Azwardi, Azwardi; Imago, Alghifari Mahdi; Wijaya, Wahyu Aji

Article

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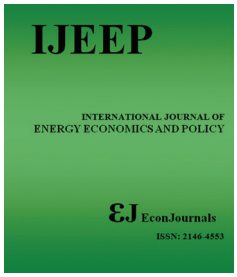

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The Concept of Waste Management on Economic Development in the European Union

Azwardi Azwardi*, Alghifari Mahdi Igamo, Wahyu Aji Wijaya

Department of Economic and Development, Faculty of Economics, Sriwijaya University, Indonesia. *Email: azwardi@fe.unsri.ac.id

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ABSTRACT

This study aims to analyze whether the circular economy variables which include per capita municipal waste production, municipal waste recycling rate, packaging waste recycling rate by type of packaging, bio-waste recycling, and e-waste recycling rates have an effect on economic development. Measured by GDP per capita (Gross Domestic Product) in European Union countries. The methodology in this study uses panel data with estimates using the common effect model, fixed effect model, random effect model and uses the best testing method, namely the Chow, Hausman, and Lagrange multiplier tests in 28 countries in the European Union for the period 2000-2020. The results showed that the final model used was the fixed effect model. Overall the concept of a circular economy which includes the level of recycling of municipal waste, the level of recycling of packaging waste by type of packaging, recycling of bio-waste, recycling of e-waste and added value in the Euro currency has a significant and positive effect on economic development as measured through per capita income, while waste production per capita is inversely proportional to that it has no significant and positive effect on economic development in European Union countries. It can be concluded that the application of the circular economy concept can ensure economic growth while reducing the use of natural resources and ensuring great environmental protection.

Keywords: Waste Management, Circular Economy, Economic Development, Sustainable Development
JEL Classifications: Q01, Q53, O10

1. INTRODUCTION

In the circular economy, the amount of waste is minimized through the careful design of new products and industrial processes in which materials are continuously circulated in closed-loop systems (Fischer and Pascucci, 2013). Waste has become a very important issue in all countries. It has been estimated that approximately 80% of all materials and consumer goods are wasted and more than 30% of processed foods are wasted once they enter the food supply chain (Scheel et al., 2020). The circular economy concept promotes environmental protection and social welfare (Jawahir and Bradley, 2016) and enables economic growth in line with sustainable development. A circular economy can reduce the environmental damage of the entire system and promote new value creation. The European Commission has estimated that the transition to a circular economy will bring additional economic benefits of €600 billion annually to manufacturing in the European Union (Korhonen et al., 2018). Current linear production methods consume energy at all stages of production. It is based on the "extract-produce-use-dump" model and represents an unsustainable model of production. Enable the economic system. Amount of waste. The idea behind the circular economy concept came from recognizing the negative environmental impact of linear production methods. This paper determines the application of the circular economy concept in the context of contemporary economic development at two levels. The first level covers the theoretical considerations of the circular economy that modern economies around the world need to achieve resource and economic sustainability. The second, at the applied level, examines the impact of economic development in European Union Member States in relation to implementing a circular economy and achieving sustainable economic development. Using the Eurostat index, researchers explored the relationship between

gross domestic product income and per capita waste generation in selected member states of the European Union, with It determined the use of secondary raw materials, and the extent to which added value in a circular economy would lead to an increase in gross domestic product.

2. LITERATURE REVIEW

Ghisellini et al., (2016) explains the term circular economy has been studied since the 1970s. Pierce and Turner examine the impact of natural resources on economic systems and their impact on linear, open-ended perspectives. Experimental results show an important contribution. Economic and ecological aspects must coexist and be balanced (Geissdoerfer et al., 2017). The economy as a closed loop to avoid the negative impacts of waste, create new jobs, and achieve resource efficiency and dematerialization of the industrial economy. Initially, the circular economy concept was based on the 3Rs (Reduce, Reuse, Recycle), but more recently it has moved to the 6Rs (Reuse, Recycle, Redesign, Remanufacture, Reduce, Recover) (Jawahir and Bradley, 2016).

In addition to exploiting limited natural resources, the circular economy ensures a wide range of mechanisms for creating new value. A circular economy can be defined in many ways. Here are some of the most cited definitions of the circular economy. "At the heart of the circular economy is a (closed) cycle of resource and energy consumption in multiple phases" (Franklin-Johnson et al., 2016). Another definition is "a spiral cycle economy, H. A system that minimizes material and energy flows and damage to the environment without limiting economic growth or social and technological progress" (Geng et al., 2009). George et al., (2015) states that "The goal of the circular economy is to create the highest value products, components and materials over time." As one of the key principles of the circular economy released allow all materials. Because those near or at the end of their life cycle can be used again as input for manufacturing the next generation of products (Tukker, 2015; Van Weelden et al., 2016).

Consumer engagement plays a key role in implementing a circular economy (Sijtsema et al., 2020). However, the circular economy concept implies systemic change based on innovation and the use of new technological systems, as well as changes in the environment. Nature and methods include politics, society, business models, and financing methods (Domenech and Bahn-Walkowiak, 2019). The last goal is to construct a system that allows materials, product components and output to be recycled in such a way that their highest value is preserved for the longest time. At the same time, resources must be able to be redesigned and desegregated into the economic complex or used as natural food. The advantage connected with the new business model are purely numerical. Mayer et al., (2019) assessing improved resource use efficiency saves him 17-24% of raw materials and his €630 million in costs in Europe. Based on product-based modeling, it is estimated that applying circular economy concepts could increase EU GDP by 3.9% by 2030.

The idea of applying circular economy concepts is prevalent in European Union documents and legislation, but different judgement have been expressed by experimenters (Clift and Druckman, 2015; Haupt et al., 2017; Kovanda, 2014). Most exploration on the usage of circular economy concepts focuses on concrete products or parts of manufacturing processes (Huysman et al., 2017). science of some elements of the manufacturing cycle has increased significantly in recent years (Cullen and Allwood, 2013; Graedel et al., 2015; Reck and Graedel, 2012), making it possible to apply circular economy concepts to specific companies. Improved ability to do so or industry (Lieder and Rashid, 2016; Pauliuk et al., 2012). A comprehensive assessment of circularity along the national or macro level is almighty abnormal (Haas et al., 2015; Hashimoto et al., 2004). Some previous exploration have focused on finding innovations in strategies and business models in the circular economy driven by new ventures. It is intended to complement well-known theories of sustainable innovation. Furthermore, it contributes to the possibility of operationalizing circular business models through pre-defined frameworks (Bigliardi and Filippelli, 2021). A concept known as a circular deck also emerged/This concept helps companies analyze, generate ideas and grow their business into a circular ecosystem full of potential innovations (Konietzko et al., 2020).

The European Union keep up to strive to get a circular economy in order to achieve greater sustainability. The European Commission has adopted a series of measures affiliated to the circular economy. This includes banning the use of single-use plastics, improving legislation on waste prevention and production of critical raw materials (European Commission), and better monitoring of EU 28 circular economy indicators (Meyer, 2012). Uni Europe adopted a circular economy strategy and action plan in 2015, aimed at a more successful implementation of the circular economy in the economy (Geissdoerfer et al., 2017). Strategies and Actions for Implementing the Circular Economy Concept lays out the steps necessary to implement recycling and waste management schemes in the European Union. It also mentions measures to effectively "close the loop" in the economic cycle and the handling of products throughout the product life cycle, from production to consumption to disposal. European regulations aim to reduce the generation and management of high quality waste, save energy and consume less resources by 2030. With this strategy, the EU has adopted a new legal framework in which investments support the transformation of the economy towards a circular economy in order to harden the economy, increase competitiveness and secure coming economic growth. This strategy will ensure that developed countries move further away from economies that discard linear products. In this way waste is reduced while avoiding the use of natural resources in the production process itself. Waste trading is liberalized in the sense that it can be more facilitated through virtual means and used as support for awareness campaigns aimed at building eco-industrial parks (Hartley et al., 2020).

Ribić et al., (2017) Although the problem of the recycling -type economy is increasing, Croatia has no framework or policies yet. The design framework focuses on how to manage waste in Croatian capital and the concept of the circulation economy. (Geng et al., 2009) discuss the need for transition from linear economy to circulation economy. Trica et al., (2019) states that the circulation economy is one of her ways to hit resource effectiveness. Andabaka

(2018) accent the advantages of relate a circulating economic principle to the Croatian economy and the transition to the economic model. Robaina et al., (2020) shows the importance of shifting from linear economy to circulatory economy. In addition, KRLEC analyzes the topic of the circulatory economy and explains the application and advantages of implementing manufacturing and waste management using general methods. Pimenta, (2022) is examining what means to realize the concept of a recycling economy at the EU level, including Croatia. Since this concept is also attracting attention from legislators and policy proppons, it has influenced governments and international organizations at local, region, international, and international levels to promote new economic concepts (Bocken et al., 2017; Geisendorf and Pietrulla, 2018).

3. METHODS

There is no adequate research on the impact of economic development on the implementation of a circular economy. Therefore, to achieve sustainable economic development the author uses this study which includes the following variables GDP per capita, Value-added EUR, Municipal waste generation per capita (kg), Recycling rate of municipal waste (%), Recycling rate of packaging waste by type of packaging (%), Recycling of bio-waste (kg per capita), Recycling rate of e-waste. The panel data regression equation model can be seen in the following equation:

$$GDPit = \beta_0 + \beta_1 (MWGit) + \beta_2 (RRMit) + \beta_3 (RRPit) + \beta_4 (RRBit) + \beta_5 RRE (PHit) + \beta_6 (VAit) + eit$$

Data for each EU member state (28) for the period 2000-2020 is obtained from Eurostat. This research refers to the study conducted by (van Langen et al., 2021; Skrinjarić, 2020; Trica et al., 2019). The purpose of circular economies is how well they live up to expectations and how much impact they have on a number of European countries. In addition, the methodology is designed to enable the evaluation of the sustainability of the circular economy model using indicators and verifying the influence of environmental factors. This study uses panel data regression analysis with 3 output models, namely the Common Effect Model, Fixed Effect Model, and Random Effect Model. In selecting the output of the three models, it is necessary to test the best model using the Chow Test, Hausman Test, and LM Test.

4. RESULTS AND DISCUSSION

4.1. Summary Data of Waste Management and Economic Development

In Table 1, the countries with the highest average GDP are Luxembourg, Ireland, and the Netherlands. Statistical data on the volume of municipal waste per capita, countries that have the highest per capita waste generation are Denmark (773 kg/capita), Luxembourg (694 kg/capita) and Cyprus (660 kg/capita). This data already shows a correlation between GDP and the volume of waste. Positive examples with respect to this indicator include the Czech Republic (340 kg/capita), Romania (318 kg/capita), and Poland (306 kg/capita). A very important indicator is also the recycling rate, which shows that although certain countries produce large amounts of waste, they also have high recycling rates by packaging waste by type of packaging such as, Belgium (78%), Netherlands (67%), and Denmark (65%). it can be seen from what is explained above that the indicator is not the only relevant one. according to Huysman et al., (2017) using indicators to measure the effectiveness of various possibilities for processing plastic waste in a circular economy. This measure takes into account the flow of plastic waste and its technical quality, and monitors consumption resources through Cumulative Exergy Extraction. Saidani et al., (2019) research is linked to the circular economy by highlighting the remaining 37 major challenges, such as effective uptake by industry. Moraga et al., (2019) provides a classification framework for categorizing circular economy indicators based on what (CE strategy) and how (environmental measurement). Howard et al., (2019) provides a framework for developing circular economy indicators related to the core objectives and principles of the circular economy.

Looking at the circular economy and economic growth, we can see the economic drivers underlying the development of the circular economy at the EU level (Busu, 2019). Trica et al., (2019) conduct a study on the economic drivers of sustainable circular economy development, building on insights from the economic literature in this area. D'Adamo et al., (2020) Examine the relationship between recycling, GDP and population. They conclude that GDP and population growth will lead to increased recycling. He built a circular economy model with two kinds of economic resources, pollution input and recycling input. Their results point to several factors that play important roles in economic development. These factors are the level of pollution caused by using the pollutant, the costs incurred by using the pollutant, the recycling rate, and the recycling of inputs relative to the marginal product. An assessment of the sustainability of circular economy models can be performed by monitoring various environment-related indicators and determining the model's impact on economic growth in the European Union (Walker et al., 2018). In line with this, it is important to analyze measurable indicators and improve implementation concepts to strengthen circular economy implementation (Haas et al., 2015; Walker et al., 2018).

4.2. Analysis of Panel Regression

The results of this article show that the common effect, fixed effect, and random effect models can be seen in Table 2:

From the output results above, there are significant differences in results between the three models. In the common effects model, it is found that the environmental variable has a positive and significant relationship below 5% except for added value with a negative relationship to per capita income in European Union countries. In the fixed effect model, all variables have coefficients and a positive directional relationship with per capita income, only the Municipal waste generation per capita variable has no significant effect on per capita income as indicated by a probability value above 5% (0.654). In the third model all variables have a positive directional relationship and have a significant effect on per capita income, except for Municipal waste generation per capita which has no significant effect. The three panel data regression

Table 1: Important indicator of waste management and economic development in EU

Country	GDP per capita	Value add (million EUR)	Municipal waste generation (per capita per year)	Recycling rate of municipal waste (%)	Recycling rate of packaging (%)	Recycling rate of bio waste (kg per capita)	Recycling rate of e-waste (%)
Austria	32147.6	2222.4	581.1	59.5	66.5	198.7	39.5
Belgium	30023.8	1915.2	451.3	53.6	78.4	96.4	32.5
Bulgaria	10981.0	267.6	525.7	22.8	57.2	8.8	68.3
Croatia	15085.7	407.2	386.5	15.6	55.5	7.9	63.0
Cyprus	23619.0	198.4	660.4	9.8	48.2	5.3	17.8
Czechia	21300.0	1109.2	340.9	16.9	67.8	15.0	33.6
Denmark	31990.5	1953.4	773.7	44.4	64.8	128.8	43.4
Estonia	17319.0	164.8	376.6	20.8	54.4	13.5	36.9
Finland	28919.0	1564.6	501.0	36.1	55.3	54.9	37.5
France	27219.0	14697.6	529.0	35.4	58.3	85.0	26.6
Germany	30485.7	28380.0	610.8	62.4	70.8	103.0	36.5
Greece	19981.0	1186.8	470.9	15.1	50.3	10.9	26.2
Hungary	16504.8	804.2	417.4	19.8	49.5	16.0	39.3
Ireland	38909.5	931.2	654.9	31.8	58.6	26.7	40.9
Italy	26247.6	14380.1	520.1	31.1	60.0	61.6	28.3
Latvia	14523.8	180.7	359.6	14.6	51.0	11.2	25.6
Lithuania	16481.0	241.2	421.6	19.7	54.2	34.5	36.9
Luxembourg	66395.2	253.9	694.2	45.3	63.6	129.7	35.9
Malta	22309.5	281.2	628.0	9.6	31.6	16.0	12.4
Netherlands	33852.4	3536.3	562.8	49.7	68.7	144.2	33.6
Poland	15481.0	2494.8	306.6	16.7	45.7	12.7	27.9
Portugal	20014.3	1233.3	475.1	20.7	52.6	49.8	32.9
Romania	12671.4	1685.4	318.6	7.2	46.8	10.4	18.3
Slovakia	17204.8	573.1	317.1	14.0	56.2	18.1	41.2
Slovenia	21357.1	238.2	470.0	31.5	59.5	28.3	27.9
Spain	23785.7	11464.7	533.1	31.1	59.0	81.6	25.6
Sweden	31628.6	3107.2	456.1	45.2	63.9	59.2	56.7
United Kingdom	28009.5	18176.4	531.1	33.2	56.7	60.4	32.5

Source: Data processed, E-views

Table 2: Panel data regression results

Variable	Common		Fixed		Random	
	Coefficient	Prob	Coefficient	Prob	Coefficient	Prob
C	4.9498	0.0000	6.8719	0.0000	7.1831	0.0000
MWG	0.5838	0.0000	0.0286	0.6454	0.1033	0.0796
RRM	0.0858	0.0107	0.1319	0.0000	0.1275	0.0000
RRP	0.2733	0.0000	0.2446	0.0000	0.2415	0.0000
RRB	0.0887	0.0000	0.0299	0.0562	0.0345	0.0248
RRE	0.0160	0.6073	0.1323	0.0000	0.1074	0.0000
VA	−0.0283	0.0007	0.1464	0.0007	0.0524	0.0210
R-Squared	0.6383		0.9146		0.5278	
F-Statistic	130.2835		135.0535		82.5149	
Prob (F-Statistic)	0.0000		0.0000		0.0000	

Source: Data processed, E-views

models also have a relatively high r-squared value, the average r-squared level is above 52%, or it can be said that the variation in the income per capita variable can be explained by the circular economy variable of 52%.

The panel data regression method requires testing the best model test using the Chow test, which is to determine whether the common effect model is better than the fixed effect model and vice versa. Hausman test to see if the random effect model is better than the fixed effect model and vice versa. LM test to see whether the common effect model is better to use than the random effect model. The results of the three tests can be seen in Table 3.

Table 3: Best model test

Model	Chow test	Hausman test	LM test
Prob	0.0000	0.0001	0.0000

Source: Data processed, E-views

Table 3 above can be seen that in the Chow test the probability value is 0.0000 or <0.05, it can be said that the Prob F value is less than 0.05 then Ho is rejected and H1 is accepted, so it can be concluded that from the results of the Chow test the best model is obtained, namely the estimation with Fixed Effects. For the second test, namely the Hausman Test, it can be seen that the Cross Section Random Probability value is 0.0001 or < 0.05, it can be said that Ho is rejected and H1 is accepted so that the best model

Table 4: Final model using fixed effect model

Correlation	Value add	Municipal waste generation per capita (kg)	Recycling rate of municipal waste %	Recycling rate of packaging waste (%)	Recycling of bio-waste (kg per capita)	Recycling rate of E-waste (%)
Coefficient	0.146439	0.028635	0.131883	0.244563	0.029896	0.132328
Prob	<0.05	>0.05	<0.05	<0.05	<0.05	<0.05

Source: Data processed, E-views

based on the Hausman Test is an estimate with Fixed Effect or it can be said that the Fixed Effect model is more appropriate to use than the Hausman Test. with a random effects model. In both tests, we can conclude that the best model used in this study is to use the Fixed Effect Model estimation.

Table 4 describes if 1% increase in GDP per capita means an average increase of about 0.14 EUR in Value added, 0.028 kg of waste per capita, 0.013% in municipal waste recycling rate, about 0.0024% in packaging waste recycling rate, approximately 0.002 kg/capita in bio-waste recycling, and 0.0013% in e-waste recycling rates. Based on the estimation results, it can be concluded that the greater the GDP, the greater the volume of municipal waste per capita. In 2018, Luxembourg had the highest GDP (78,900 EUR per capita), as well as having the highest volume of waste at 803 kg/capita. In 2017, the country with the highest rate of use of secondary raw materials was the Netherland and had lower levels of waste volume among the countries observed in the higher GDP range. The relationship between circular economy and higher GDP is evidenced by the fact that all developed countries like Germany, Austria, Netherlands, Denmark and Sweden have larger numbers in circular economy and higher GDP.

The results display that the developed countries of the European Union generate more waste, but also provide except pointer of circular economy implementation. On the other hand, in order to achieve better results in the world's developing countries, more financial resources need to be invested in activities such as research and development, new technology development and innovation. It is also essential that environmental activists become more involved in activities that promote a circular economy (Sijtsema et al., 2020). Achieving these two goals of hers will improve the implementation of sustainable economic development in EU Member States.

5. CONCLUSION

This research theme will determine the application of the circular economy concept in EU Member States from 2000 to 2020 and how the implementation of the circular economy affected economic growth. The most common linear economic model is based on the belief that resources are limitless and that there is infinite space for waste disposal. Such models are clearly unsustainable and must be changed. The circular economy concept remains a poorly understood concept by all economic stakeholders and the general public. The transition to a circular economy requires not only changes in single activities, but systemic changes in industry, social elements, energy, transport, agriculture, etc. Since each economic sector has its own principles and limits, and each country in the European Union is unique, transitioning to a circular economy requires different approaches and timeframes.

From the results of this study, it can be concluded that there is a link between economic development and circular economy indicators. The application of circular economy concepts cannot just wait for government intervention or subsidies. Businesses and citizens can also take their own initiatives towards the transition, starting with waste sorting, recycling, and energy conservation. By adopting the concept of circular economy, companies can address inefficiencies in their business organization such as resource scarcity, taxation and externalities more. A circular economy model can generate income and create new jobs that most countries, especially Croatia, need. A circular economy model successfully combines economic and environmental benefits and contributes to the further development of entrepreneurship. By using waste as a resource and applying circular economy principles, we can reach new milestones in economic development. We need to continue to stimulate our citizens both economically and educationally, and the transition to a circular economy, including infrastructure issues and technological advances. Addressing this will require greater social engagement, cooperation at local and national levels, adoption of new business models, support of industrial clusters for by-product trading, and new urban management systems, which will require this will take some time.

Recommendations for further research will certainly be put forward to investigate whether the Republic of Croatia is ready to move towards a circular economy and which countries can be used as examples of better practice. From this we can conclude that, in addition to investments in information, education and technology dissemination, it is also necessary to: By applying the concept of circular economy, it develops and strongly promotes entrepreneurship at both medium and large scale.

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