OPEN ACCESS
Scientific journal of the
European Ecocycles Society

ECOCYCLES
ISSN 2416-2140

Ecocycles, Vol. 8, No. 2, pp. 37-46 (2022)
DOI: 10.19040/ecocycles.v8i2.236

RESEARCH ARTICLE

Economics of sustainable development and its environmental impact in the European Union: Case study

Martin Maris[1]

[1] *Slovak University of Agriculture in Nitra, Nitra 94976, Slovakia*

Corresponding author: Ing.Martin Mariš,PhD. email: martin.maris@uniag.sk

Abstract – The natural environment and the human economy are tightly interrelated systems. The paper investigates long-term input-output relations between economics and the environment regarding draws (raw materials) from the system and loads (pollution) to the system. More recent evidence about consumption and use patterns was provided regarding raw extraction and waste production. New insights about the contribution of the EU member states toward the sustainable use and reuse of materials and waste have been highlighted. The results support the EKC hypothesis regarding the firm and negative relationship between income and GHG emissions in CO2 eq., strengthening the evidence about a further drop in emissions responding to income growth. However, the inconclusive results suggest a cyclical waste production and raw materials consumption pattern. Thus economic growth instead encourages consumption. Moreover, there is a lack of cooperation between the EU member states on a national level to fill common environmental goals. EU member states are pursuing their goals rather than individually, thereby "locking" themselves against each other. Their effort results in substantial differences, and their overall progress is vague. The cluster analysis shows relatively significant heterogeneity between the subclusters and high inter-class variance within; regarding renewable energy share, water use, waste recycling and circular material use. More inclusive coordination of policies and broader decentralization of power-decision bodies on the regional level might shape economic-environmental relations more sustainably.

Keywords – European Union, environmental Kuznets curve, EKC hypothesis**,** economic-environmental interdependence, sustainability, EU member states, environmental policy, environmental impact

Received: August 26, 2022 Accepted: October 3, 2022

INTRODUCTION

Economic activity's environmental impact can be seen as extractions from or insertions into the environment. In economic activity, the environment serves as a resource base, amenity service base and waste sink (Common, 1995). Perman et al. (2003) note that the total level of impact can be considered the size of the human population and the per capita impact. The per capita impact depends on each individual's consumption and production technology. A commonly used description for identification of the impact made by human activity on the environment is IPAT identity. Thus impact (I) was expressed as the product of population (P), (2) affluence (A), and (3) technology (T). The introduction of this equation is credited to Ehrlich and Holdren (1970); although first used to quantify contributions to unsustainability, the formulation has been reinterpreted to assess the most promising path to sustainability (Chertow, 2001). Later, the identity was renovated as the 'ImPACT' identity, proposed by Waggoner and Ausubel (2002). In the 'new' ImPACT identity, parents modify P, workers modify A, consumers modify C, and producers modify T (Waggoner and Ausubel, 2002).

The new understanding of environmental and resource economics is that the natural environment and the human economy are interrelated. Change in one could have a significant effect(s) on the function of the other. The human economy has grown to a size that can no longer be considered negligible relative to the natural world (Hussen, 2000). Ongoing ecosystem destruction and overall degradation of natural systems have been well documented (World bank, 2008; Millennium Ecosystem Assessment, 2005).

Environmental degradation occurs and is occurring everywhere, although they tend to vary with the economic system, the state of the economy, the geographic area, the climatic conditions, and the growth of the population. The European environmental agency considers biodiversity loss, resource use, climate change impacts and environmental risks to health and well-being as the most pressing problems. Global megatrends such as demographic change intensify many environmental challenges, while rapid technological change brings new risks and uncertainties (EEA, 2019).

Earlier, Stern (2007) provided a comprehensive overview of the impact of ongoing climate change on the human population and vice-versa. Its executive summary notes that climate change should influence essential elements of human life on earth – access to water, goods production, health and the environment. Hundreds of millions may suffer from hunger, water shortage, and floods as the planet are warm (Stern, 2007). In this relation, Barbier (2010) speaks about a poverty-environment trap as a condition when many rural people in developing countries rely directly on natural resources and the environment for agriculture, livestock husbandry, fishing, basic materials, and fuel – to meet their subsistence requirements and to sell in markets for cash income.

(Barret et al., 2013) Distinguish between manufactured capital and natural capital. Ecosystems are specific forms of natural capital assets that provide various services. They maintain a genetic library, preserve and regenerate soils, fix nitrogen and carbon, recycle nutrients, control floods, filter pollutants, pollinate crops, and operate the hydrological cycles. Degradation of ecosystems is much like the depreciation of physical capital (e.g., roads, buildings and machinery) but with two significant differences: damages are frequently hard to reverse, and ecological processes tend to be nonlinear so that the ecosystem can collapse abruptly, without much prior warning. It has been hypothesized that a relationship between environmental degradation and economic development does exist. Such a relationship is called an environmental Kuznets curve (EKC) after Kuznets (1955), who hypothesized an inverted 'U' for the relationship between a measure of inequality in the distribution of income and the level of income (Uschiyama, 2016; Perman et al., 2003). The EKC proposes that indicators of environmental degradation first rise and then fall with increasing income per capita (Stern, 2004).

Such a relationship, or the relationship between economic growth and environmental pollution, has been the subject of intense research. The empirical evidence has brought inconclusive results, whether several suggestions for environmental policy enforcement were provided (Acaravci and Ozturk, 2010; Lin et al.,2016; Ben Nasr et al., 2015; Farhani et al.,2014). Stern (2004) suggests little evidence for a common inverted U-shaped pathway that countries follow as their income rises. Furthermore, it seems unlikely that the EKC is an adequate model of emissions or concentrations. Overall, EKC results do have a very flimsy statistical foundation. Lin et al. (2016); and Ben Nasr et al. (2015) found no support for the EKC hypothesis in a sample of African countries. Instead, the environmental policy should focus on encouraging energy efficiency, enhancing the use of clean energy and harnessing the positive impacts of urbanization. In conclusion, it will need to sacrifice economic growth, which is unfeasible for most countries to reduce emissions.

Contrary to initial estimations, Farhani et al. (2014) found an inverted U-shape relationship between environmental degradation and income and, in the case of modified EKC (MEKC), a link between sustainability and human development. The moderating factors were introduced, like energy, trade, manufacturing and the role of law. Findings also suggest that the EKC hypothesis, HD and sustainability are crucial to building effective environmental policies. Lin et al. (2016) found that the EKC hypothesis is well supported for all three primary pollutant emissions in China. However, challenges to the EKC hypothesis were cited, namely energy consumption, trade liberalization and growing urbanization, as the most severe factors which may jeopardize the overall goal for carbon emissions.

Economists can influence environmental policy in several ways. One is by advocating using particular tools for achieving better environmental outcomes through research, teaching, and outreach to policymakers. Another is by analyzing the benefits and costs of regulations and standards, which may demonstrate the inefficiencies of the goals. A third way is by analyzing how decisions are made – by examining the political economy of environmental regulation.

The narrow definition of the economic instrument in environmental policy enforcement is typically restricted to incentive-based mechanisms such as emission taxes, deposit-refund schemes, tradable permits, subsidies, and removal of subsidies.

Such mechanisms can achieve environmental outcomes at a lower cost than direct regulation (Hahn, 1998). (OECD, 2017) advocates for using economic instruments in environmental policy enforcement. Taxes, subsidies, and other instruments provide necessary market signals that can influence the behaviour of producers and consumers. They can incorporate environmental costs and benefits into the budgets of businesses and households by increasing (or decreasing) the price of a product or service. As such, they help internalize the use of natural resources or the emission pollutants into firms or household decisions. They can effectively and cost-effectively achieve environmental goals, such as fighting air pollution and climate change or protecting biodiversity. Mura and Marisova (2021) argue the necessity of delivering environmental policy instruments to the local level. Notably, territorial self-government is one of the essential pillars of the functioning of public administration. In territorial self-government, local and regional bodies are closest to the citizens and know their daily needs.

Furthermore, Bumbalova et al. (2022) point to a close link between local waste management and environmental protection, which belong to the core competencies of self-government units. Thus, municipalities have a significant ability to influence waste management, transportation (mobility), and circular economy topics. Legal tools, partnerships and information and communication tools were those that can be most utilized in their activities relating to environmental protection and environmental policy enforcement.

The European Union (EU) recognizes its relatively tepid approach to integrating environmental policy into the framework of fiscal policies at the EU level. Attempts to integrate environmental policies into other policies and to correct wrong market mechanisms were pursued in the 1990s but failed to deliver (Scheuer, 2005). Currently, EU environmental policies are guided by three thematic policy priorities: (1) to protect, conserve and enhance the EU's natural capital; (2) to turn the EU into a resource-efficient, green and competitive low carbon economy; (3) to safeguard the EU's citizens from environment-related pressures and risks to their health and well-being (EEA, 2019). Today, many environments and climate policies combine different types of public interventions, such as (1) traditional regulatory approaches, sometimes labelled 'command and control measures (e.g. emission standards, bans of toxic substances or land planning instruments); (2) market-based instruments (e.g. environmental taxes and emission trading); (3) awareness raising (e.g. energy efficiency labels or communication campaigns) (EEA, 2016).

Besides using economic instruments for environmental policy goals achievement, other supporting tools might be employed. In these terms, we might speak about the Cohesion policy EU framework, which is the specific policy concerning economic and social disparities among the EU member states. Several studies clarified the objectives of the EU cohesion policy (Molle, 2007; Bachtler et al., 2017; Fratesi and Wishlade, 2017). In the current programming period (2021-2027), the environmental issues are well incorporated in the EU political objective no.2: a greener, low-carbon transition towards a net zero carbon economy.

MATERIALS AND METHODS

The paper provides valuable insights into economic-environmental relations on a casual basis. Thereby combines and follows a traditional topic of investigation (e.g. EKC hypothesis or/and IPAT identity) for providing recent evidence about the impact of human activity on the environment. The paper should deliver "more evidence "about the EU results regarding the economic transition towards sustainability.
Firstly, an assessment of the environmental footprint caused by economic activity is investigated.

Notably, the Kuznets hypothesis and IPAT identity is an object of interest, whether more developed nations can mitigate environmental degradation's impact. Several indicators qualified as 'environmental demand' were opted to illustrate the society's ongoing life trends: *GHG emissions in CO2 tonnes, raw materials extraction in thousand tonnes* and *produced communal waste per capita*. The novelty of the approach rests in indicators use, which well describes ongoing patterns in consumption, resource use and waste production.

These indicators are expressed as logs of GDP in PPS at the EU level. The scattergram shows a possible association between each indicator and income per capita smoothed by the trend curve.

Secondly, the EU member state's contribution to standard EU environmental policies by pursuing joint environmental goals was investigated. For this purpose, several indicators (e.g. indicators of 'sustainability') were chosen, which are also part of the most critical EU environmental policies: *the share of renewables in gross final energy consumption, the recycling rate of municipal waste, circular materials use rate* and *water exploitation index*. This part of the paper provides results of long-term efforts to mitigate resource over-consumption and over-use patterns toward greater sustainability via environmental policy tools.

All these indicators were observed at the EU member state level for the last recorded period. The current state has been analyzed through cluster analysis (agglomerative hierarchical clustering – AHC), thereby highlighting differences between the EU member states. Formally are considered N objects, represented by the EU member states plus UK. On each object, k characters are investigated, which means sustainability indicators.

It is possible to find $Nk-$ vectors $x_1, x_2, \dots x_N$. Let denote them X as a set of all objects. The goal of cluster analysis is to aggregate x_i objects into n clusters $S_1, S_2, \dots S_n$, respectively. Objects of the cluster analysis are aggregated into clusters by distance or similarity criteria. As a basis for *'dissimilarity'* determination among the clusters or states is *Euclidean distance* v, which can be formalized as a distance between two arbitrary vectors Y and Z

$$v_{YZ} = \sqrt{\sum_{i=1}^{k}(y_i - z_i)^2} \quad \text{Eq. (1)}$$

In each step, clusters are considered 'new' objects and are submitted to further clustering according to the same principle as the prior one. The primary basis for clustering procedures is the distance matrix (v_{rs}) of each pair of objects. We can use several methods of clustering. For our purposes, we use *Ward's method* as an essential criterion for clustering. This method is based on minimizing total dispersion within the cluster. Thus the method uses a modified Euclidean distance squared (Hendl, 2012).

$$v_{rs} = v(\{X_r\}, \{X_s\}) = \|X_r - X_s\|^2 \quad \text{Eq.(2)}$$

As a research sample, we have used statistical data on the level of EU member states. In the case of environmental demand indicators, the data on the EU level assembled in time series have been used. The length of each time series varies because of the differences in records among the indicators, but 1995-2020 time series data have been used in general. For the cluster analysis, data on EU member states were used for 2017-2020. Again, there are some differences in records between the indicators. For the analysis, secondary data from

Eurostat were used. At first, the evidence about the relevance of the EKC hypothesis applicable to the EU level was investigated.

RESULTS

Figure 1 shows the relation between the GHG emissions in CO_2 eq. and GDP per capita in PPS at the EU level for 1995-2020, smoothed by the nonlinear curve. The display suggests apparent relation between the variables. Indeed, the calculated value of Kendall's correlation coefficient (τ) became strong (-0.835) and statistically significant (p-value<0.0001). It also suggests that with rising income (x-axis) EU has been able to significantly decrease GHG emission levels (y-axis) measured as CO_2 equivalents (tonnes per capita) from 1995-2020.

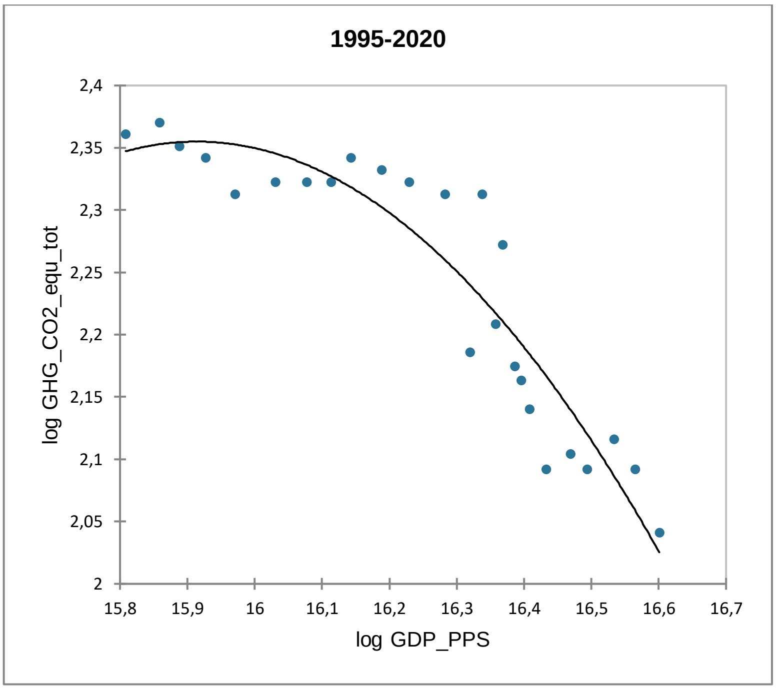


Figure 1: Plot of *log GHG emission in CO_2 eq. vs log of GDP per capita in PPS*, EU level

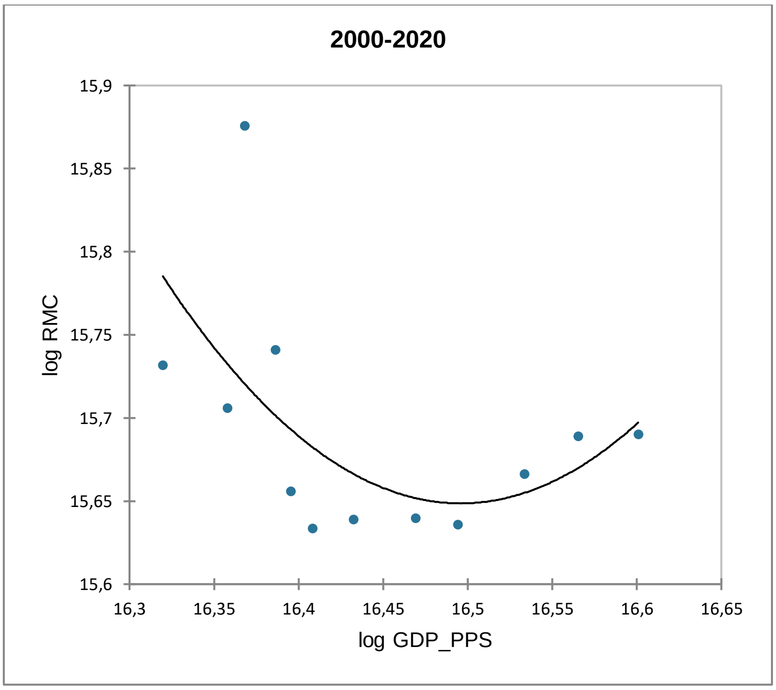


Figure 2: Plot of *log RMC vs log of GDP per capita in PPS*, EU level

Figure 2 shows the relation between raw material consumption (in thd. tonnes) and GDP per capita in PPS at the EU level for 2000-2020 smoothed by the nonlinear curve. The graph suggests nonlinear relation between raw materials consumption and GDP per capita. The relation is moderately negative, the value of $\tau = -0.212$, which became barely statistical significant (p-value<0.05). The results suggest that rising income can moderate raw materials consumption, but after some income level (not determined), it appears that raw materials consumption has risen again.

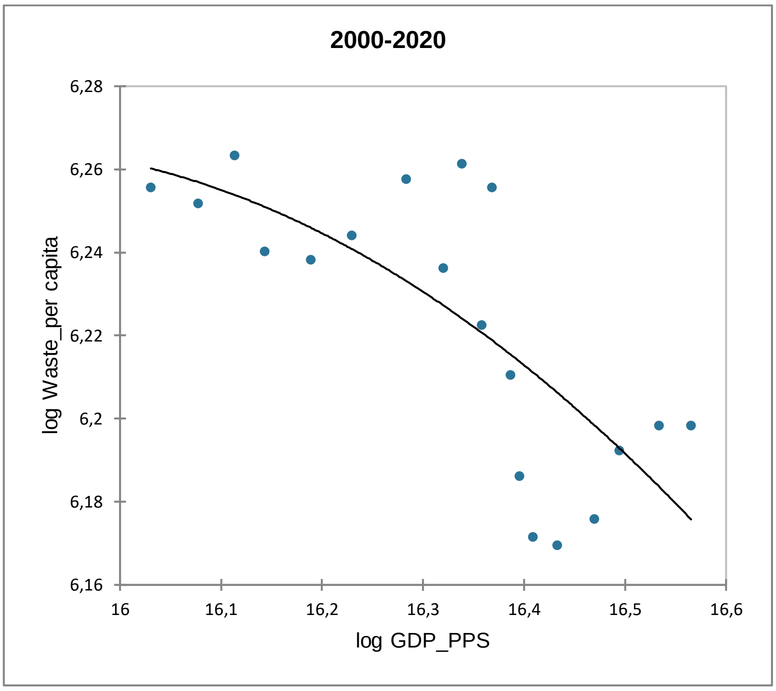
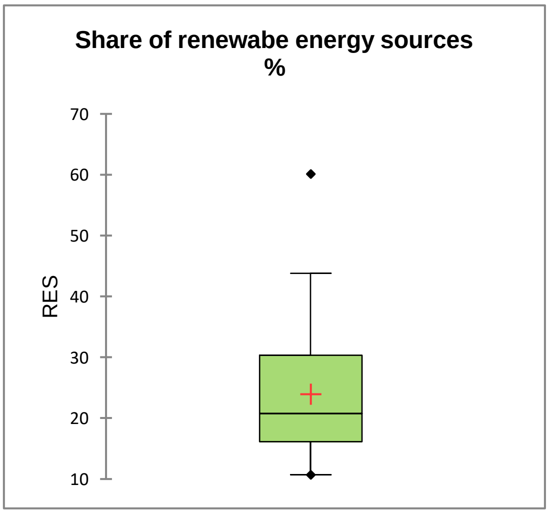
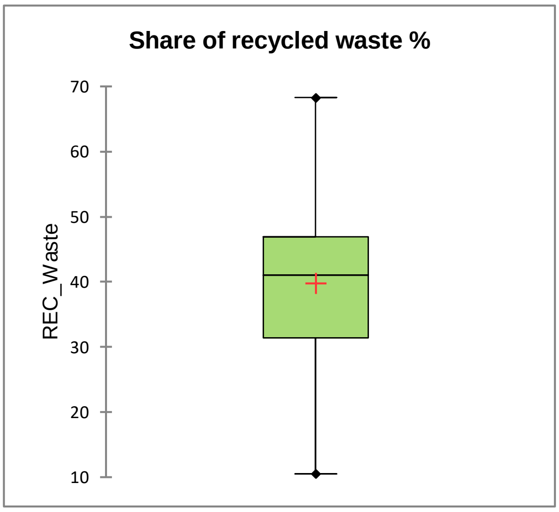


Figure 3: Plot of *log Waste per capita vs log of GDP per capita in PPS*, EU level

Figure 3 shows the relation between waste capita production (in thd. tonnes) and GDP per capita in PPS at the EU level for 2000-2020 smoothed by the nonlinear curve. The graph suggests nonlinear relation between waste production and GDP per capita. The relation is strongly negative, the value of $\tau = -0.547$, which became statistically significant (p-value<0.01). However, the display of the figure shows some inconsistency, suggesting cyclical development of waste produced in the EU.

Next, the progress of EU member states towards sustainability goals was investigated.





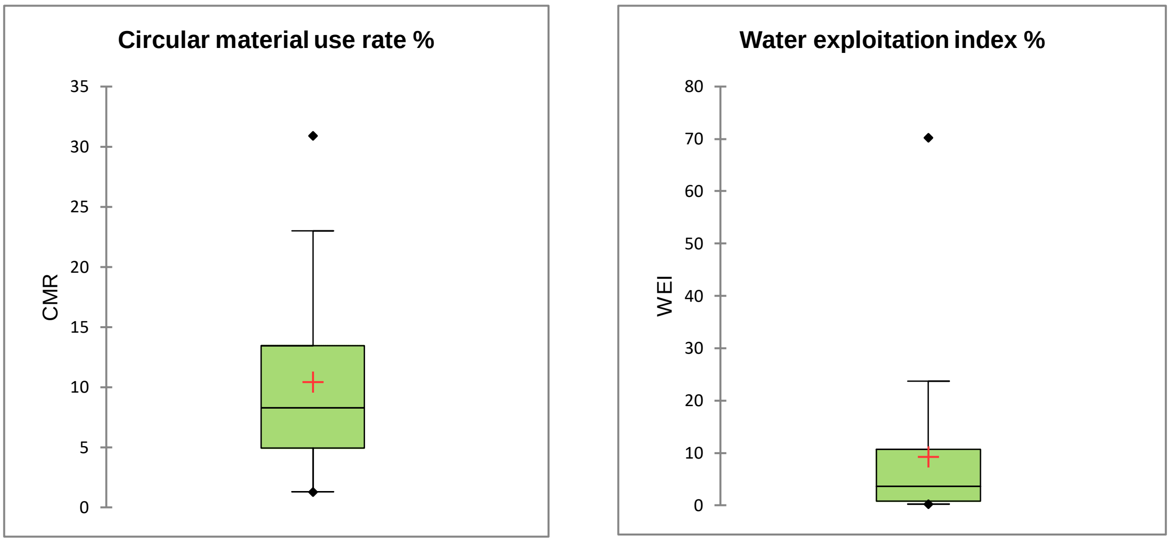


Figure 4: Box plot analysis of sustainability indicators

Figure 4 shows variance among investigated sustainability indicators. Generally, vast differences might be observed within and between the indicators among the EU member states. Mostly, 'fair' distribution shows the share of recycled waste and circular material use rate, close to normal distribution. However, relatively positive skewness prevails in the share of renewable energy and water exploitation index. Both indicators have long right tails marked by apparent outliers, highlighting differences among the member states. In the case of the RES and CMR, there is relatively little progress toward more sustainability, meaning that median values are just close to 10% for CMR and 20% for RES, respectively. When speaking about recycled waste, tremendous success is noted – up to 40% of municipal waste is being recycled in the EU on average. In the case of the WEI, low values are positive, suggesting less water scarcity; however, some EU member states are also being threatened by water scarcity.

Finally, AHC has been used to distribute EU member states to clusters, thereby highlighting their similarities and differences in the scope of all sustainability indicators.

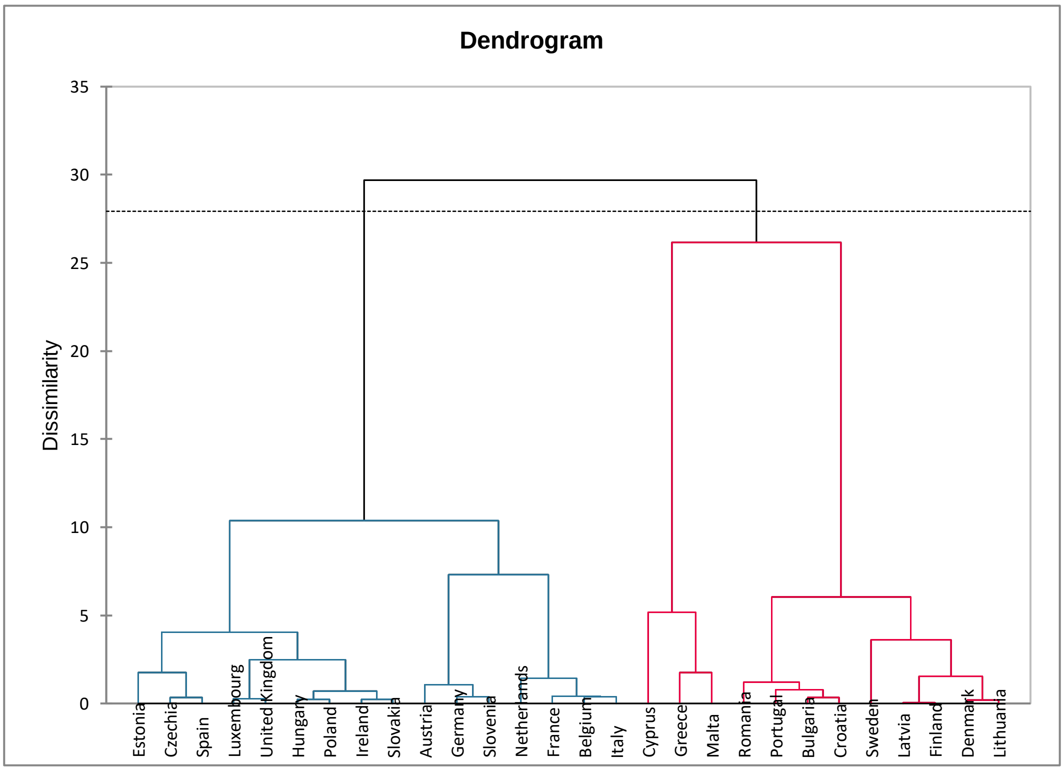


Figure 5: Plot of EU member states aggregated into clusters based on sustainability indicators

Figure 5 displays the results of the cluster analysis. Two distinct clusters may be observed. Cluster C1 (blue) shows a minor variance than cluster C2 (red). Moreover, smaller pockets of EU member states might be found in each cluster. In general, subclusters do not respect the national borders of EU member states (but there are some exceptions), and so-called 'old' and 'new' member states are well mixed up. The overall picture suggests the application of common environmental goals on an individual basis.

DISCUSSION

Overall results have shown a moderately strong association between economic growth and selected indicators. The link showed a strong, negative association between the GHG emission in CO2 eq. and economic growth. It suggests that over time, as society becomes wealthier, more resources aim for GHG emission drop, which became fruitful. Acaravci and Ozturk (2010) found long-run relationship between carbon emissions, energy and real GDP for several EU member states; however, not all of them. For these countries, a positive long-run elasticity between emissions and real GDP was noted and thus supported EKC hypothesis in Denmark and Italy. However, authors conclude that EKC hypothesis is not valid for most countries considered in those studies. Similar conclusions were provided by Apergis and Ozturk (2015) on a research sample of Asian economies. The authors suggest that environmental degradation increased per capita during the early stages of growth and then declined with per capita income after arriving at a treshold. However, Kaika and Zervas (2013), in their metanalysis of the evidence of the EKC hypothesis, pointed to well-up mixed results and noted that the process of economic growth does not reduce emissions over time, thought that CO2 emissions are related to economic growth through the energy consumption. Generally, comparing research results with other empirical sources, it might be concluded that "signs "about the link between economic growth and drop in emission production were confirmed; however, such evidence is not worldwide observated nor consistent. The reason might be due to the differing methodologies, objects of study (regions) and study periods. A large-scale study involving large data panels might bring "new "results, thus enabling "opinion to settle down ".

In the case of the RMC and Waste production, the results are more inconclusive. The association was moderately solid and negative; however, data showed a cyclical pattern of material use and waste production. In their research, Grdic et al. (2020) found a significant association between waste production and economic growth, moreover confirmed a statistically significant "trade-off "effect between the recyclation rate and waste production along the economic growth path. This association in the paper was found inconclusive.

Secondly, the level of adaptation to common environmental goals through policy enforcement among the EU member states was observed. The research on 'sustainability indicators' showed vast differences in the level of adaptation (achieved rate) among the individual EU member state. The highest progress recorded is the waste recyclation rate – when around 40% of all municipal waste in the EU is now recycled.

The weakest figure becomes the circular material use rate, up to 10% on average. Similarly, Haas et al. (2015) put the global material recyclation rate at just 6%, whereas the EU is slightly above the global average. Shpak et al. (2021); Busu and Trica (2019) reason significant differences between the EU member states in their progress toward to circular economy, namely in material and energy recovery and waste recycling. In this scope, the EU represents 'multiway' Europe; while naming some EU countries as leaders, others made steady progress, and some are just in the beginning. This part of the research is mostly in line with empirical results provided by various authors. Moreover, the results imply different approaches toward environmental policy enforcement on the national level among the EU member states.

In the case of renewable energy sources, overall progress is slow; just around 20% of energy consumption in the EU is covered by renewable energy sources, which underlines the importance of this topic. The reasoning of such a state might replenish the complementarity of searched results. (Haas et al., 2011) cite significant differences in RES adoption across the member states, which are determined by the path-dependency, structure of economies and also geographical location. (Striekowsky et al.,2013) Speak about significant hurdles that remain to reach generally binding environmental goals in terms of the RES in the EU. The main issue is the high energy costs imposed on consumers due to the introduction of investment demanding green technologies. Researched results in this topic generally highlight findings of earlier empirical sources, stating the reasons and obstacles toward the higher RES share introduction in the EU.

In terms of the water exploitation index, the overall level of water exploitation is relatively small, just up to 10%, which suggests that EU member states can save and reuse water sources. However, some EU member states showed very high water use rates (exceeding 20%), which suggests some water scarcity and potential weakening of the freshwater stock. Researched results confirm significant variation of WEI among the EU member states, which also reflects freshwater stocks of individual countries. Among some examples, Marcos de Monte (2007); EEA (2009) point to significant differences in the WEI in some EU countries, even on the regional level of the member state. For instance, Malta is characterized as a region with intense competition for water, as its WEI is more than 67%; otherwise, Spain as a whole country has a WEI of 29%, but some of its southern parts have up to 100% Southern Europe is one of the areas where water scarcity is expected to increase in the future. Macedonia and Malta are at the highest risk, whereas the situation in Greece and Slovenija seems to be much better. Other countries with the lowest freshwater availability (Greece, Italy, Portugal and

Spain) have already introduced regulating guidelines to regulate this field.

Finally, sustainability indicators data on the level of individual EU member states were hierarchized into clusters sed on their mutual similarity/dissimilarity. Results showed two distinct clusters, which can be further broken into at least two. Within the (sub)-clusters, the member states are grouped chiefly regardless of the national borders; spatial autocorrelation is perhaps low; however, there are still some exceptions. Results suggest that each member state fulfils common environmental issues individually without broader coordination on a supranational level.

Results might be complemented by Maris and Flouros (2021). As a possible "culprit," they reason the EU member states incoherent approach toward adopting standard energy, climate, and environmental policies. They point out that variation can be explained through various reasons, such as domestic players, lacking capacities and populist governments.

Europeanisation is a multi-faceted and dynamic process, which can be viewed with a top-down and bottom-up perspective that continuously evolves during the long process of adopting new legislation to a local system. However, this process often encounters reactions, delays, partial acceptance, and, ultimately, a controversial and incomplete implementation of measures.

In this relation, Börzel (2002) coins the EU member states by so-called "foot-dragging", "fence-sitting", and "pace-setting" states according to the level of compliance with the EC directions and recommendations concerning energy, climate and environmental strategies

CONCLUSION

The paper's main objective was an investigation of economic-environment relations in a general input-output framework. Such relations were previously well described via the EKC hypothesis and IPAT identity. The research largely follows these constructs; however, the results were replenished by more recent evidence about transiency toward economic sustainability at the EU level. The evidence states that the long-term decrease in pollution (in terms of GHG emissions per capita) is parallel with income growth in the EU. The relation was proved statistically significant, and despite non-implying causation, the such effect should not be ruled out.

Raw material extraction and communal waste production represent input-output relations. The results instead provide inconsistent evidence about raw extraction savings or waste reduction. Moreover, in the case of raw extraction, the evidence suggests that economic development serves instead for the sake of more raw extraction; or raw materials recycling is not strong enough.

Finally, progress toward economic sustainability was evaluated through sustainability indicators. This approach also partially reflects environmental policy enforcement. The results point to vast differences "within "and" between "sustainability indicators as a relative share of the average contribution by each EU member state. Subsequent hierarchical clustering shows the "randomness "of clustering based on policy goal achievement. There is a relatively low spatial correlation in policy coordination on the national level, and policies are enforced individually.

Generally, it might be noted that the drop in GHG emissions so far has been met with some success. In the case of other important environmental topics, the research fails to provide conclusive results or manifest just the opposite. When speaking about environmental policy enforcement, the overall progress so far has been meagre, maybe also due to the lack of cooperation on the sub-national level. Natural resources, particularly renewable ones, do not respect national borders. Thus cross-border initiatives aiming at sustainably harnessing natural potential may become helpful. Also, broader decentralization of competencies in environmental policy enforcement can become handy in unbinding joint project opportunities on the subregional level. Subsequent research may provide more evidence about the abovementioned issues, perhaps outlining some causal relations or investigating the environmental policy enforcement issues at the EU level. In particular, the research about "convergence clubs "in the EU in terms of environmental policy enforcement might be interesting.

ACKNOWLEDGEMENTS

This research was funded by the Slovak Research and Development Agency under the Grant No. APVV-20-0076 "entitled "Waste and Construction - Modelling the Effectiveness of Alternative Options for Cooperation between Administrative Authorities".

REFERENCES

Acaravci, A.; Ozturk, I. 2010. On the relationship between energy consumption, CO_2 emissions and economic growth in Europe. *Energy*, 35, pp.5412-5420.
DOI: 10.1016/j.energy.2010.07.009

Bachtler, J.; Berkowitz, P.; Hardy, S.; Muravska, T .2017.*EU Cohesion Policy.Reassessing performance and direction*. Routledge: NY. Retrieved from: EU Cohesion Policy (Open Access) (uw.edu.pl) (accessed on 18. August, 2022)

Barbier, B., E. 2010. Poverty, Development, and Environment. *Environment and Development Economics*, 15, pp. 635-660.
DOI: 10.1017/S1355770X1000032X

Barret, B., Ch.; Bulte, H., E.; Ferraro, P.; Wunder, S. 2013. *Economic instruments for nature conservation in Macdonald*. Key Topics in Conservation Biology No.2. Oxford, U.K.: John Wiley & Sons.
DOI: 10.1002/9781118520178.ch4

Börzel, T. 2002. Pace Setting, Foot-Draging, and Fence-Sitting: Member State Responses to Europeanization. *Journal of Common Market Studies*, 40, pp.193-214.
DOI: 10.1111/1468-5965.00351

Bumbalová, M.; Marišová, E.; Valenćiková, M., 2022. Ability of Slovak municipalities to implement SDGS concerning waste and environmental issues. p.87. *XXV. International colloquium on regional sciences,* pp 473.

Busu, M.; Trica, L., C.2019. Sustainability of Circular Economy Indicators and Their Impact on Economic Growth of the European Union. *Sustainability*, 11.
DOI: 10.3390/su11195481

Common, M. 1995. Sustainability and Policy: Limits to Economics. Cambridge University Press, Melbourne.

EEA (2016) Environment and climate policy evaluation. Retrieved from: Environment and climate policy evaluation — European Environment Agency (accessed on 10. August, 2022)

EEA (2019) The European environment – state and outlook 2020. Retrieved from: The European environment — state and outlook 2020: knowledge for transition to a sustainable Europe — European Environment Agency (europa.eu). (accessed on 5. August, 2022)

Farhani, S.; Mrizak, S.; Chaibi, A.; Rault, Ch.(2014). The Environmental Kuznets curve and sustainabillity: A panel data analysis. *Energy Policy,*71, pp.189-198.
DOI: 10.1016/j.enpol.2014.04.030

Fratesi, U.; Wishlade, F.,G. 2017. The impact of European Cohesion Policy in different context. *Regional Studies, 51(6):817-821.*
DOI:10.1080/00343404.2017.1326673

Grdic, S., Z.; Nizic, K., M.; Rudan, E. 2020. Circular Economy concept in the Context of Economic Development in EU Countries. *Sustainability,* 12(7).
DOI: 10.3390/su12073060

Haas, R.; Panzer, Ch.; Resch, G.; Ragwitz, M.; Reece, G.;Held, A. 2011. A historical review of promotion strategies for electricity from renewable energy sources in EU countries. *Renewable and Sustainable Energy Reviews*, 15, pp.1003-1034.
DOI: 10.1016/j.rser.2010.11.015

Haas, W.; Krausmann, F.; Wiedenhofer, D.; Heinz, M. 2015. How Circular is Global Economy? An Assessment of Material Flows, Waste Production, and Recycling in the European Union and the World in 2005. *Journal of Industrial Ecology*, 19(5),pp.765-777.
DOI: 10.1111/jiec.12244

Hahn, R. 1999. The Impact of Economics on Environmental Policy. BCSIA Discussion Paper 99-01, ENRP Discussion Paper E-99-01, Kennedy School of Government, Harvard University, Cambridge. Retrieved from: SSRN-id167028.pdf (accessed on 9. August, 2022)

Helm, D. 2005. Economic Instruments and Environmental Policy. *The Economic and Social Review*, 36(3),pp. 205-228. http://hdl.handle.net/2262/60159 (accessed on 17. August, 2022)

Hendl, J. 2012. *Přehled statistických metod. [The Overview of Statistical Methods].* Portál: Praha

Hussen, M., A. 2000. *Principles of Environmental Economics. Economics, ecology and public policy*. Routledge, London & New York.

Chertow, R., M. 2001. The IPAT Equation and Its Variants: Changing Views of Technology and Environmental Impact. Journal of Industrial Ecology, 4(4), pp.13-29.
DOI: 10.1162/10881980052541927

Kaika D.; Zervas, E. 2013. The Environmental Kuznets Curve (EKC) Theory – Part A: Concept, causes and CO_2 emissions case. *Energy Policy,* 62, pp.1392-1402.
DOI: 10.1016/j.enpol.2013.07.131

Lavrnić, S.; Zapater-Pereyera, M.; Mancini, L.,M. 2017.Water Scarcity and Wastewater Reuse Standards in Southern Europe: *Focus on Agriculture. Water, Air & Soil Pollution*, pp.228-251.
DOI: 10.1007/s11270-017-3425-2

Lin, B.; Omuju, E.,O.; Nwakeze, M.,N.; Okonkwo, U.,J.; Megbowon, T.,E. 2016. Is the environmental Kunzents curve hypothesis a sound basis for environmental policy in Africa? *Journal of Cleaner Production*, 133
DOI: 10.1016/j.jclepro.2016.05.173

Maris, G.; Flouros, F. 2021. The Green Deal, National Energy and Climate Plans in Europe: Member States' Compliance and Strategies. *Administrative sciences*, 11(3),pp.75.
DOI: 10.3390/admsci11030075

Marecos de Monte, M.H. (2007). Water reuse in Europe. European Water Association (EWA). Retrieved from: Microsoft Word - 07.09.28 E-WATER WATER REUSE in EUROPE_edited.doc (ewa-online.eu) (accessed on 16. August, 2022)

Millenium Ecosystem Assessment. 2005. Ecosystems and Human Well-being: Synthesis. Island Press, Washington DC Retrieved from:
https://www.millenniumassessment.org/documents/document.356.aspx.pdf (accessed on 14. August, 2022)

Molle, W. 2007.*European Cohesion Policy*. Routledge: London.

Mura, L., Marišová, E. (2021). Effectiveness of public administration performance in the context of the age structure of its employees. *14th International Scientific Conference Relik 2021: Reproduction of Human Capital - mutual links and connections*. Book of abstracts

Nasr, B., A.; Gupta, R.; Sato, R., J. 2015. Is there and Environmental Kuznets Curve for South Africa? A co-summability approach using a century of data. *Energy Economics*, 52, pp. 136-141.
DOI: 10.1016/j.eneco.2015.10.005

OECD. 2017. Policy Instruments for the Environment. Retrieved from: Policy Instrument Database - OECD (accessed on 10. August, 2022)

Perman, R.; Ma, Y.; McGilvray, J.; Common, M. 2003. *Natural Resource and Environmental Economics*. Pearson Education Limited.

Shpak, N.; Melnyk, O.; Horbal, N.; Ruda, M.; Sroka, W. 2021. Assessing the Implementation of the Circular Economy in the EU Countries. *Forum Scientiae Oeconomia*. 9(1), pp. 26-39.
DOI: 10.23762/FSO_VOL9_NO1_2

Stern, N. 2006. The Economics of Climate Change: The Stern Review. Retrieved from:[ARCHIVED CONTENT] Stern Review final report - HM Treasury (nationalarchives.gov.uk) (accessed on 14. August, 2022)

Stern, I., D. 2004. The Rise and Fall of the Environmental Kuznets Curve. *World Development*, 32(8),pp. 1419-1439. DOI: 10.1016/j.worlddev.2004.03.004

Strielkowski, W.; Krška, Š.; Lisin, E. 2013. Energy Economics and Policy of Renewable Energy Sources in the European Union. *International Journal of Energy Economics and Policy*, 3, pp.333-340. Retrieved from:
https://www.econjournals.com/index.php/ijeep/article/view/528 (accessed on 9. August, 2022)

Scheuer, S. 2005. EU Environmental Policy Handbook: A Critical Analysis of EU Environmental Legislation. European Environmental Bureau. Retrieved from: EU Environmental Policy Handbook - Stefan Scheuer (accessed on 12. August, 2022)

Waggoner, E.P; Ausubel, H.J. 2002. A Framework for Sustainability Science:A Renovated IPAT Identity. *Proceedings of the National Academy of Sciences of the United States of America*, 99(12), pp. 7860-7865.
DOI: 10.1073/pnas.122235999

World Bank. 2008. Biodiversity, Climate Change and Adaptation. Nature-Based Solutions from the World Bank Portfolio. Washington, USA. Retrieved from: Biodiversity, Climate Change, and Adaptation : Nature-based Solutions from the World Bank Portfolio (accessed on 12. August, 2022