Economic Analysis and Policy 73 (2022) 670–682

Contents lists available at ScienceDirect

Economic Analysis and Policy

journal homepage: www.elsevier.com/locate/eap

Modelling economic policy issues

Environmental taxation in the European Union: Are there common trends?

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ARTICLE INFO

Article history:
Received 9 November 2020
Received in revised form 26 December 2021
Accepted 26 December 2021
Available online 1 January 2022

JEL classification:
H23
Q58

Keywords:
Environmental taxation
European Union
Convergence
Clubs

ABSTRACT

Environmental taxation has been a permanent feature of the policy agenda over the past few decades. It has represented about 2.5 percent of GDP and 6 percent of total taxation in the EU in recent years. In this paper, we study the evolution of total environmental taxation and its two main subcategories, energy and transport taxes, as a percentage of GDP and as a share of total taxation in the EU, through a club convergence analysis of the period 1995–2016. From the GDP perspective, the results show three groups of countries or clubs for the total environmental taxation and only two clubs for the two other categories analysed. Considering the taxation structure perspective, two clusters emerge for the total environmental taxes, three for the energy case and only one for the transport taxation, denoting overall convergence in this case. These results indicate a high grade of convergence in environmental taxation in the EU.

1. Introduction

Taxation has shifted in the past few decades from direct to indirect taxes, and the environmental taxes have been called to play a relevant role in current and future taxation. According to statistics from Eurostat, environmental taxation represented 2.44 percent of GDP and 6.11 percent of total taxation in the EU-28 in 2016. A current view of the environmental taxation in the EU is provided by the European Environment Agency (2016).[1]

Taxation is an environmental policy instrument,[2] and in seeking more efficient tax systems and the protection of the environment, governments have decided to tax activities that negatively affect the environment (externalities).[3] Rather than being designed to obtain revenues – the primary reason for the establishment of any tax – environmental taxes are designed to modify the behaviour of economic agents, such as households and firms. Thus, they must be carefully designed and implemented to achieve the desired results. There is consensus among economists that such taxes are one

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1 Additionally, Tews (2015) offers an interesting discussion about energy and climate policy in Europe.

2 Other environmental policy instruments are subsidies, fees and charges, tradable permits, deposit-refund systems or voluntary approaches (OECD, 2017).

3 Following the methodology in the EU, an environmental tax is 'a tax whose tax base is a physical unit (or a proxy of a physical unit) of something that has a proven, specific negative impact on the environment, and which is identified in ESA – European System of Accounts – as a tax' (Eurostat, 2013).

https://doi.org/10.1016/j.eap.2021.12.019

of the most cost-effective instruments, owing to their profound global effect on agents' decisions at a low cost (Baranzini et al., 2017). By implementing a tax on negative environmental externalities, governments stimulate a multitude of small changes in the day-to-day decisions of different economic agents. The specific regulation of each one of these behavioural changes would otherwise be costly, difficult and ineffective in most cases.

In the context of fiscal federalism, it is clear that both central and sub-central governments have significant roles to play in environmental policy in general (see Oates, 1998; Jordan et al., 2003 for the European case and Fredriksson and Wollscheid, 2014 for an empirical study on the relationship between centralisation and environment) and in environmental tax policy.[4] This multilevel (government) policy leads to the analysis of tax competition (Cremer and Gahvari, 2004) and tax harmonisation (Dorigoni and Gulli, 2002), with the prevention of a race-to-the-bottom competition not observed in the European Union (Holzinger and Sommerer, 2011).

Within the theoretical literature on environmental taxation,[5] the double dividend hypothesis states that is possible to obtain economic and environmental benefits through the use of environmental taxes by simultaneously reducing other pre-existing (distortionary) taxes in a revenue-neutral framework (Pearce, 1991; Repetto et al., 1992; Grubb et al., 1993; Nordhaus, 1993; Goulder, 1995; Oates, 1995; Bovenberg and de Mooij, 1997).[6] Recently, Freire-Gonzalez (2018) conducted a meta-regression analysis of studies on the double dividend, concluding that 55 percent of simulations did result in a double dividend. The rest of the simulations showed that using revenues to reduce other taxes always reduces the costs of imposing an environmental tax. Other similar studies (Patuelli et al., 2005; Gago et al., 2013), using different types of meta-analysis methodologies, also showed some ambiguity in results.

Some empirical literature has covered the determinants of environmental taxation. For example, Castiglione et al. (2014) analyse the case of Europe by considering three types of factors: production and consumption, environmental performance and quality of governance. In addition, convergence analyses have been applied in several areas in the context of environmental economics: CO_2 emissions (Li and Lin, 2013; Ahmed et al., 2017; Liu et al., 2018; Presno et al., 2018; Rios and Gianmoena, 2018), energy use (Fallahi, 2017), energy consumption (Payne et al., 2017; Ivanovski et al., 2018; Kounetas, 2018; Pan and Maslyuk-Escobedo, 2019), energy prices (Dreher and Krieger, 2010) and energy productivity (Apergis and Christou, 2016; Bhattacharya et al., 2018).

However, to the best of our knowledge, the present study is the first to offer analysis of the convergence of environmental taxation among countries,[7] and thus, this is our major contribution. Our aim is to investigate if there is convergence to the same stationary state (convergence in levels) or conditional convergence (convergence in growth rates) in some clubs of environmental taxation. Therefore, we study whether there are common trends in this kind of taxation, which are the countries involved in those trends and what the nature of the convergence found is to better understand the reality and dynamics of the environmental taxation in the European Union. With regard to the harmonisation of this taxation in the EU, it should be noted that the Energy Tax Directive (2003/96/EC) only contains harmonised minimum rates in some cases.[8]

Specifically, we analyse environmental taxation among countries in the EU from two perspectives: environmental taxation revenues as a percentage of GDP and of the total taxation revenues.[9] We study two main categories of environmental taxation: energy and transport taxes. The other two important taxation areas, pollution and resource taxes, are not considered here owing to their current low quantitative relevance, as explained in detail in Section 3.

The remainder of the paper is organised as follows. Section 2 describes the methodology of club convergence analysis. Section 3 presents the data, and Section 4 gives the main results. Finally, Section 5 contains the conclusions.

2. Club convergence

Phillips and Sul (2007, 2009) propose an approach to test for convergence in a panel of countries (the 'log t' test), which allows the classification of countries into convergence groups or clubs. This approach considers a panel data set for a variable y_{it}, $i = 1, \ldots, N$ and $t = 1, \ldots, T$ (N and T are the number of countries and the sample size, respectively) and focuses on the construction of 'relative transition paths':

$$h_{it} = \frac{y_{it}}{N^{-1}\sum_{i=1}^{N} y_{it}} \quad (1)$$

4 Ekins (1999) reviews the environmental taxation in the EU in the 1990s. Another overview of that period can be found in Sterner and Köhlin (2003). In other areas, Wang et al. (2019) perform an interesting study on environmental tax and regional inequality in China, and Wang et al. (2020) provide a cost–benefit analysis of the environmental tax policy in China as well.

5 For a recent survey, see Williams (2016). In addition, Kampas and Horan (2016) offer a theoretical discussion of the comparison between first-best (Pigouvian) and second-best pollution taxation.

6 In a recent paper, Karydas and Zhang (2019) analyse the effects of an environmental tax reform in the context of an endogenous growth model with innovation. Oueslati (2014) also studies the macroeconomic effects of green tax reform in an endogenous growth model, including welfare effects. Finally, Giménez and Rodríguez (2020) state theoretically that, starting from a tax system without environmental taxation, the tax mix derived from a revenue-neutral green tax reform is not the closest to the optimal one.

7 For a recent study of convergence of total taxation in the EU, see Delgado and Presno (2017).

8 Directive 2003/96/EC of 27 October 2003, restructuring the community framework for the taxation of energy products and electricity, available at https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32003L0096&from=FR.

9 Alternatively, Filipovic and Golusin (2015) propose a new indicator, the *Environmental Taxation Efficiency*, finding significant differences in ranking of European countries using several methodologies.

which trace out an individual trajectory over time for economy i relative to the cross-section average, while eliminating the common growth path.

In the case of convergence (when all the economies move towards the same transition path), h_{it} converges to unity for all i as $t \to \infty$, and the cross-sectional variance of h_{it}:

$$H_t = N^{-1} \sum_{i=1}^{N} (h_{it} - 1)^2 \tag{2}$$

converges to zero asymptotically. In the case of no convergence, H_t remains positive as $t \to \infty$, and a number of outcomes are possible: convergence to a positive constant (which is typical of club convergence), bounded above zero but not convergence or divergence.

Based on these properties under convergence, Phillips and Sul (2007) propose the 'log t' convergence test, which involves estimating the following OLS regression with a robust covariance matrix:

$$\log\left(\frac{H_1}{H_t}\right) - 2\log(\log(t)) = \mathrm{a} + \gamma \log(t) + u_t \tag{3}$$

for $t = [rT], [rT] + 1, \ldots, T$, and some fraction r>0, being $[rT]$ the integer part of rT (for sample sizes below $T = 50$, it is recommended to set $r = 0.3$). Empirical regressions are therefore based on time series data in which the first r% of the data are discarded.[10]

Under the null of convergence, the point estimate of γ converges to the scaled speed of convergence parameter 2α. Thus, the null of convergence can be tested by a one-sided t test of $\alpha \geq 0$ (using $\hat{\gamma}$ and HAC standard errors) and rejected if $t_{\hat{\gamma}} < -1.65$(5 percent significance level).

If convergence is rejected for the overall sample, Phillips and Sul (2007) describe a four-step clustering mechanism, which detects endogenously possible clubs of convergence (see Phillips and Sul, 2007, 2009 for further details on this methodology).

To prevent overestimation of the number of clubs, Phillips and Sul (2009) propose a merging procedure using the log t test. The log t test can also be applied to analyse the possibility of some transitioning between groups.

Finally, not only is the sign of $\gamma = 2\alpha$ of interest but so is its magnitude because it measures the speed of convergence. The procedure allows us to distinguish different degrees of convergence:

- $0 \leq \hat{\gamma} < 2$ ($0 \leq \hat{\alpha} < 1$) implies conditional convergence (i.e., convergence in growth rates).
- $\hat{\gamma} \geq 2$ ($\hat{\alpha} \geq 1$) indicates absolute convergence (i.e., convergence in levels).

3. Data

Eurostat has provided data for the total environmental taxation revenues and for four categories since 1995[11]: energy, transport, pollution and resources. We study 27 EU countries, or EU-28 except Croatia, because relevant data for this country have only been available since 2002. We focus on the total environmental taxation and the two main areas, energy and transport.[12]

Table 1 contains the descriptive statistics, and the individual data are reported in the Annex (years 1995, 2005 and 2016). With regard to the total environmental taxation as a percentage of GDP, the average of all countries only rises from 2.55 in 1995 to 2.66 in 2016, but the analysis of the individual country data highlights the cases of Latvia and Estonia, where the increases of 2.67 and 2.18 percentage points, respectively, are remarkable. Similar conclusions are derived from the perspective of share of total taxation, with rises of 8.35 and 6.36 percentage points in those countries. In the former case, that share reaches 11.57 percent in 2016 — the largest in the EU. On the contrary, Luxembourg presents the lowest values in 2016, with 1.75 percent of GDP and 4.42 percent of overall taxation.

In the case of energy taxes, the most important subcategory in terms of revenues, the average of all countries grows from 1.78 to 2.04 percent of GDP and from 4.91 to 5.63 percent of total taxation. In this case, Ireland (1.23 percent) and Belgium present the lowest shares of GDP and total taxation, respectively, in 2016, while Slovenia (3.28) and Latvia (9.85) have the highest shares in the two indicators, respectively. If we look at the variation between 1995 and 2016, we can see that Estonia, Cyprus and Latvia experienced the largest increases.

10 It helps to mitigate the sensitivity of the test to initial effects.

11 https://ec.europa.eu/eurostat/statistics-explained/index.php/Environmental_tax_statistics. Following Eurostat (2013): (i) energy taxes (including fuel for transport): energy products for transport purposes, energy products for stationary purposes, greenhouse gases; (ii) transport taxes (excluding fuel for transport): motor vehicles import or sale, registration or use of motor vehicles, road use, congestion charges and city tolls, other means of transport (ships, aeroplanes, railways), flights and flight tickets, vehicle insurance; (iii) pollution taxes: measured or estimated emissions to air, ozone depleting substances, measured or estimated effluents to water, non-point sources of water pollution (pesticides, artificial fertilisers, manure); and (iv) resources: water abstraction, harvesting of biological resources, extraction of raw materials (minerals, oil and gas), landscape changes and cutting of trees.

12 Regarding the transport taxes, an interesting issue refers to the relationship with the decarbonisation process of the economy. Recently, Gago et al. (2021) analysed the case of Spain, focusing on the impacts on distribution and equity and suggesting alternatives for their viability.

Table 1
Descriptive statistics of environmental taxation indicators calculated for EU-27 countries, 1995 and 2016.
Source: Eurostat and own elaboration.

	Total		Energy		Transport	
	1995	2016	1995	2016	1995	2016
Environmental tax revenues/GDP (%)						
Mean[a]	2.55	2.66	1.78	2.04	0.68	0.52
St. Dev.	0.79	0.68	0.66	0.55	0.62	0.36
C.V.	0.31	0.25	0.37	0.27	0.91	0.69
Min.	0.88	1.75	0.49	1.12	0.00	0.06
Max.	4.31	3.99	3.06	3.28	2.27	1.58
Range	3.43	2.24	2.57	2.16	2.27	1.52
Environmental tax revenues/Total tax revenues (%)						
Mean[a]	7.15	7.29	4.91	5.63	1.99	1.39
St. Dev.	2.28	1.89	1.74	1.75	2.12	0.90
C. Var.	0.32	0.26	0.35	0.31	1.06	0.64
Min.	2.45	4.42	1.55	3.03	0.00	0.17
Max.	11.22	11.57	7.93	9.85	8.54	3.38
Range	8.77	7.15	6.38	6.82	8.54	3.21

[a]Unweighted average.

Table 2
Convergence club results – %GDP.
Source: Own elaboration.

Club	Countries	Average[a]	$t_{\hat{\gamma}}$	$\hat{\gamma}(s.e.)$	$\hat{\alpha}$
(A) Total					
Full sample			−11.602*	−0.954 (0.082)	−0.477
Club 1	DK, SI, EL, LV, IT, NL, FI, EE, CY, MT, BG, HU, PL, PT, UK, AT, FR	2.97	−0.083	−0.008 (0.100)	−0.004
Club 2	RO, BE, SE, CZ	2.19	0.592	0.412 (0.696)	0.206
Club 3	LT, DE, ES, IE, SK, LU	1.92	0.523	0.693 (1.326)	0.346
(B) Energy					
Full sample			−5.659*	−1.089 (0.192)	−0.544
Club 1	SI, LV, EL, IT, EE, BG, PL, CY, DK, FI, RO, HU, CZ, NL, LU	2.34	−1.524	−0.411 (0.269)	−0.205
Club 2	PT, FR, UK, LT, SE, SK, DE, ES, AT, MT, BE, IE	1.64	2.952	0.730 (0.247)	0.365
(C) Transport					
Full sample			−3.140*	−0.235 (0.075)	−0.117
Club 1	DK, MT, NL, FI, AT, EL, IE, BE, IT, UK, LV, SE, SI, BG, RO	0.71	2.179	0.299 (0.137)	0.150
Club 2	CY, PT, HU, DE, FR, PL, ES, SK, CZ, LU, LT, EE	0.27	1.034	0.157 (0.152)	0.078

Note: Abbreviations: AT — Austria, BE — Belgium, BG — Bulgaria, CZ — Czech Republic, DK — Denmark, DE — Germany, EE — Estonia, IE — Ireland-, EL — Greece, ES — Spain, FR — France, IT — Italy, CY — Cyprus, LV — Latvia, LT — Lithuania, LU — Luxembourg, HU — Hungary, MT — Malta, NL — Netherlands, PL — Poland, PT — Portugal, RO — Romania, SI — Slovenia, SK — Slovakia, FI — Finland, SE — Sweden, UK — United Kingdom.
[a]Average past five years.
*Rejection of the null hypothesis of convergence at 5 percent level.

In the case of transport taxation, the mean shows an opposing tendency, falling from 0.68 to 0.52 percent of GDP and from 1.99 to 1.39 percent of total taxation. Looking again at 2016, we see that this category varies from 0.06 of GDP in Estonia to 1.58 percent in Denmark and from 0.17 of total taxation in Estonia to 3.38 percent in Malta.

In addition, Fig. 1 reflects the evolution of the coefficient of variation of the series during the period, the indicator used to measure the so-called sigma convergence, which implies a decreasing coefficient of variation over time. We observe a clear sigma convergence process in the transport taxation but not in the total nor in energy taxation, owing to a sigma divergence path – an increasing coefficient of variation – since the beginning of the 2000s, meaning that the European countries as a whole have adopted differentiated environmental tax policies in that period. Despite this aggregate pattern for all the countries in the period considered, the club convergence approach allows us to investigate patterns of convergence among clubs of countries, distinguishing cases of absolute and conditional convergence, as described earlier.

4. Main results

The results of the club convergence analysis are reported in Table 2 (% GDP), 3 (% taxation) and 4 (overview combining the two perspectives). The null hypothesis of overall convergence from the GDP and tax approaches is rejected at the 5 percent significance level both for the total and the two individual sectors, with the exception of the transport as percentage of total taxation. Hence, we can conclude that EU-27 countries have not converged to the same steady state

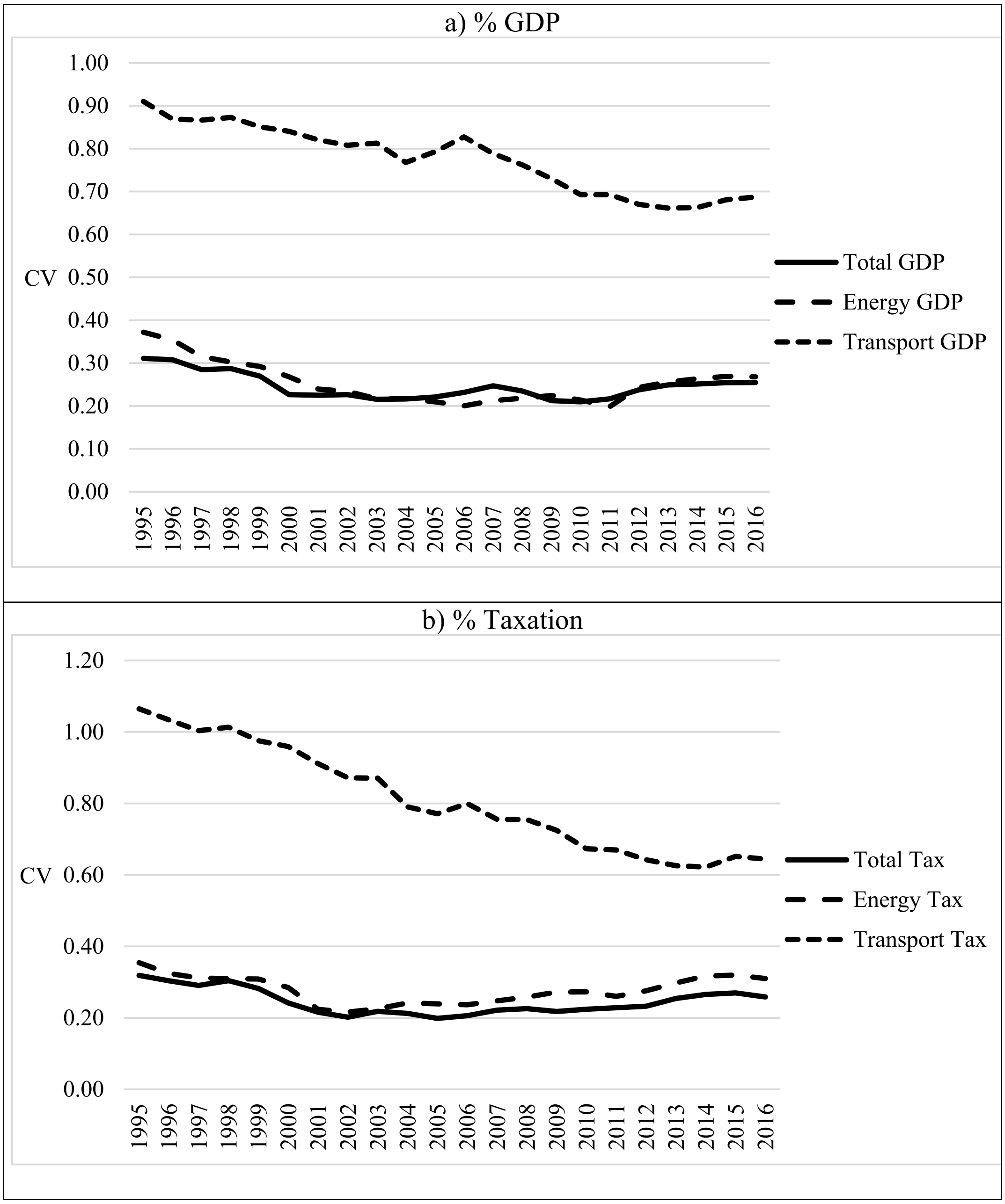

Fig. 1. Evolution of coefficient of variation (CV) in EU-27 countries — sigma convergence.
Source: Own elaboration.

equilibrium in terms of environmental taxation between 1995 and 2016, despite the efforts undertaken to harmonise environmental taxation in the EU. In cases where convergence is rejected, club convergence algorithm is implemented, with the aim of examining the existence of clubs of convergence.

4.1. GDP perspective

The analysis of total environmental tax revenues classifies the countries into three different groups or clubs. One club, with higher taxation as percentage of GDP and an average for the past five years of 2.97 percent (see Table 2), is composed of Denmark, Slovenia, Greece, Latvia, Italy, the Netherlands, Finland, Estonia, Cyprus, Malta, Bulgaria, Hungary, Poland, Portugal, the United Kingdom, Austria and France. A second club contains Romania, Belgium, Sweden and the Czech Republic; this club presents an average of 2.19 percent in the past five years. The third club is formed by Lithuania, Germany, Spain, Ireland, Slovakia and Luxembourg, with a five-year average of 1.92 percent.

Based on the transition curves, Club 1 shows a noticeable upward trend in its relative transition paths, while the opposite behaviour is found in Clubs 2 and 3. These two clubs show similar paths during part of the sample, and the separation between Clubs 1 and 2 is clearer since 2005.

In addition, it should be noted that the point estimate of γ is negative in Club 1, but we fail to reject the null hypothesis of convergence, which suggests that those countries form a weak convergence club. In Clubs 2 and 3, conditional convergence is detected, implying that within those clubs, differentials tend to decrease over time.

In the case of the energy taxation, the results differ. Now just two clubs emerge: the first one, with an average of 2.34 percent in the past five years, includes Slovenia, Latvia, Greece, Italy, Estonia, Bulgaria, Poland, Cyprus, Denmark, Finland, Romania, Hungary, the Czech Republic, the Netherlands and Luxembourg, with relative transition paths above one and an upward trend. The second club contains the rest of the countries, with a five-year average of 1.64 percent, and we observe the opposite behaviour in relation to the transition paths. The two clubs have moved apart since 2002, with no clear explanation for this behaviour.

Again, note that the estimate of γ is negative in Club 1, but it is not statistically significant; it suggests that those countries form a weak convergence club.

When we analyse transport taxation, we estimate two clubs: Club 1 is composed of Denmark, Malta, the Netherlands, Finland, Austria, Greece, Ireland, Belgium, Italy, the United Kingdom, Latvia, Sweden, Slovenia, Bulgaria and Romania; and Club 2 comprises Cyprus, Portugal, Hungary, Germany, France, Poland, Spain, Slovakia, the Czech Republic, Luxembourg, Lithuania and Estonia. These clubs present five-year averages of 0.71 percent and 0.27 percent, respectively. In this case, the clubs diverge from 2004, the year of the great enlargement of the European Union to include eight Central and Eastern European countries and Cyprus and Malta, and just after the approval of the Energy Tax Directive (2003/96/EC).

As a final remark, most clubs present conditional convergence.

4.2. Taxation perspective

Regarding the total environmental taxation as a percentage of total taxation, the procedure classifies the countries into two clubs: the first is composed of Latvia, Slovenia, Bulgaria, Greece, Romania, Cyprus, Estonia, the Netherlands, Denmark, Malta, Italy, Poland, Ireland, Hungary and the United Kingdom. This club presents an average for the past five years of 8.64 percent (see Table 3). The second one, with a lower share of the total taxation in the EU and a five-year average of 5.53 percent, contains the rest of the countries. Again, Club 1 shows weak convergence. These two clubs tend to approximate until 2002, but they have been diverging since then.

In the case of energy taxation, initially we find three clubs: Club 1, with Slovenia, Bulgaria, Romania, Estonia, Greece, Poland, Cyprus, Italy, the Czech Republic and Ireland; Club 2, formed by Lithuania, Portugal, the United Kingdom, Hungary, Slovakia, the Netherlands, Finland, Denmark, Spain, Malta, Luxembourg, Sweden, France and Germany; and Club 3, with Austria and Belgium. Additionally, there is a divergent country: Latvia. As previously stated, Latvia has experienced a notable increase in the period, specifically from 3.05 to 9.85 percent of total taxation, far from the average of 5.63 percent. The five-year averages of the three clubs established in the analysis are 6.99 percent, 4.67 percent and 3.14 percent, respectively.

Following the merging procedure by Phillips and Sul (2009) mentioned earlier, we apply the test to analyse the possibility of merging clubs and find that Clubs 2 and 3 could be merged ($t_{\hat{\gamma}} = 0.186$, $\hat{\gamma} = 0.028$). In all remaining cases, the merging procedure is rejected.

Finally, in the transport taxation, we find conditional convergence for all countries.

4.3. Overview of the two perspectives

Table 4 summarises the results derived from the two perspectives. When considering the total environmental taxation, the case of Ireland, which is in the high club in the taxation view but in the low club from the GDP perspective, should be noted. This can be explained by the low (overall) tax burden of Ireland, which was only 24 percent of GDP in 2016, far from the EU-28 average of 39.9 percent. In the reverse situation, we can find the cases of Finland, Portugal, Austria and France.

Overall, we can state that harmonisation efforts, from the perspective from which we analyse environmental taxation in the EU, are not succeeding as could be expected. Concretely, the Energy Tax Directive (2003/96/EC) aimed at being a harmonisation instrument of different aspects of energy taxation among member states. Efforts in other areas have not even been attempted. It is important from a macroeconomic and environmental perspective that all countries have similar tax burdens, and if not, that they converge. Otherwise, other policies to reduce environmental impacts can be offset owing to capital mobility within the EU.

Table 3
Convergence club results – %Taxation.
Source: Own elaboration.

Club	Countries	Average[a]	$t_{\hat{\gamma}}$	$\hat{\gamma}(s.e.)$	$\hat{\alpha}$
(A) Total					
Full sample			−11.462*	−1.227 (0.107)	−0.613
Club 1	LV, SI, BG, EL, RO, CY, EE, NL, DK, MT, IT, PL, IE, HU, UK	8.64	−1.493	−0.174 (0.117)	−0.087
Club 2	FI, PT, LT, CZ, SK, AT, ES, SE, BE, FR, DE, LU	5.53	1.346	0.206 (0.153)	0.103
(B) Energy					
Full sample			−21.586*	−1.438 (0.067)	−0.719
Club 1	SI, BG, RO, EE, EL, PL, CY, IT, CZ, IE	6.99	0.149	0.031 (0.210)	0.015
Club 2	LT, PT, UK, HU, SK, NL, FI, DK, ES, MT, LU, SE, FR, DE	4.67	1.339	0.421 (0.314)	0.210
Club 3	AT, BE	3.14	−0.984	−0.426 (0.432)	−0.213
Divergence	LV	9.65			
(C) Transport					
Full sample			0.065	0.003 (0.051)	0.001

[a]Average past five years.
*Rejection of the null hypothesis of convergence at 5 percent level.

Table 4
Summary of results of club convergence.
Source: Own elaboration.

4.a. Total

%Tax/%GDP	I	II	III
I	DK, SI, EL, LV, IT, NL, EE, CY, MT, BG, HU, PL, UK	RO	IE
II	FI, PT, AT, FR	BE, SE, CZ	LT, DE, ES, SK, LU

4.b. Energy

%Tax/%GDP	I	II
I	SI, EL, IT, EE, BG, PL, CY, RO, CZ, LV[a]	–
II+III	DK, FI, HU, NL, LU	PT, FR, UK, LT, SE, SK, DE, ES, AT, MT, BE, IE

4.c. Transport

%Tax/%GDP	I	II
I	DK, MT, NL, FI, AT, EL, IE, BE, IT, UK, LV, SE, SI, BG, RO	CY, PT, HU, DE, FR, PL, ES, SK, CZ, LU, LT, EE

[a]Divergent (high).

4.4. Discussion of results

The energy–environment relationship in the EU has been analysed in recent decades without reaching a clear consensus to achieve the integration of environmental goals into energy policies. In this regard, contributions to this debate can be found in Tosun and Solorio (2011), Morata and Solorio (2012), Kuzemko et al. (2012), Maltby (2013) or Talus (2013).

The role of harmonisation to achieve the climate and energy policy targets defined by the EU has also been debated during the past few years, and different positions have arisen. In fact, some Member States are not in favour of establishing common rules in the energy policy, and, so far, they have not been interested in moving competences into this area at the European level. In addition, there is not a single answer to the question of whether tax harmonisation is a prerequisite for achieving the climate objectives in the region. In this framework, recently, Cheng et al. (2020), in a theoretical approach with a model for two countries, concluded that when unbundling costs are so high that parts and assembly must collocate in the pre-globalised world, pollution is spatially concentrated, and harmonising environmental taxes maximises global welfare. However, harmonisation fails to maximise global welfare with low unbundling costs, triggering the dispersion of parts and thus pollution around the world. In addition, Vlassis (2013) explore the welfare consequences of pollution-tax harmonisation, confirming the existence of potential Pareto improvements in large open economies. Thus, the tax harmonisation and its effects remains as an open matter, both theoretically and empirically.

A correct design of environmental taxation and its transborder effects can make the difference between achieving a specific environmental goal or not. The EU stated some specific climate and energy objectives for 2020 (da Graça, 2012), which were mostly achieved (Kryk and Guzowska, 2021), but not in all countries – Vavrek and Chovancová (2020), in their analysis of eight input indicators including CO_2 intensity, electricity and gas price or energy productivity for 2008–2016, conclude that the differences among countries persisted — owing to several factors. One of these could include a lack of harmonisation among Member States, but this should be analysed in further research. The EU's main current objectives are: (1) a 2030 greenhouse gas emission reduction target, including emissions and removals, of at least 55 percent compared to 1990 emissions. As part of the European Green Deal[13] proposed by the European Commission (COM (2020a,b) 562 final) in September 2020, this target was increased from 40 to 55 percent. By 2050, Europe aims to become the world's first climate-neutral continent; (2) at least a 32 percent share for renewable energy; and (3) at least a 32.5 percent improvement in energy efficiency.

In July 2021, the European Commission adopted a set of legislative proposals (COM (2020a,b) 80 final) setting out how it intended to achieve climate neutrality in the EU by 2050, including the intermediate target of at least a 55 percent net reduction in greenhouse gas emissions by 2030. Among these, taxation is expected to play an important role. Of course, the new European funds, Next Generation EU, launched in 2020 for the period 2021–2026, are also crucial for these objectives because countries must allocate a minimum of 37 percent for the green transition.

Ecological dumping owing to less strict environmental policies in some countries inside the EU can jeopardise not just environmental policies but also a fair economic competition and confidence among member states. This makes it important to progress towards a greater harmonisation of taxation policies within the EU. Therefore, the policy implications of these results are numerous. From a global perspective, the three main implications are: (i) greater economic integration in a context of a monetary union, but not fiscal union, which can lead to economic imbalances; (ii) higher efficiency of climate and energy policies at the EU level; and (iii) fairness in allocating the costs of environmental reductions within EU Member States. However, it should be taken into account that the environmental tasks are, and should be faced through, world policies. In this regard, the recent agreement on taxation of multinationals, with a minimum corporate tax rate, could serve as guidance or a reference to achieve similar agreements in environmental taxation.

5. Concluding remarks

Environmental taxation is one of the main environmental policy instruments, together with fees and charges, subsidies or tradable permits. These taxes represent about 2.5 percent of GDP and 6 percent of total taxation in the EU in recent years and include energy, transport, pollution and resources taxes. Specifically, the total environmental taxation in 2016 ranged from 1.75 percent of total taxation (Luxembourg) to 3.99 percent (Denmark) of GDP and from 4.42 percent (Luxembourg) to 11.57 percent (Latvia), denoting the relevance of this taxation in the current European tax mix (see Table A.1).

In this paper, we carry out a club convergence analysis of environmental taxes in the EU to investigate if there is tax convergence among groups of countries, either absolute (in levels) or relative (in growth rates). Specifically, we consider 27 EU countries for the period 1995–2016, focusing on the environmental taxes as a percentage of GDP and also as a share of total taxation.

Our preliminary analysis based on sigma convergence shows a sigma convergence process in the transport taxation, but not in the total or in energy taxation, owing to a sigma divergence path since the beginning of the 2000s.

With regard to the club convergence analysis, the results, from the GDP perspective, show three groups of countries or clubs for the total environmental taxation and only two clubs for the other two categories analysed. From the taxation structure perspective, two clusters emerge for the total revenues of environmental taxes, three for the energy case and only one for the transport taxation, denoting conditional convergence in this case.

Multiple policy implications can arise from the analysis. From a wider perspective, the results of this analysis are a consequence of the difficulties of establishing a unique tax policy in the European Union. The Treaty of the EU requires unanimity amongst Member States to modify taxation, given states want to keep control of their tax systems. Only the Energy Tax Directive has tried to create some harmonisation, although this study shows that from the perspective analysed, this has failed. However, it should be noted that harmonisation of tax policies can imply many different aspects, not only those directly related to the final obtained revenues in different countries.

A common market with a common monetary policy, but not a tax one, can lead to difficulties in adjusting economic circumstances from a centralised public policy perspective. Differences in tax burdens can lead to capital leakage, tax competition and a redistribution of sources of environmental impacts among Member States, rather than reduction of them, offsetting other environmental policies in the EU.

In a broader context, the European Green Deal and the orientation of the new European funds, Next Generation EU 2021–2026, with a minimum of 37 percent devoted to the green transition, have placed environmental tasks at the forefront of European policies. This specific taxation programme should be clearly revised and agreed upon, although it is desirable, and necessary, to reach agreements at the global level. Climate change and its challenges must be addressed with ambitious policies, taxes included, and the European Union may play a key role, but this must always be in line

[13] https://ec.europa.eu/info/strategy/priorities-2019-2024/european-green-deal_en

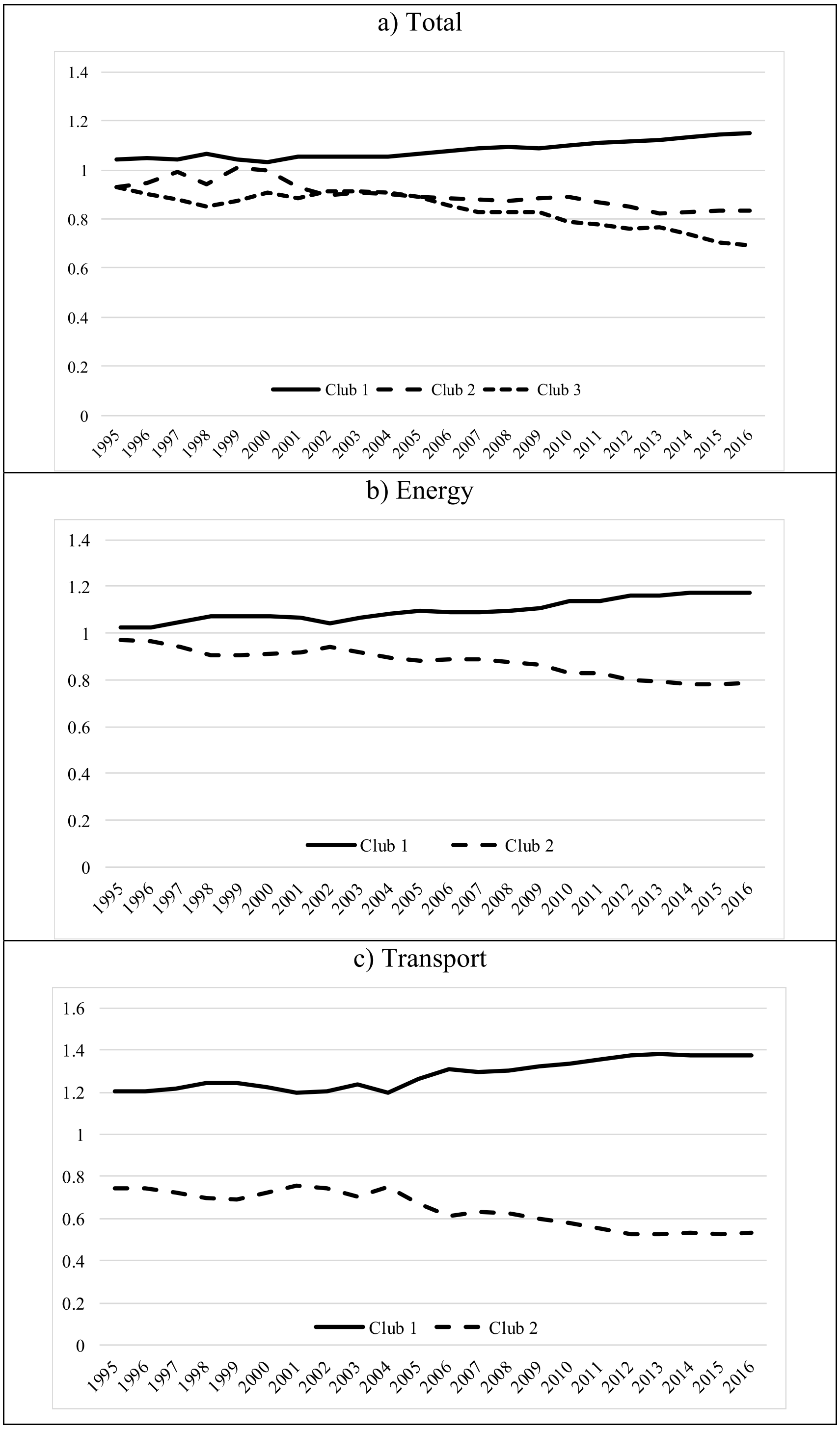

Fig. 2. Average relative transition curve for each club – %GDP.
Source: Own elaboration.

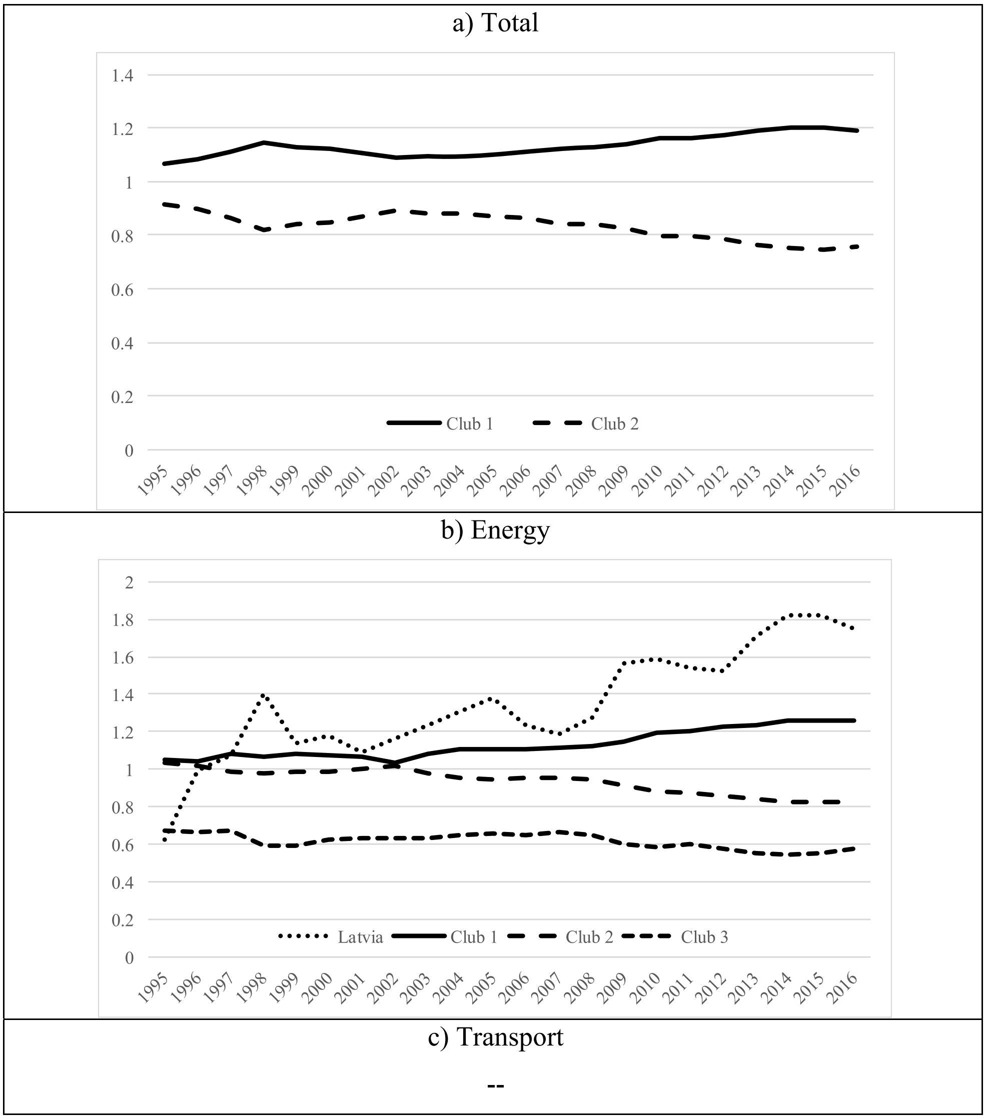

Fig. 3. Average relative transition curve for each club – %Taxation.
Source: Own elaboration.

with the other countries around the world. This alignment that allows an appropriate balance among economic growth, fairness and environmental protection will continue to be, surely, the greatest challenge in the coming decades.

Finally, future research should emphasise the size and role of harmonisation of other kinds of environmental policies, not just taxation. It would also be interesting to analyse the convergence or divergence patterns of environmental taxation with respect to the other tax resources, and the tax burden as a whole, in the search for resilient tax systems in the coming decades. Another subject requiring further research is the importance of harmonisation in achieving climate, policy and economic goals.

Acknowledgment

We are grateful to the Editor-in-Chief and anonymous referees for their valuable comments and suggestions on preliminary versions

Annex. Data

See Tables A.1–A.3.

Table A.1
Total environmental taxes.
Source: Eurostat.

Country	%GDP			%Taxation		
	1995	2005	2016	1995	2005	2016
Austria	2.16	2.58	2.37	5.02	6.12	5.53
Belgium	2.40	2.45	2.22	5.32	5.37	4.74
Bulgaria	1.67	2.92	2.77	5.90	9.58	9.57
Cyprus	2.62	3.32	2.96	10.52	10.58	8.82
Czech Republic	2.64	2.47	2.11	7.62	7.20	6.07
Denmark	4.31	4.92	3.99	8.96	9.96	8.43
Estonia	0.88	2.27	3.06	2.45	7.54	8.81
Finland	2.86	2.97	3.11	6.33	7.04	7.03
France	2.49	2.00	2.23	5.74	4.49	4.69
Germany	2.12	2.42	1.86	5.25	6.27	4.60
Greece	3.15	2.11	3.82	10.6	6.31	9.09
Hungary	2.47	2.73	2.76	6.14	7.46	7.00
Ireland	2.96	2.48	1.84	8.76	7.91	7.73
Italy	3.46	2.90	3.50	8.57	7.39	8.16
Latvia	0.98	2.52	3.65	3.22	8.97	11.57
Lithuania	1.87	2.29	1.93	6.77	7.77	6.41
Luxembourg	2.84	2.97	1.75	7.59	7.57	4.42
Malta	3.10	3.07	2.79	11.22	9.30	8.28
Netherlands	3.28	3.56	3.37	8.44	9.84	8.58
Poland	1.78	2.67	2.72	4.75	7.88	7.91
Portugal	3.35	2.89	2.59	10.63	8.43	7.02
Romania	1.74	1.98	2.33	6.28	7.00	8.99
Slovakia	2.29	2.34	1.81	5.78	7.43	5.58
Slovenia	4.13	3.15	3.87	10.70	8.24	10.48
Spain	2.14	1.90	1.85	6.65	5.29	5.41
Sweden	2.69	2.72	2.22	5.77	5.77	4.99
United Kingdom	2.50	2.28	2.43	8.03	6.56	6.94

Table A.2
Energy taxes.
Source: Eurostat.

Country	%GDP			%Taxation		
	1995	2005	2016	1995	2005	2016
Austria	1.40	1.71	1.50	3.27	4.06	3.49
Belgium	1.49	1.44	1.42	3.31	3.15	3.03
Bulgaria	1.51	2.55	2.38	5.36	8.36	8.22
Cyprus	0.49	1.88	2.28	1.98	6.01	6.78
Czech Republic	2.14	2.28	1.96	6.17	6.64	5.64
Denmark	2.09	2.52	2.21	4.34	5.10	4.67
Estonia	0.56	1.92	2.69	1.55	6.37	7.75
Finland	2.08	1.78	2.11	4.61	4.21	4.77
France	1.94	1.61	1.85	4.47	3.62	3.88
Germany	1.75	2.04	1.54	4.33	5.29	3.81
Greece	2.35	1.26	3.02	7.93	3.77	7.19
Hungary	2.20	2.08	2.01	5.47	5.68	5.10
Ireland	1.68	1.30	1.12	4.97	4.15	4.72
Italy	3.01	2.31	2.83	7.45	5.89	6.60
Latvia	0.93	2.12	3.11	3.05	7.53	9.85
Lithuania	1.10	1.73	1.75	3.98	5.88	5.81
Luxembourg	2.71	2.87	1.60	7.23	7.30	4.04
Malta	0.83	1.21	1.46	3.00	3.67	4.33
Netherlands	1.54	1.87	1.90	3.96	5.18	4.84
Poland	1.21	2.26	2.35	3.21	6.66	6.83
Portugal	2.49	1.99	1.90	7.92	5.82	5.14
Romania	1.40	1.83	2.09	5.07	6.45	8.06
Slovakia	2.05	2.08	1.60	5.18	6.63	4.94
Slovenia	3.06	2.42	3.28	7.93	6.35	8.89
Spain	1.74	1.47	1.53	5.41	4.10	4.49
Sweden	2.31	2.27	1.75	4.95	4.81	3.92
United Kingdom	1.99	1.78	1.80	6.39	5.11	5.12

Table A.3
Transport taxes.
Source: Eurostat.

Country	%GDP			%Taxation		
	1995	2005	2016	1995	2005	2016
Austria	0.74	0.85	0.85	1.71	2.01	1.99
Belgium	0.75	0.81	0.67	1.66	1.78	1.43
Bulgaria	0.15	0.23	0.32	0.52	0.75	1.12
Cyprus	2.12	1.43	0.68	8.54	4.57	2.02
Czech Republic	0.31	0.17	0.13	0.90	0.49	0.39
Denmark	2.01	2.11	1.58	4.17	4.26	3.33
Estonia	0.19	0.07	0.06	0.54	0.23	0.17
Finland	0.75	1.13	0.97	1.67	2.67	2.18
France	0.41	0.27	0.26	0.94	0.61	0.54
Germany	0.37	0.38	0.32	0.92	0.98	0.79
Greece	0.79	0.85	0.80	2.67	2.54	1.90
Hungary	0.15	0.52	0.36	0.37	1.43	0.92
Ireland	1.28	1.15	0.69	3.79	3.67	2.92
Italy	0.44	0.56	0.63	1.09	1.42	1.46
Latvia	0.00	0.29	0.46	0.00	1.04	1.47
Lithuania	0.73	0.48	0.09	2.66	1.61	0.29
Luxembourg	0.13	0.11	0.13	0.36	0.27	0.32
Malta	2.27	1.66	1.14	8.22	5.02	3.38
Netherlands	1.24	1.21	1.01	3.20	3.35	2.58
Poland	0.18	0.28	0.23	0.49	0.83	0.66
Portugal	0.85	0.89	0.67	2.71	2.61	1.83
Romania	0.00	0.06	0.24	0.00	0.22	0.91
Slovakia	0.24	0.19	0.18	0.60	0.60	0.55
Slovenia	1.00	0.49	0.44	2.61	1.27	1.19
Spain	0.39	0.41	0.23	1.20	1.14	0.68
Sweden	0.31	0.38	0.45	0.66	0.80	1.00
United Kingdom	0.51	0.43	0.56	1.63	1.22	1.60

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