'Waste culture' assessment using Hofstede's and Schwartz's cultural dimensions – an EU case study

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Abstract
The issue of municipal solid waste (MSW) arisings has received great attention recently as it is a by-product of economic activity but also serves as an input to the economy through material or energy recovery. In relation to that, the main focus of this study is cultural formation and especially the current picture of waste culture and public perception across European Union (EU) Member States. Thus this study will first evaluate environmental efficiency with Data Envelopment Analysis (DEA) based on five parameters: waste, gross domestic product (GDP), labour, capital, and population density for 22 EU Member States and for the years 2005, 2010 and 2015 in order to evaluate which Member States are more efficient. Then the results from the efficiency analysis are contrasted to Hofstede’s and Schwartz’s cultural dimensions on STATA with the use of regression modelling. Results show that for year 2005 no significant relationship is noticed between the efficiency scores and the cultural dimensions’ data from both researchers, whereas for years 2010 and 2015 there appears to be a significant connection with changes in the predictors also affecting the response variable. The above mentioned findings can be associated with the financial crisis that has hit Europe after 2008 making people more skeptical on environmental issues and how waste is best to be managed making sense financially but also environmentally. At the same time EU legislations have laid out some important Directives in the field of waste management. Finally, along with the factors above, EU has faced severe environmental challenges due to waste arisings, as well as accidents and injuries for people working in this sector which in turn have widely modified EU’s waste culture as supported by this study’s results.

Keywords: Environmental efficiency; waste culture; Hofstede; Schwartz; DEA; environmental policy; regression analysis; cultural dimensions.

JEL Codes: O44; Q53; Q56; Z1

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1. Introduction

The issue of municipal solid waste (MSW) arisings has received great attention recently as it is a by-product of economic activity but also serves as an input to the economy through material or energy recovery (Defra, 2011). Increasing population, urbanisation and changing lifestyle patterns have affected MSW production (Aini et al., 2002). About 600 million tons of MSW are produced per year, meaning a daily production of 1.6 kg per capita in the countries of the Organization for Economic Cooperation and Development (OECD) (De Feo and Napoli, 2005).

The main issue with waste generation nowadays is that although the legislations are in place in order to help get resources back, these tend to be overlooked as not much importance is given to the protection of the environment despite the financial contribution it may have. In those regards, the word "waste" can either be seen as a noun or a verb, whereas the noun "waste" attributes the fault to the item itself, the verb "to waste" attributes the fault to the party who neglects to appreciate the value of the item (Lee, 2017).

Arguments prioritising culture as a prominent development factor exist for many years now, namely in 1905 Max Weber was the first one to raise awareness on the importance of a set of values to explain the success of industrial capitalism vis-a-vis pre-capitalist agrarian societies across Europe (El Leithy, 2017). The main focus of the present study is cultural formation and especially the current picture of 'waste culture' and public perception across European Union (EU) member states. At this point it is essential to make the distinction between culture and society.

Culture is defined as the way of life, especially the general customs and beliefs, of a particular group of people at a particular time based on the Cambridge Dictionary. Cultural values are shared and constitute the broad goals that members of a society are encouraged to pursue (Williams, 1970; Schwartz, 1999). Hofstede (1980) defined culture as 'the collective programming of the mind which distinguishes the members of one human group from another'. Society on the other hand is a group of people sharing a common culture and social system (Parsons, 1951).

There are three sources of influence in those regards: the value culture in the surrounding society, the personal value priorities of organisational members and the nature of the organisation's primary tasks (Sagiv and Schwartz, 2007). Hence it stands to reason that people's perceptions, beliefs and values regarding the environment will be different among countries based on national culture characteristics which will result to different levels of countries' environmental performance as well (Hofstede et al., 2010). In relation to that there are different environmental policies which are reflected on their environmental performance levels (Halkos and Tzeremes, 2013a).

Thus this study will first evaluate environmental efficiency based on five parameters: waste, gross domestic product (GDP), labour, capital, and population density for 22 EU Member States and for the years 2005, 2010 and 2015. These parameters have been chosen as they are related to MSW arisings and their relevant efficiency. Then the results from the efficiency analysis through Data Envelopment Analysis (DEA) are contrasted to Hofstede's and Schwartz's cultural dimensions as the aim of this study is to define the waste culture across the selected EU member states. This study's contribution is that by following and building on previous other studies, it helps develop an improved resource and environmental efficiency evaluation approach regarding EU member states' 'waste culture'.

The structure of the paper is as follows. Section 2 reviews the main models that provide the cultural dimension indicators while section 3 presents the proposed methodology together with the data used and the environmental production frameworks applied in the analysis. Section 4 presents the empirical findings with section 5 discussing the results and their implications. Finally, the last section (section 6) concludes the paper.

2. Background

Many studies of cultural values have focused extensively on nations. These include but are not limited to the following: 1. Hofstede's dimensions of national cultures, 2. Trompenaars' and Hampden-Turner's cultural factors, 3. Schwartz's cultural values, 4. Inglehart's World Values Survey, 5. GLOBE'S (Global Leadership and Organizational Behavior Effectiveness) cultural dimensions and 6. Lewis Model. As the empirical analysis of this paper will focus on cultural dimensions' data from the Hofstede and Schwartz models, these will be analysed in greater detail below. Furthermore a comparison between these two models is presented and a description of 'waste culture' and what this includes.

2.1 Hofstede's cultural dimensions

Hofstede's cultural dimensions' theory is a framework for cross-cultural communication, developed by Geert Hofstede. Hofstede (1980) conducted an employee attitude survey from 1967 to 1973 within IBM's subsidiaries in 66 countries. The responses comprise of 117,000 questionnaires trying to investigate the respondents' 'values', which he defines as 'broad tendencies to prefer certain states of affairs over others' and which are according to him the 'core element in culture' (Hofstede, 1980; Halkos and Tzeremes, 2013b). Then he statistically analysed the collected data and constructed four national cultural indexes and found that there are four central and 'largely independent' (Hofstede, 1983) dimensions of a national culture. Then he gave a comparative score on each of these dimensions.

As mentioned the original theory proposed four dimensions along which cultural values could be analysed: individualism-collectivism; uncertainty avoidance; power distance (strength of social hierarchy) and masculinity-femininity (task orientation versus person-orientation) (Hofstede, 1980). Furthermore a fifth dimension was added by research conducted in Hong Kong, long-term orientation, this would then cover aspects of values not included in the original paradigm, then in 2010, Hofstede added a sixth dimension, indulgence versus self-restraint.

Even though Hofstede's work has been widely criticised, the size of the sample and the dimensions' stability over time have provided credibility and reliability (Hofstede, 2001; Kogut and Singh, 1988). His theory has been widely used in several fields as a paradigm for research, particularly in cross-cultural psychology, international management and cross-cultural communication. It continues to be a major resource in cross-cultural fields and has inspired a number of other major cross-cultural studies of values, as well as research on other aspects of culture, such as social beliefs (Halkos and Tzeremes, 2010).

A lot of criticism has been done on the empirical validity of Hofstede's framework (Shackleton and Ali, 1990; Sondergaard, 1994; Triandis, 1982; Yoo and Donthu, 1998). Based on the generalisation of the research findings the main disadvantage presented is the fact that the sample used, only focused on one large multinational company (Triandis, 1982; Yoo and Donthu, 1998). Furthermore Yoo and Donthu (1998) suggest that the dimensions of national culture could only refer to that period of study. Despite this criticism Hofstede's framework is generally accepted as the most inclusive framework of national cultural values (Kogut and Singh, 1988; Sondergaard, 1994; Yoo and Donthu, 1998). Thus it is of great value and shows significant correlations with economic, social and geographic indicators (Kogut and Singh, 1988). Furthermore, Hofstede's dimensions of national culture have been found to be valid, reliable and stable over time (Bond, 1988; Kogut and Singh, 1988; Yoo and Donthu, 1998).

2.2 Schwartz's cultural dimensions

Schwartz (1994) was actually one of those researchers who has raised several serious concerns regarding Hofstede's cultural dimensions. First, he suggests that Hofstede's dimensions are not thorough enough as the original survey's goal was not to analyse societies' cultures and thus may not show the complete picture. Secondly Hofstede's sample of countries is not a complete reflection of national cultures and if more were added to the sample results could have been different. Finally as the sample was drawn from IBM employees it is not representative of the population of the relevant country in terms of education and background for instance.

According to Schwartz (1999) cultural dimensions need to be analysed and clarified in order to understand the value people place on them. Many scholars support Schwartz's opinion and approach, but for instance Steenkamp (2001) although recognising the value of Schwartz's model, he still doesn't give up on using Hofstede's model as it is not fully tested like Hofstede's one.

Schwartz (1992) created a comprehensive set of 56 individual values recognised across cultures, thus covering all value dimensions. He also examined the relevant meaning of these values across different countries and reduced them to 45. Following that he surveyed school teachers and college students from 67 countries as of 1988, averaged the scores on each of the 45 value items for each country, and used smallest-space analysis to find out if these values differ in the various countries (Drogendijka and Slangen, 2006). This procedure concluded with the creation of seven dimensions, namely 'conservatism', 'intellectual autonomy', 'affective autonomy', 'hierarchy', 'egalitarian commitment', 'mastery', and 'harmony' (Schwartz, 1994, 1999). As explained by Schwartz (1999), certain pairs of cultural value orientations share relevant assumptions. The conflicts and compatibilities among the orientations yield the following coherent circular order of orientations: embeddedness, hierarchy, mastery, autonomy, egalitarianism, harmony and return to embeddedness.

Schwartz's cultural values are presented in Figure 1.

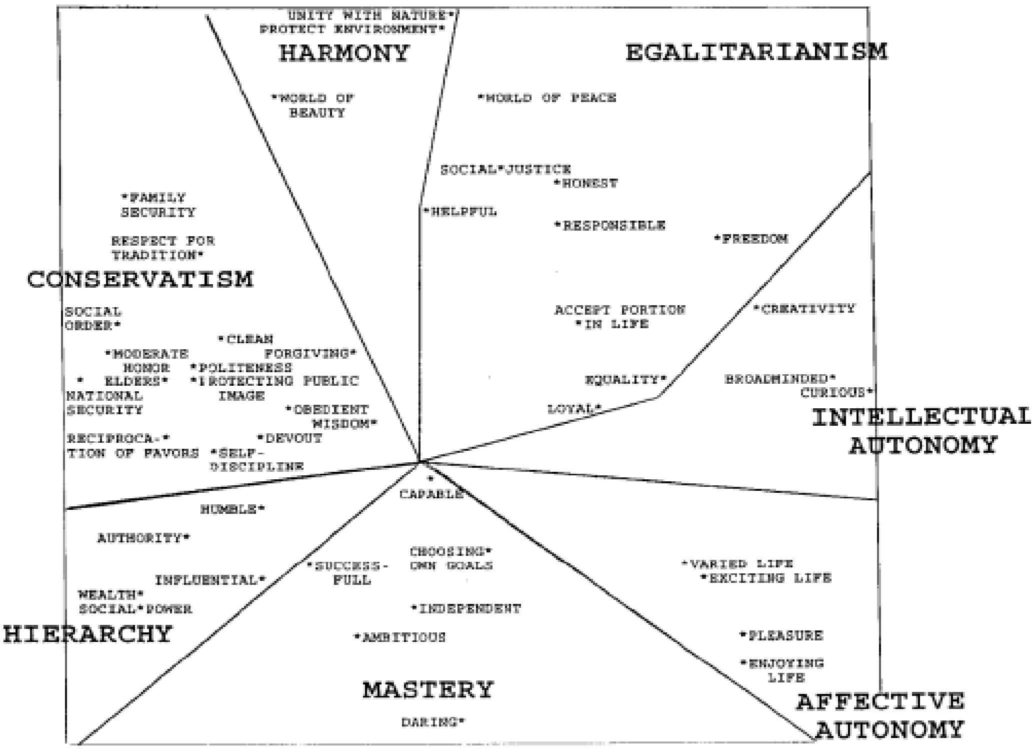

Figure 1: Schwartz's cultural values (Schwartz, 1994)

2.3 Comparison of the two models

These two models have been widely discussed in academic literature and both have been criticised as well. He also suggested that his framework included Hofstede's dimensions either way. Both Hofstede (1980) and Schwartz (1994) identified national cultural dimensions that could be used to compare cultures. Hofstede prepared his framework empirically, while Schwartz developed his theoretically while both scholars empirically examining their frameworks using large-scale multi-country samples and finding greater cultural differences between countries than within countries, suggesting the frameworks could be used to compare countries (Ng et al., 2006).

Brett and Okumura (1998) believe that Schwartz's framework is superior to Hofstede's because it is based on a conceptualisation of values, it was developed with systematic sampling and analysis techniques and its data are more recent. In addition to that the strong theoretical foundations of Schwartz's model are stressed by Steenkamp (2001), although he raises some concerns with regards to its few empirical applications.

2.4 Cultural dimensions and waste – 'waste culture' formation

Culture maintains a balance between humans, society and the physical environment and provides the context within which human activities take place (Roberts and Okereke, 2017). It is essential to integrate culture within the sustainability programmes as culture can greatly impact most societal functions, including waste management (Schneider, 1972). Many studies suggest that cultural values mainly influence the formation of green purchase intentions (Chekima et al., 2016). Therefore, the above mentioned cultural dimensions can serve as a valuable tool to analyse and evaluate the public's approach towards certain societal issues and in this case towards waste arisings in order to get the complete picture of the waste culture across these 22 EU Member States. Waste could be considered as the final product of a specific production chain: wealth, consumption, waste (De Feo and De Gisi, 2010). 'Waste culture' can be examined through various perspectives such as moral, philosophical, societal etc., but what is important to note is that waste is everywhere and it is essential to understand our mentality towards it (Lee, 2017). What is generally noticed is that in today's fast moving consumer – especially western – societies an unsustainable convenience culture has been formed (Hall, 2017).

What is more this convenience culture is mainly output-oriented and brings with it waste arisings from all production processes (Lee, 2017). To overcome this culture of waste it would be appropriate to move towards an input-oriented approach, therefore in this production process one would start with the resources available, appreciate them and work forward to use them most effectively to generate value (Lee, 2017).

An important part of ‘waste culture’ formation also has to do with the availability of environmental information and the use of information as a policy tool. Thus this information will increase environmental awareness and concern leading to more sustainable consumption practices (Aini et al., 2002). Information also has the potential to persuade and create positive attitudes towards for instance the recycling system among the public (Petty and Cacioppo, 1986; Bator and Cialdini, 2000). Moreover environmental psychologists stress the fact that personal norms serve as moral obligations in environmental behaviour, which may be internalised social norms or norms deriving from higher order values (Schwartz, 1977; Hopper and Nielsen, 1991; Bratt, 1999).

3. Research method, data and production frameworks for the analysis

3.1 The proposed methodology

3.1.1 Data Envelopment Analysis

Environmental efficiency has been gaining a lot of attention and has both theoretical value and practical meaning (Song et al., 2012). With the help of DEA one can measure the efficiency performances of comparable Decision Making Units (DMUs) which have multiple inputs and likewise outputs in conditions where there is accurate information on their values and no knowledge about the production or cost function (Rogge and De Jaeger, 2012). DEA was initially designed to be used in microeconomic research, but can equally be used in macroeconomic analysis too (Honma and Hu, 2009). DEA is s a non-parametric approach applied to assess the efficiency of the DMUs into consideration with the use of linear programming techniques (Boussofiane et al., 1991). It compares each DMU with all others and shows the ones that operate inefficiently compared to others by identifying best practice scenarios (Sherman and Zhu, 2006). One important benefit of DEA is that one does not need to make any assumptions regarding the relationship between inputs and outputs (Seiford and Thrall, 1990). DEA models are either input-oriented minimizing inputs while at least achieving the given output levels or output-oriented models maximizing outputs without requiring more inputs.

Farrell's (1957) input measure operationalization of efficiency for multiple inputs /outputs assuming free disposability and convexity of the production set was introduced via linear programming estimators by Charnes et al. (1978). Therefore for a given DMU operating at a point it can be defined as:

$$\hat{\Psi}_{DEA} = \Big\{ (x, y) \in R_{+}^{p,q} \,\Big|\, y \leq \sum_{i=1}^{n} \gamma_i Y_i ; x \geq \sum_{i=1}^{n} \gamma_i X_i , \text{for } (\gamma_1, \ldots, \gamma_n) \\ \text{s.t.} \sum_{i=1}^{n} \gamma_i = 1; \gamma_i \geq 0, i = 1, \ldots, n \Big\}.$$

Simar and Wilson (1998, 2000, 2008) stress that DEA estimators are shown to be biased by construction, thus developed an approach based on bootstrap techniques to correct and estimate the bias of the DEA efficiency indicators. Bootstrap is based on the idea of simulating the data generating process (DGP) and applying the original estimator to copy the sampling distribution of the original estimator (Efron, 1979). Moreover bootstrap procedures produce confidence limits on the efficiencies of the units in order to capture the true efficient frontier within the specified interval (Dyson and Shale, 2010). Then the bootstrap bias estimate for the original DEA estimator θ *DEA* (*x*, *y*) can be calculated as:

$$\widehat{BIAS}_B(\hat{\theta}_{DEA}\ (x, y) = B^{-1} \sum_{b=1}^{B} \hat{\theta}^{*}_{DEA,b\,(x,y)} - \hat{\theta}_{DEA\,(x,y)}$$

The biased corrected estimator of (*x*, *y*) can be calculated as:

$$\ddot{\theta}_{DEA\,(x,y)} = \hat{\theta}_{DEA\,(x,y)} - \widehat{BIAS}_B\,(\hat{\theta}_{DEA\,(x,y)}) = 2\,\hat{\theta}_{DEA\,(x,y)} - B^{-1} \textstyle\sum_{b=1}^{B} \hat{\theta}^{*}_{DEA,b\,(x,y)}$$

Finally, the (1−α) x 100 - percent bootstrap confidence intervals can be obtained for $\theta(x, y)$ as:

$$\frac{1}{\hat{\hat{\delta}}_{DEA}(x,y) - nc^*_{1-\alpha/2}} \leq \theta(x,y) \leq \frac{1}{\hat{\hat{\delta}}_{DEA}(x,y) - nc^*_{\alpha/2}}$$

Furthermore, in DEA it is required to specify whether the use of constant returns to scale (CRS) or variable returns to scale (VRS) is more appropriate. Charnes et al. (1978) were the first to propose the measurement of DMUs' efficiency under constant returns to scale (CRS), provided that all DMUs operate at their optimal level. Then Banker et al. (1984) employed VRS in their model, thus accounting for the use of technical and scale efficiencies in DEA. To test this approach and following Simar and Wilson (1998) bootstrap approach we compare between CRS and VRS according to these hypotheses: H_o : Ψ^θ is globally CRS against H_1 : Ψ^θ is VRS. The test statistic mean of the ratios of the efficiency scores is then provided by:

$$T(X_n) = \frac{1}{n}\sum_{i=1}^{n}\frac{\hat{\theta}_{CRS,n}(X_I, Y_i)}{\hat{\theta}_{VRS,n}(X_I, Y_i)}$$

Then the *p-value* of the null-hypothesis can be obtained:

$$p - value = prob\,(T(X_n) < T_{obs}\,]\, H_0\; is\; true)$$

where *Tobs* is the value of T computed on the original observed sample *Xn* and B is the number of bootstrap reputations. Then the *p-value* can be approximated by the proportion of bootstrap values of T^{*b} less the original observed value of *Tobs* such as:

$$p - value \approx \sum_{b=1}^{B}\frac{\mathrm{I}\,(T^{*b} \leq T_{obs})}{B}$$

Following the results from the tests described in the above equations the paper identifies that for the problem in hand the Charnes et al. model which allows constant returns to scale is more appropriate as the results obtained are higher than 0.05 thus accepting the null hypothesis (B = 999). In more details in this application there are two models as shown in table 1.

Table 1: Results on testing CRS vs VRS in this study's three models for all examined years

Frameworks	**2005**	**2010**	**2015**
M1	0.2442	0.1051	0.4124
M2	0.7157	0.4164	0.8418

In terms of methodology, the bad output (pollutant) in question, MSW generation, is modelled as a regular bad output by applying the transformation introduced by Seiford and Zhu (2002, 2005). In the two proposed models, different inputs are taken into account and MSW (bad output) and GDP (good output) form the two outputs examined.

For all 22 countries in the DEA analysis a radial model was used, which is output oriented and under CRS as mentioned above. The above described frameworks of inputs/outputs are presented in Figures 2 and 3.

M1: inputs – labour, capital   Outputs – GDP, waste

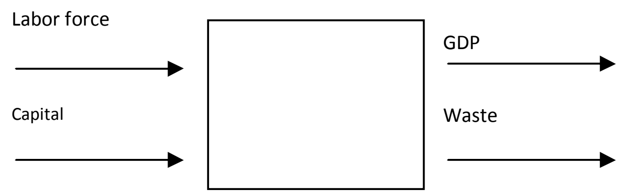

Figure 2: Description of environmental production framework (M1 indicator)

M2: inputs – capital, labor, population density   Outputs – GDP, waste

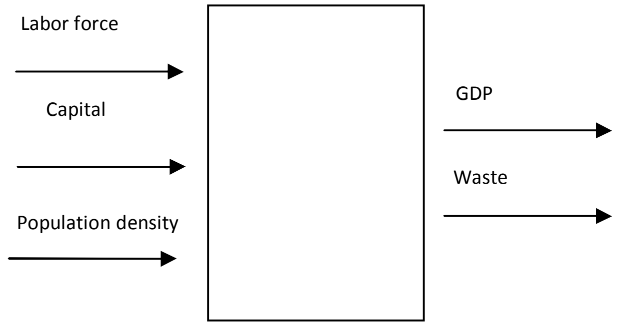

Figure 3: Description of environmental production framework (M2 indicator)

3.1.2 Regression analysis

The efficiency scores obtained through the DEA analysis as described above have then been analysed in comparison to Hofstede's and Schwartz's cultural dimensions. This has been done on STATA with the use of multiple regression models. Multiple regression is used to predict the value of a dependent variable based on the value of two or more independent variables. Therefore, regression analysis is a mathematical and statistical tool used to sort out which of the independent variables in question do have an impact on the dependent variable (Gallo, 2015). The regression model that is formed is as follows:

$$y(efficiency\ scores) = f\ (cultural\ indexes)$$

Various assumptions need to be accounted for before using linear regression models (Halkos 2006, 2011; Nau, 2018):

a. Linearity and additivity of the relationship between the variables: (1) the expected value of the dependent variable is a straight-line function of each independent variable, (2) the slope of that line does not depend on the values of the other variables and (3) the effects of different independent variables on the expected value of the dependent variable are additive.

b. Statistical independence of the errors (in particular, no correlation between consecutive errors in the case of time series data)
c. Homoscedasticity (constant variance) of the errors: (1) versus time (in the case of time series data), (2) versus the predictions, (3) versus any independent variable and
d. Normality of the error distribution.

In the presentation of the results and for simplicity we will refer to just some of the main outputs provided in the regression output like the *coefficient of determination (R^2)* showing the proportion of the variance in the dependent variable explained by the independent variables, though without reflecting the extent to which any particular independent variable is associated with the dependent variable; the F statistic and its P-value referring the overall statistical significance of each model and the individual significance as indicated by the t statistic: and the associated P-value (Halkos 2006, 2011; The Trustees of Princeton University, 2007):

3.2 Data used

In this DEA application the following variables are used: waste, GDP, labour, capital, population density with data obtained from Eurostat[1]. In total 22 EU Member States are studied for the years 2005, 2010 and 2015. The parameters are counted in the following units for this analysis:

- Waste: waste generated by households (tonnes)
- GDP: current prices (million €)
- Labour: number of people (in thousand)
- Gross fixed capital formation: current prices (million €)
- Population density: persons per km^2

[1] In cases where data was not available for a variable for the specific years chosen, the data from the previous year was used.

Following the DEA analysis, the efficiency scores are contrasted to Hofstede's cultural dimensions, which include as already mentioned: Power distance index, Invidualism vs Collectivism, Masculinity vs Feminity, Uncertainty Avoidance index, Long term vs short term orientation and Indulgence versus Restraint. Moreover they are contrasted to Schwartz's cultural dimensions which are comprised of: Harmony, Conservatism, Hierarchy, Mastery, Affective autonomy, Intellectual autonomy and Egalitarianism. According to Hofstede (1983) individualism is positively related to economic development and some of the psychological features that define modern society, such as low integration of relatives, independence and future orientation, etc. (Yang, 1988). In this analysis it is assumed that cultural dimensions' data do not change over this examined period as it takes a longer time for a change of behaviour to be established.

4. Empirical findings

According to the bias corrected efficiency measures the countries with the higher environmental efficiency scores (i.e. > 0.80) over the years are reported to be:

- Framework M1: Denmark, Greece, Italy, Netherlands and Poland.
- Framework M2: Denmark, Finland, Greece, Italy, Netherlands, Poland and Sweden.

Tables 2 and 3 present the efficiency scores of the 22 countries, the bias corrected efficiency scores and the 95-percent confidence intervals: lower and upper bound obtained by B=999 bootstrap replications using the algorithm described in Section 3.1.

Table 2: Bias corrected efficiency scores of the 22 countries for modelling framework M1

DMU	VRS	Bias corrected	bias	std	lower	upper	2005
Austria	0.8200	0.7727	0.0473	0.0231	0.7415	0.8172	
Belgium	0.8548	0.7976	0.0572	0.0264	0.7595	0.8542	
Bulgaria	0.7304	0.7016	0.0289	0.0167	0.6840	0.7362	
Croatia	0.7436	0.7134	0.0303	0.0171	0.6946	0.7480	
Czech Rep	0.6715	0.6286	0.0429	0.0183	0.6009	0.6668	
Denmark	0.8924	0.8489	0.0434	0.0223	0.8194	0.8973	
Estonia	0.5744	0.5514	0.0230	0.0131	0.5373	0.5785	
Finland	0.8230	0.7834	0.0396	0.0201	0.7569	0.8266	
France	0.9105	0.7541	0.1564	0.0991	0.6256	0.9617	
Germany	1.0000	0.7378	0.2622	0.1487	0.5118	1.0458	
Greece	0.9071	0.8603	0.0468	0.0233	0.8282	0.9080	
Hungary	0.7946	0.7597	0.0349	0.0188	0.7372	0.7961	
Ireland	0.6338	0.5981	0.0357	0.0163	0.5748	0.6307	
Italy	0.9010	0.7771	0.1240	0.0778	0.6771	0.9531	
Netherlands	0.9219	0.8448	0.0771	0.0367	0.7886	0.9158	
Poland	1.0000	0.9408	0.0592	0.0283	0.9014	0.9951	
Portugal	0.8180	0.7785	0.0395	0.0199	0.7521	0.8205	
Romania	0.7776	0.7437	0.0339	0.0182	0.7219	0.7781	
Slovakia	0.6910	0.6615	0.0294	0.0161	0.6428	0.6924	
Slovenia	0.7090	0.6807	0.0284	0.0163	0.6633	0.7142	
Spain	0.6943	0.6243	0.0700	0.0414	0.5675	0.7087	
Sweden	0.8551	0.8005	0.0546	0.0253	0.7630	0.8515	

DMU	VRS	Bias corrected	bias	std	lower	upper	2010
Austria	0.8434	0.8110	0.0324	0.0145	0.7933	0.8471	
Belgium	0.8564	0.8229	0.0336	0.0188	0.8020	0.8691	
Bulgaria	0.6556	0.6112	0.0443	0.0261	0.5755	0.6580	
Croatia	0.7253	0.6830	0.0423	0.0224	0.6522	0.7276	
Czech Rep	0.6981	0.6746	0.0235	0.0130	0.6603	0.7094	
Denmark	0.9556	0.9131	0.0425	0.0205	0.8858	0.9582	
Estonia	0.6326	0.5823	0.0504	0.0331	0.5386	0.6510	
Finland	0.8174	0.7890	0.0284	0.0125	0.7740	0.8219	
France	0.9366	0.8227	0.1139	0.0959	0.7250	1.0806	
Germany	1.0000	0.8264	0.1736	0.1250	0.6728	1.1340	
Greece	0.9934	0.9487	0.0446	0.0197	0.9198	0.9916	
Hungary	0.8243	0.7856	0.0387	0.0185	0.7618	0.8307	
Ireland	0.9523	0.9026	0.0497	0.0252	0.8670	0.9566	
Italy	0.9714	0.8875	0.0839	0.0703	0.8174	1.0556	
Netherlands	0.9510	0.9031	0.0479	0.0301	0.8701	0.9777	
Poland	0.9291	0.8914	0.0377	0.0232	0.8671	0.9538	
Portugal	0.8486	0.8131	0.0356	0.0160	0.7927	0.8514	
Romania	0.7110	0.6888	0.0223	0.0102	0.6768	0.7190	
Slovakia	0.7641	0.7333	0.0308	0.0145	0.7157	0.7711	
Slovenia	1.0000	0.8122	0.1878	0.1295	0.6393	1.0392	
Spain	0.8395	0.7799	0.0595	0.0492	0.7332	0.8958	
Sweden	0.8435	0.8123	0.0312	0.0187	0.7928	0.8604	

DMU	VRS	Bias corrected	bias	std	lower	upper	2015
Austria	0.7128	0.6559	0.0569	0.0308	0.6177	0.7361	
Belgium	0.7164	0.6475	0.0689	0.0435	0.5960	0.7548	
Bulgaria	0.6149	0.5453	0.0696	0.0380	0.4877	0.6392	
Croatia	0.6336	0.5489	0.0848	0.0469	0.4759	0.6643	
Czech Rep	0.6250	0.5795	0.0454	0.0276	0.5477	0.6531	
Denmark	0.8186	0.7577	0.0609	0.0327	0.7178	0.8442	
Estonia	0.5571	0.5099	0.0472	0.0300	0.4702	0.5896	
Finland	0.7395	0.6783	0.0611	0.0271	0.6377	0.7408	
France	0.9406	0.7115	0.2292	0.1713	0.5143	1.0921	
Germany	1.0000	0.6685	0.3315	0.2073	0.3733	1.0800	
Greece	1.0000	0.7352	0.2648	0.1208	0.4954	0.9224	
Hungary	0.6794	0.6281	0.0513	0.0229	0.5941	0.6843	
Ireland	0.7482	0.6800	0.0682	0.0296	0.6328	0.7422	
Italy	1.0000	0.7685	0.2316	0.1459	0.5759	1.0693	
Netherlands	0.8465	0.7524	0.0941	0.0573	0.6808	0.8772	
Poland	0.8270	0.7440	0.0830	0.0547	0.6799	0.8803	
Portugal	0.8707	0.7525	0.1183	0.0563	0.6577	0.8494	
Romania	0.6649	0.6154	0.0495	0.0302	0.5814	0.6971	
Slovakia	0.6326	0.5902	0.0424	0.0189	0.5628	0.6348	
Slovenia	0.6173	0.5110	0.1063	0.0583	0.4138	0.6495	
Spain	0.8527	0.7086	0.1441	0.1039	0.5851	0.9325	
Sweden	0.7071	0.6390	0.0681	0.0434	0.5878	0.7437	

Table 3: Bias corrected efficiency scores of the 22 countries for modelling framework M2

DMU	VRS	Bias corrected	bias	std	lower	upper	2005
Austria	0.8229	0.7728	0.0502	0.0247	0.7381	0.8289	
Belgium	0.8548	0.8048	0.0500	0.0250	0.7716	0.8569	
Bulgaria	0.7304	0.7071	0.0233	0.0104	0.6948	0.7329	
Croatia	0.7436	0.7179	0.0257	0.0118	0.7035	0.7453	
Czech Rep	0.6715	0.6313	0.0402	0.0189	0.6043	0.6724	
Denmark	0.8924	0.8515	0.0409	0.0183	0.8251	0.8900	
Estonia	0.5744	0.5551	0.0193	0.0085	0.5445	0.5755	
Finland	0.8583	0.7704	0.0879	0.0500	0.7021	0.8698	
France	1.0000	0.7131	0.2869	0.1932	0.4494	1.1166	
Germany	1.0000	0.7485	0.2515	0.1629	0.5200	1.0791	
Greece	0.9095	0.8626	0.0470	0.0231	0.8291	0.9108	
Hungary	0.7946	0.7651	0.0296	0.0135	0.7476	0.7974	
Ireland	0.6370	0.5893	0.0476	0.0245	0.5532	0.6462	
Italy	0.9010	0.7792	0.1218	0.0877	0.6731	0.9736	
Netherlands	0.9219	0.8523	0.0697	0.0375	0.7994	0.9202	
Poland	1.0000	0.9418	0.0582	0.0272	0.9039	1.0025	
Portugal	0.8180	0.7814	0.0366	0.0167	0.7589	0.8194	
Romania	0.7776	0.7484	0.0292	0.0132	0.7313	0.7803	
Slovakia	0.6910	0.6659	0.0251	0.0114	0.6513	0.6949	
Slovenia	0.7090	0.6857	0.0233	0.0107	0.6731	0.7117	
Spain	0.7260	0.6098	0.1162	0.0777	0.5142	0.7726	
Sweden	0.9523	0.8285	0.1238	0.0894	0.7223	1.0398	

DMU	VRS	Bias corrected	bias	std	lower	upper	2010
Austria	0.8459	0.8048	0.0410	0.0204	0.7754	0.8523	
Belgium	0.8564	0.8235	0.0330	0.0191	0.8020	0.8674	
Bulgaria	0.6556	0.6145	0.0411	0.0240	0.5804	0.6646	
Croatia	0.7253	0.6862	0.0391	0.0204	0.6561	0.7310	
Czech Rep	0.6981	0.6721	0.0260	0.0147	0.6542	0.7054	
Denmark	0.9556	0.9101	0.0455	0.0209	0.8770	0.9562	
Estonia	0.6326	0.5867	0.0459	0.0306	0.5462	0.6538	
Finland	0.9012	0.8482	0.0529	0.0320	0.8070	0.9223	
France	1.0000	0.8017	0.1983	0.1805	0.6206	1.2255	
Germany	1.0000	0.8369	0.1631	0.1342	0.6876	1.1654	
Greece	1.0000	0.9474	0.0526	0.0210	0.9139	0.9974	
Hungary	0.8243	0.7867	0.0376	0.0171	0.7609	0.8203	
Ireland	0.9943	0.9486	0.0456	0.0218	0.9141	0.9962	
Italy	0.9714	0.8947	0.0767	0.0700	0.8292	1.0803	
Netherlands	0.9510	0.9047	0.0463	0.0271	0.8718	0.9694	
Poland	0.9291	0.8841	0.0450	0.0303	0.8505	0.9576	
Portugal	0.8486	0.8105	0.0382	0.0167	0.7838	0.8439	
Romania	0.7110	0.6854	0.0256	0.0126	0.6680	0.7166	
Slovakia	0.7641	0.7344	0.0297	0.0137	0.7149	0.7608	
Slovenia	1.0000	0.8296	0.1704	0.1259	0.6688	1.0670	
Spain	0.8832	0.8014	0.0817	0.0597	0.7362	0.9422	
Sweden	0.9646	0.8783	0.0863	0.0726	0.8056	1.0642	

DMU	VRS	Bias corrected	bias	std	lower	upper	2015
Austria	0.7128	0.6417	0.0711	0.0363	0.5962	0.7311	
Belgium	0.7164	0.6510	0.0654	0.0376	0.6067	0.7413	
Bulgaria	0.6149	0.5600	0.0548	0.0307	0.5157	0.6330	
Croatia	0.6336	0.5675	0.0662	0.0376	0.5114	0.6583	
Czech Rep	0.6250	0.5813	0.0436	0.0227	0.5518	0.6389	
Denmark	0.8186	0.7599	0.0588	0.0283	0.7232	0.8290	
Estonia	0.5571	0.5188	0.0383	0.0256	0.4869	0.5870	
Finland	0.9534	0.8691	0.0843	0.0685	0.8021	1.0451	
France	1.0000	0.6754	0.3246	0.2557	0.3770	1.2250	
Germany	1.0000	0.7138	0.2862	0.2222	0.4497	1.1529	
Greece	1.0000	0.7666	0.2334	0.1288	0.5556	0.9724	
Hungary	0.6794	0.6345	0.0450	0.0188	0.6057	0.6797	
Ireland	0.7699	0.6836	0.0863	0.0450	0.6196	0.7961	
Italy	1.0000	0.7812	0.2189	0.1483	0.5978	1.1233	
Netherlands	0.8465	0.7576	0.0889	0.0522	0.6923	0.8656	
Poland	0.8270	0.7369	0.0900	0.0538	0.6700	0.8556	
Portugal	0.8707	0.7682	0.1025	0.0558	0.6873	0.8815	
Romania	0.6649	0.6128	0.0521	0.0265	0.5767	0.6740	
Slovakia	0.6326	0.5955	0.0372	0.0156	0.5725	0.6340	
Slovenia	0.6173	0.5345	0.0828	0.0482	0.4593	0.6526	
Spain	0.9744	0.8512	0.1232	0.1010	0.7475	1.1284	
Sweden	0.9124	0.7497	0.1627	0.1554	0.6086	1.1133	

Multiple regression analysis was used to test if the bias corrected efficiency scores can significantly be predicted by Hofstede's and Schwartz's cultural dimensions for both frameworks and for all the years examined. The regression results are presented in summary in Table 4 for Hofstede's cultural dimensions and Table 5 for Schwartz's ones.

Table 4: Multiple regression analysis results for Hofstede's cultural dimensions

Results per year/ modelling framework	M1	M2
2005	• R^2=0.3551 – Low predictability indicating only 35.51% of variation in efficiency scores is explained • p-value of F stat = 0.2862 indicating no significant overall statistical relationship between the variables	• R^2=0.2930 - Low predictability indicating only 29.3% of variation in efficiency scores is explained • p-value of F stat = 0.4406 indicating no significant overall statistical relationship between the variables
2010	• R^2=0.7426 – High predictability indicating that 74.26% of variation in efficiency scores is explained model • p-value of F stat = 0.0006 statistically significant suggesting that changes in predictors affect the response variable	• R^2=0.7845 - High predictability indicating that 78.45% of variation in efficiency scores is explained model • p-value of F stat = 0.0003 statistically significant suggesting that changes in predictors affect the response variable
2015	• R^2=0.5828 – Moderate predictability indicating that 58.28% of variation in efficiency scores is explained • p-value of F stat = 0.023 < 0.05 statistically significant suggesting that changes in predictors affect the response variable	• R^2=0.5086 - Moderate predictability indicating that 50.86% of variation in efficiency scores is explained model • p-value of F stat = 0.00633 statistically significant suggesting changes in predictors affect the response variable

Table 5: Multiple regression analysis results for Schwartz's cultural dimensions

Results per year/ modelling framework	M1	M2
2005	• R^2=0.1472 - Low predictability indicating that only 14.72% of variation in efficiency scores is explained • p-value of F stat = 0.9191, indicating no significant overall statistical relationship between the variables	• R^2=0.1363 - Low predictability indicating only that only 13.63% of variation in efficiency scores is explained • p-value of F stat = 0.9347 indicating no significant overall statistical relationship between the variables
2010	• R^2=0.5463 - Moderate predictability indicating 54.63% of variation in efficiency scores is explained • p-value of F stat = 0.0766 <0,10 significant at 0,10 significance level suggesting changes in predictors affect the response variable	• R^2=0.5624 - Moderate predictability indicating 56.24% of variation in efficiency scores can be explained • p-value of F stat = 0.0629 <0,10 significant at 0,10 significance level suggesting changes in predictors affect the response variable
2015	• R^2=0.7160 - High predictability indicating that 71.6% of variation in efficiency scores is explained • p-value of F stat = 0.0050 showing an overall statistically significant relationship between the variables	• R^2=0.5764 - High predictability indicating that 57.6% of variation in efficiency scores is explained • p-value of F stat = 0.00526 showing an overall statistically significant relationship between the variables

Results show that for the year 2005 no significant relationship is noticed between the efficiency scores and the cultural dimensions' data from both researchers, whereas for years 2010 and 2015 there appears to be a significant connection with changes in the predictors also affecting the response variable. Moreover for years 2010 and 2015, the R^2 provides support for the assumed relationship between culture and environmental efficiency in EU member states.

5. Discussion

Sometimes factors may be correlated but it's not obvious to see the cause and effect relationship between them so it's important to evaluate also what is happening in the real world (Redman, 2008). Sustainability requires substantial change in our conception of natural resources (de Kadt, 1994). The analysis results presented above show that although in 2005 the cultural characteristics do not seem to have a significant relationship with the efficiency scores of each country, in 2010 and 2015 the picture is completely different. Thus this implies that people's attitudes towards waste management have changed based on the cultural dimensions' data provided. In more detail it is possible to evaluate which specific cultural dimensions influence people's attitudes more (p-value from regression analysis < 0.05), which can be seen in summary in table 6 for Hofstede's dimensions and table 7 for Schwartz's ones.

Table 6: Hofstede's cultural dimensions – p value analysis

Hofstede's cultural dimensions	M1	M2
2005	None	None
2010	Individualism vs. Collectivism Uncertainty avoidance index Long term vs. short term Indulgence vs. Restraint	Individualism vs. Collectivism Uncertainty avoidance index Long term vs. short term Indulgence vs. Restraint
2015	Individualism vs. Collectivism Uncertainty avoidance index Long term vs. short term	Individualism vs. Collectivism Long term vs. short term

Table 7: Schwartz's cultural dimensions – p value analysis

Schwartz's cultural dimensions	M1	M2
2005	None	None
2010	None	None
2015	Conservatism Affective autonomy Egalitarianism	None

Among Hofstede's dimensions, individualism, uncertainty avoidance, long term orientation and indulgence were positively associated with the efficiency scores regarding waste arisings for 2010 and 2015. The relationship between Schwartz's cultural values and the DEA efficiency scores was not found to be significant apart from conservatism, affective autonomy and egalitarianism but only for year 2015. Overall findings suggest that Hofstede's cultural dimensions would be best to be considered when developing national level strategies and campaigns to manage waste arisings.

A complete cultural change towards waste management of course won't be achieved very quickly, but behavioural change can be achieved when faced with an imminent crisis (Oosthuizen, 2018). In those regards the above mentioned findings can be associated with the financial crisis that has hit Europe after 2008 making people more skeptical on environmental issues and how waste is best to be managed that will make sense financially but also environmentally. At the same time EU jurisdiction has laid out some important Directives in the field of waste management with regards to ways of disposal, special requirements, restrictions and potential sustainable solutions (Oosthuizen, 2018). Finally along with the factors above, EU has been faced with severe environmental challenges due to waste arisings, as well as accidents and injuries for people working in this sector.

All in all, it comes forward that the current economic and environmental situation across Europe has affected culture among those member states and along with the industrial symbiosis laid out in EU legislation, have led to fostering innovation and long-term culture change.

6. Conclusions

This study evaluated environmental efficiency with DEA based on five parameters: waste, GDP, labour, capital, and population density for 22 EU Member States and for the years 2005, 2010 and 2015 in order to evaluate which Member States are more efficient. Then the results from the efficiency analysis are contrasted to Hofstede's and Schwartz's cultural dimensions on STATA with the use of regression modelling. Results show that for year 2005 no significant relationship is noticed between the efficiency scores and the cultural dimensions' data from both researchers, whereas for years 2010 and 2015 there appears to be a significant connection with changes in the predictors also affecting the response variable.

Among Hofstede's dimensions, individualism, uncertainty avoidance, long term orientation and indulgence were positively associated with the efficiency scores regarding waste arisings for 2010 and 2015. The relationship between Schwartz's cultural values and the DEA efficiency scores was not found to be significant. Findings suggest that Hofstede's cultural dimensions would be best to be considered when developing national level strategies and campaigns to manage waste arisings.

These findings can be associated with the financial crisis that has hit Europe after 2008 making people more sceptical on environmental issues and how waste is best to be managed making sense financially but also environmentally. At the same time EU legislations have laid out some important Directives in the field of waste management. Finally, along with the factors above, EU has been faced with severe environmental challenges due to waste arisings, as well as accidents and injuries for people working in this sector. All these factors have widely modified waste culture and public's approach towards waste as represented by the study's results as well.

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