$ index the average value of the standard deviation is 0.63 indicating that power distance has a higher greater effect on the 'bad' index. Similarly the same pattern of effects can be observed for the case of individualism (z2), Masculinity (z3) and Uncertainty Avoidance (z4). Since the environmental efficiency index is a product of the "good" and "bad" index the effect of countries' cultural values will be also applied to countries EF performances. However it is difficult to establish that relationship looking only at the descriptive statistics provided in table 2.

Table 2 about here

Finally, figure 1 provides us with kernel density plots of the conditional environmental efficiency values. Each panel illustrates the effect of each cultural value over the three census years. The blue solid line represents the density line of the year 1980, the red dashed line for 1990 and the black dotted for 2000. It appears that the estimates conditioned to cultural values are leptokurtic for the years 1980 and 1990 in contrast with the estimates for 2000 which are appear to be in all cases platykurtic. The leptokurtic distributions indicate that there is a rapid fall-off in the density as we move away from the mean. Furthermore, the pickedness of the distribution suggests a clustering around the mean with rapid fall around it. As such it appears that cultural values in a society had influenced more countries' environmental performance over the years 1980 and 1990 compared to year 2000. This is an indication not only of a change of the examined countries' cultural values over the three census years but also of their effect on countries' environmental efficiencies.

Figure 1 about here

In addition figure 2 illustrates the effect of countries cultural values on their environmental efficiency over the examined years (see equations 14 and 15). As can be realised in 1980 national cultural values had no effect on countries' environmental efficiency (almost a flat line). However for the year 1990 the same effect remained for countries with higher cultural values of individualism, masculinity and uncertainty avoidance. In contrast the countries with higher power distance values which seem their cultural values affected positively countries' environmental efficiency.

Finally looking at the results of the year 2000 we realise that countries with higher values of power distance and individualism have a positive effect on their environmental efficiency. However countries with higher values of masculinity and uncertainty avoidance seem to have a neutral effect on their environmental efficiency. This change of cultural values through out the years is an indication of the development of environmental norms and ethics which in turn have a direct effect on countries' environmental efficiencies. People and policy makers are now much informed regarding the problems caused to the environment from certain patterns of development and this positive effect of different cultural values on countries' environmental efficiency is hoped to be continued over the near future.

Figure 2 about here

4. Conclusion

According to Berry and Annis (1974) the conception of culture can be defined as a group's way of adapting problems encountered in its habitat. Furthermore, several authors (Helm, 1962; Berry and Annis, 1974) suggest that environmental issues and ecological settings limit, alter probabilities and constrain certain behaviours. According to several authors there is a need to bind social, ethical and cultural perspectives with environmental economics (Mohr, 1994; Nassauer, 1995; Eriksson, 2005). Given the need that studies to be able to integrate human behavior and economic/ environmental factors in a framework of new approaches (Liu, 2001), this study for the first time is doing so by using the latest advances in efficiency measurement. Following the methodology from Daraio and Simar (2005) which is based on the ideas of robust measurement introduced by Cazals et al. (2002) this paper investigates the effect of four cultural dimensions (Hofstede, 1980) on countries environmental efficiency (Färe et al., 1999; Halkos and Tzeremes, 2009a). For the first time to our knowledge this paper uses order-m frontiers in order to construct environmental efficiency ratios. In contrast with most of the studies using DEA techniques, the use of robust estimator can help us to avoid several measurement weaknesses traditionally associated with those DEA measures. These are the deterministic nature and the curse of dimensionality. As such we can be able to work with samples of moderate sizes. Then in a second stage of our analysis, the paper uses different smoothing techniques with the application of appropriate kernel estimators and bandwidths of appropriate sizes (Daraio and Simar, 2005, 2007a, 2007b) in order to condition the obtained environmental efficiencies to countries' cultural dimensions. Finally, in a third stage by using nonparametric regressions (Nadaraya, 1964; Watson, 1964) the paper measures the effect of countries' national culture on their environmental efficiencies. The results obtained indicate that countries with higher power distance and individualistic values seem to have influenced positively their environmental efficiency. However, countries with high masculine and uncertainty avoidance values seem to have moderate effects on their environmental efficiency. It appears that countries' cultural norms are changing slowly over the years enhancing countries' environmental efficiency, but since cultural values are not inborn and can be taught (Hofstede, 1980) the biggest task of governments and policy makers' lies ahead and that is to shape countries national culture values towards environmental norms and ethics.

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Table 1: Descriptive statistics, unconditional environmental efficiency scores, good and bad efficiency scores

	$\theta_m^G(x,y)$			$\theta_m^B(x,y)$			EF		
Countries	**1980**	**1990**	**2000**	**1980**	**1990**	**2000**	**1980**	**1990**	**2000**
Australia	0.72	0.75	0.75	0.74	0.82	0.94	0.98	0.92	0.80
Austria	0.78	0.71	0.67	0.91	0.95	1.03	0.86	0.76	0.65
Belgium	0.68	0.65	0.61	0.63	0.79	0.78	1.09	0.82	0.78
Canada	0.74	0.81	0.83	0.86	0.88	1.19	0.86	0.93	0.70
Denmark	0.75	0.75	0.76	0.82	0.81	0.86	0.91	0.92	0.88
Finland	0.64	0.66	0.58	0.57	0.69	0.63	1.13	0.95	0.92
France	0.87	0.91	0.90	1.52	1.70	1.57	0.57	0.53	0.57
Germany	0.91	0.90	0.94	0.99	0.95	2.62	0.93	0.94	0.36
Greece	0.52	0.51	0.53	0.55	0.54	0.52	0.95	0.96	1.03
Italy	0.96	0.95	0.93	1.58	1.58	1.55	0.61	0.60	0.60
Japan	0.99	0.98	0.97	1.02	1.13	1.09	0.97	0.87	0.89
Netherlands	0.72	0.70	0.72	1.33	1.51	1.38	0.54	0.46	0.52
Portugal	0.95	0.87	0.93	1.13	0.89	0.79	0.84	0.98	1.18
Spain	0.81	0.80	0.83	0.84	0.90	0.97	0.96	0.89	0.85
Sweden	0.90	0.88	0.78	1.20	1.32	1.12	0.75	0.67	0.70
United Kindom	0.82	0.78	0.84	0.88	0.87	1.07	0.93	0.90	0.78
United States	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Mean	0.81	0.80	0.80	0.97	1.02	1.12	0.88	0.83	0.78
Std	0.13	0.13	0.14	0.30	0.32	0.48	0.17	0.17	0.20
Min	0.52	0.51	0.53	0.55	0.54	0.52	0.54	0.46	0.36
Max	1.00	1.00	1.00	1.58	1.70	2.62	1.13	1.00	1.18

Table 2: Descriptive statistics of conditional of 'good', 'bad' and EF countries' efficiency scores

	$\theta_m^G(x,y\|z_1)$			$\theta_m^G(x,y\|z_2)$			$\theta_m^G(x,y\|z_3)$			$\theta_m^G(x,y\|z_4)$		
	1980	**1990**	**2000**	**1980**	**1990**	**2000**	**1980**	**1990**	**2000**	**1980**	**1990**	**2000**
Mean	0.90	0.91	0.94	0.83	0.84	0.86	0.90	0.89	0.90	0.93	0.90	0.89
Std	0.20	0.21	0.27	0.16	0.15	0.22	0.23	0.23	0.21	0.24	0.21	0.19
Min	0.51	0.52	0.55	0.54	0.58	0.53	0.57	0.56	0.57	0.61	0.51	0.52
Max	1.24	1.34	1.63	1.12	1.04	1.24	1.46	1.44	1.39	1.48	1.34	1.26
	$\theta_m^B(x,y\|z_1)$			$\theta_m^B(x,y\|z_2)$			$\theta_m^B(x,y\|z_3)$			$\theta_m^B(x,y\|z_4)$		
	1980	**1990**	**2000**	**1980**	**1990**	**2000**	**1980**	**1990**	**2000**	**1980**	**1990**	**2000**
Mean	0.98	1.02	1.34	0.96	0.99	1.12	0.95	0.98	1.26	0.96	1.04	1.53
Std	0.25	0.29	1.35	0.30	0.31	0.48	0.30	0.31	0.77	0.25	0.34	1.27
Min	0.56	0.53	0.51	0.53	0.56	0.49	0.59	0.52	0.55	0.52	0.51	0.61
Max	1.59	1.60	6.45	1.59	1.66	2.6	1.55	1.71	3.52	1.51	1.63	5.31
	$EF\|z_1$			$EF\|z_2$			$EF\|z_3$			$EF\|z_4$		
	1980	**1990**	**2000**	**1980**	**1990**	**2000**	**1980**	**1990**	**2000**	**1980**	**1990**	**2000**
Mean	0.93	0.94	0.88	0.91	0.88	0.84	0.97	0.94	0.83	0.98	0.92	0.78
Std	0.11	0.26	0.28	0.17	0.17	0.27	0.16	0.12	0.25	0.13	0.28	0.31
Min	0.60	0.57	0.25	0.60	0.56	0.48	0.65	0.59	0.28	0.77	0.58	0.18
Max	1.16	1.69	1.60	1.25	1.16	1.44	1.48	1.10	1.18	1.26	1.85	1.32

Figure 1:Kernel density functions of countries' environmental efficiencies derived from conditional Order-m frontiers using Gaussian Kernel and the appropriate bandwidth (Silverman, 1986)

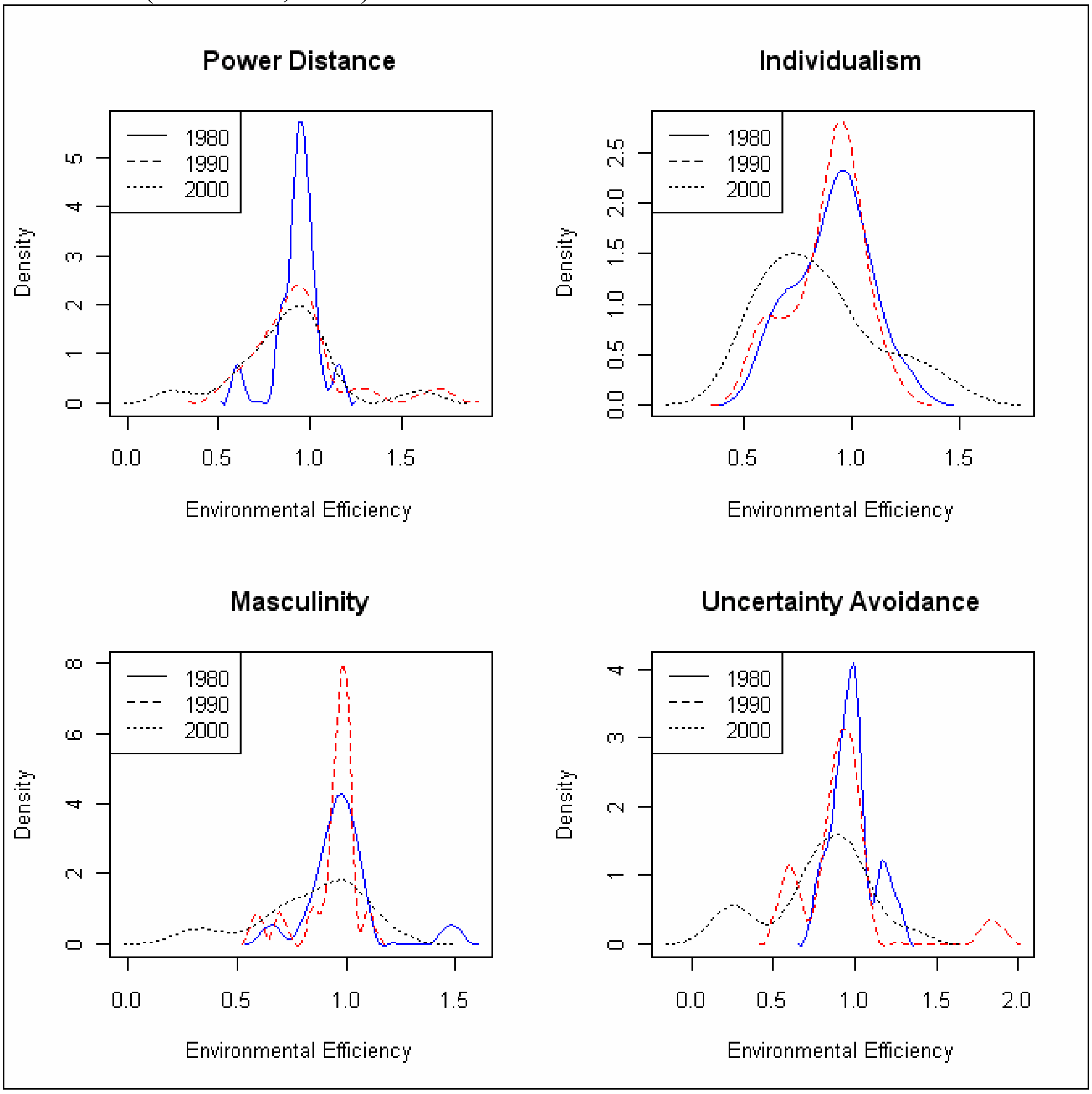

Figure 2: Time representation of the Global effect of cultural dimensions on countries' environmental efficiency

YEAR 1980	YEAR 1990	YEAR 2000