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Influence of Employment and Investment in Circular Economy on the Economic Growth of EU Countries: A Dynamic panel Data Regression Approach (2008-2024)

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It is widely recognised that the circular economy has gained substantial traction across countries due to its strong potential to promote sustainable development. By minimizing waste and pollution, reducing reliance on raw materials, generating employment opportunities, and safeguarding the environment, this model offers a comprehensive approach to economic growth. Unlike the traditional linear economic framework, which follows a "take–make–dispose" pattern, the circular economy emphasizes value retention and regeneration, thereby enhancing long-term growth prospects for nations.

In this study, we consider all countries within the European Union and utilize data at constant prices covering the period from 2008 to 2024. The empirical findings indicate that investment in the circular economy exerts a positive and highly significant impact on gross value added (GVA). Labour also demonstrates a positive influence on GVA, although its level of significance is comparatively moderate. Furthermore, when examining the growth of GVA derived from circular economy activities, investment continues to show a strong positive and statistically significant effect.

Keywords: circular economy, economic growth, employment, investment and dynamic panel

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1. Introduction

Over the past decade, the idea of a circular economy has become more important around the world as people look for better ways to achieve sustainable development. Unlike the traditional linear system, which follows a "take–make–use–dispose" approach, the circular economy focuses on reducing waste and making better use of resources. It encourages practices like reusing, recycling, and regenerating materials so that they can be used for a longer time.

This shift is important because it helps deal with major issues like environmental damage and climate change. By using resources more carefully and reducing waste, the circular economy supports a healthier balance between human activities and nature.

The circular economy is not only good for the environment but also for the economy. It helps save resources, promotes new ideas and innovation, and creates job opportunities. In this way, it supports long-term economic growth while also protecting the environment.

It works through two main cycles. The technical cycle focuses on keeping products and materials in use for as long as possible through repair, reuse, and recycling. The biological cycle, on the other hand, allows natural materials to return safely to the environment and support natural processes.

Many studies have shown that there is a positive link between circular economy practices and sustainable development. Some recent research also suggests that it can directly support economic growth. However, not much attention has been given to how investment and employment together influence this process. Understanding this is important for getting a clearer picture of how the circular economy can support overall economic development.

2. Review of Literature

The existing literature on the circular economy is extensive and can be broadly categorized based on its thematic focus and methodological approach. In this section, we briefly review some of the relevant contributions-

Kolpinski and Kratzer (2024) highlight the role of key macroeconomic indicators, especially full-time employment and investment in the circular economy, in promoting sustainable development across European Union countries. However, they also emphasize the need to revise employee compensation structures to facilitate an effective transition towards a circular economy. **Apostu et al. (2023)** show the relationship between environmental conditions, economic growth, and the circular economy in 31 European countries over the period 2009–2020. They suggested that gross fixed capital formation and total greenhouse gas emissions are associated with reductions in municipal waste, whereas higher levels of final energy consumption, GDP, GHG emissions contribute to increased waste generation. In another study, **Apostu et al. (2022)** investigated the interlinkages between economic growth, oil prices, and the circular economy through the lens of biomass energy consumption in South Asian countries. The results indicated that, in the short run, elasticities are statistically significant for Pakistan, India, and Bangladesh. In the long run, oil prices show a positive association with economic indicators in Pakistan and Sri Lanka, while biomass energy consumption is negatively related to oil prices in India and Bangladesh.

Mehmood et al. (2021) explore the growing importance of the circular economy as a strategy to address environmental, social, and economic challenges, particularly within the agri-food supply chain. Their study identifies key drivers and barriers to circular economy adoption, highlighting environmental benefits, policy support, and financial incentives as major motivating factors.

Similarly, **Mohsin et al. (2021)** showed a relationship between economic growth and energy consumption, and greenhouse gas emissions in developing Asian economies used panel data from 25 countries over the period 2000–2016. Their findings reveal that overall economic growth is positively associated with both energy consumption and greenhouse gas emissions. **Gradic et al. (2020)** emphasized that increasing environmental pressures and the unsustainable nature of traditional linear production systems necessitate a transition towards a circular economy. Their study found that circular economy practices not only support economic development but also contribute to environmental protection in EU countries.

Further, **Laubinger et al. (2020)** point out that the transition towards a resource-efficient the circular economy requires specific skills, knowledge, and competencies. However, they observe that insufficient attention has been given to reskilling the existing workforce and preparing future skill sets necessary for the expansion of the circular economy. Overall, the reviewed studies largely focus on the roles of employment, sustainability, and environmental outcomes within the framework of the circular economy. Building on this literature, the present study aims to examine the influence of labour and investment on gross value added (GVA) in European Union countries, thereby contributing to a more nuanced understanding of the economic dynamics of the circular economy.

3. Objectives of the Study

Based on the above review of literature and the identified research gap, the study has the following objectives:

1. To measure the influence of employment and investment in the circular economy on the gross value added (GVA) of EU countries over the period 2008–2024.
2. To examine the influence of growth in employment and growth in investment in the circular economy on the growth of gross value added (GVA) in EU countries during the period 2008–2024.

4. Data and Methodology

This study is an empirical study based on secondary data collected from Euro stat database. All the monetary data are expressed at 2015 constant euro prices. So far as the methodology is concerned, we have used dynamic panel regression method which is known as Arellano-Bover model. As per the Arellano-Bover we can write dynamic panel regression for level as follows:

$$(GVA)_{it} = \alpha(GVA)_{i\ t-1} + \beta_1(Labour)_{it} + \beta_2(Investment)_{it} + \eta_i + v_{it} \dots (1)$$

where, i = number of countries belonging to EU; t= time ranging from 2008 to 2024.Moreover, GVA= Gross value added expressed at constant price (2015 euro); Labour= employment in circular economy sector expressed in equivalent to full time employment; Investment= Investment made in circular economy.

Similarly, we can write the dynamic panel regression equation for growth of the dependent and independent variables as follows:

$$(GGVA)_{it} = \alpha(GGVA)_{i\ t-1} + \beta_1(GLabour)_{it} + \beta_2(GInvetment)_{it} + \eta_i + v_{it} \dots (2)$$

Where, GGVA= growth of gross value added; GLabour= growth of labour and GInvestment= growth in investment in circular economy.

5. Analysis and Interpretation

(a) Descriptive Analysis

At the very outset of our data analysis we have shown the descriptive nature of data (see appendix table-1). We have found a wide range of variations in the average values among the countries as also in the variability measured in terms of CV. In case of gross value added obtained from circular economy (CE) the countries Germany, France and Italy have occupied first three places respectively and the countries Malta, Cyprus and Latvia have occupied last three places in the formation of GVA. However, the countries like France, Ireland and Netherlands have occupied first three places for achieving lowest variability respectively. Further, in case full time employment in circular economy the countries Germany, Italy and France have occupied first three places respectively whereas Bulgaria, Italy and Czechia have obtained first three places in terms of achieving lowest variations over the period of our study. In case of investment made in circular economy over the period of our study we have found that the countries Germany, France and Netherlands have occupied first three places respectively for heavy investment in CE. On the other hands, countries like Malta, Cyprus and Slovenia have occupied last three places respectively for their lowest investment in CE. Moreover, the countries like France, Belgium and Sweden have achieved lower level of variability. However, our descriptive analysis part reveals the wide range of variability exists among the countries for all selected variables. In case of GVA, the lowest variation is recorded as 9.18% whereas the highest variation is found to be 50.72%. In case of investment the highest variation is recorded as 9.37% where the highest variation is found to be 102.74%. Similarly, in case of employment the lowest variation is 3.19% where the highest variation is 53.59%.

So we can plausibly conclude that the differences in the technological progress, size of economy and availability of skilled workers are responsible for such differences in both average values and in variabilities across the EU countries over the period of our study.

(b) Econometric Analysis

At the initial stage of our econometric analysis we have tried to measure the Influence of labour engage in circular economy (CE henceforth) and investment made in CE on the gross value added obtained from the CE at level over the period from 2008 to 2024 using dynamic panel regression method (Arellano-Bover model). The results presented in Table 1 indicate that the model is statistically significant ($p < 0.01$). The number of instruments is lower than the number of groups, suggesting the absence of instrument proliferation. The Arellano–Bond tests for AR(1) ($p = 0.114$) and AR(2) ($p = 0.347$) are not statistically significant, indicating the absence of second-order serial correlation and supporting the validity of the model. Furthermore, the Hansen test ($p = 0.196$) confirms that the instruments used are valid. The lagged value of GVA is positive and statistically significant, indicating persistence over time. Labour shows a positive but marginally significant effect on GVA. In contrast, investment has a positive and statistically significant impact on GVA. Quantitatively, a one-unit increase in investment leads to an approximate increase of 0.51 units in GVA, holding other factors constant. Although labour exhibits a positive effect, its influence is relatively weaker compared to that of investment.

Table 1: Dynamic Panel Regression Results for Level

Dependent Variable: GVA	Number of obs = 432Number of groups = 27Number of instruments = 20	F(3, 26) = 1373.21Prob > F = 0.000
Independent Variables	Coefficient	p-value
GVA at lag 1	0.7419806	0.000
Labour	8.318	0.074
Investment	0.5093705	0.007
Arellano-Bond test for AR(1) in first differences: z = -1.58; Pr > z = 0.114		
Arellano-Bond test for AR(2) in first differences: z = 0.94; Pr > z = 0.347		
Hansen test of overid. restrictions: chi2(16) =20.55; Prob > chi2 = 0.196		

Source: Authors' computation

When the same methodology is applied using the growth rates of both dependent and independent variables, the results exhibit some notable differences (see Table 2). The overall regression is statistically significant, as indicated by the F-statistic ($p < 0.01$). The number of instruments remains lower than the number of groups, suggesting no issue of instrument proliferation, and the Hansen test ($p = 0.093$) supports the validity of the instruments. The Arellano–Bond test for AR(1) ($p = 0.000$) indicates the presence of first-order serial correlation, which is expected in first-differenced models, while the AR(2) test ($p = 0.233$) confirms the absence of second-order serial correlation, thereby validating the model specification.

The estimated coefficients reveal some interesting dynamics. The lagged growth of GVA has a negative and highly significant effect on current GVA growth, suggesting a possible adjustment or convergence effect over time. The growth in labour shows a positive but statistically insignificant influence on GVA growth. In contrast, the growth in investment has a positive and highly significant impact on GVA growth under the circular economy framework. Specifically, a 1 percent increase in investment growth leads to an approximate 0.18 percent increase in GVA growth, holding other factors constant.

Table 2: Dynamic Panel Regression Result for Growth

Dependent Variable: GGVA	Number of obs = 404Number of groups = 27Number of instruments = 19	F(3,26) = 112.72Prob>F = 0.000
Independent Variables	Coefficient	p-value
GGVA at lag 1	-0.2330817	0.000
GLabour	0.0766237	0.535
GInvestment	0.1818875	0.000
Arellano-Bond test for AR(1) in first differences: z = -4.02 Pr > z = 0.000		
Arellano-Bond test for AR(2) in first differences: z = -1.19 Pr > z = 0.233		
Hansen test of overid. restrictions: chi2(15) = 22.61 Prob > chi2 = 0.093		

Source: Authors' computation

6. Conclusion

From the above analysis the following conclusions have emerged:

Firstly, due to differences in the level of development, technological progress and availability

of skilled labour across countries, there are noticeable differences in value added, investment and employment. However, countries like Germany, France and Italy are making efforts to expand the circular economy so that economic growth can be sustained.

Secondly, investment has a positive and highly significant effect on GVA at the level. On the other hand, labour also has a positive effect but is only moderately significant. This indicates that more skilled and trained workers, along with proper remuneration, are needed to improve GVA in the circular economy. õ

Finally, in terms of growth of GVA, investment in the circular economy shows a positive and significant impact. This suggests that if EU countries want to increase GVA from the circular economy, they should focus more on increasing investment in this sector

Limitations: This study makes a modest attempt to identify the key factors influencing gross value added (GVA) within the circular economy framework. The analysis is limited to labour and investment as the primary explanatory variables. However, since the circular economy contributes to reducing greenhouse gas emissions, lowering import dependency, and promoting sustainable development, the model can be further improved by incorporating additional relevant variables.

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APPENDIX

Appendix Table 1: Descriptive Statistics across the EU Countries

Countries	Var.	Labour	Investment(In 2015 constant euro)	GVA (In 2015 constant euro)
Austria (AT)	Mean	64036.2353	6019165174	8315410948
	CV	4.62832437	11.88784733	14.28550866
Belgium(BE)	Mean	62402.5882	6984855299	8776044725
	CV	4.84111595	22.79781707	15.63996577
Bulgaria (BG)	Mean	100234.294	405992807.7	1025591830
	CV	3.18696843	39.89284872	43.01571059
Croatia(HR)	Mean	62901.6471	312447805	1132689909
	CV	10.3212805	24.99584054	28.58266347
Cyprus(CY)	Mean	10708	112652560.4	352568612
	CV	22.9181991	44.76194706	18.28486975
Czechia(CZ)	Mean	134265.412	1814354453	4525616591
	CV	4.59969381	26.2439555	27.54481811
Denmark(DK)	Mean	42588.5882	2863983190	5474983907
	CV	6.95858814	20.12904706	21.0860449
Estonia(EE)	Mean	26374.0588	221288959	605782280.7
	CV	49.4505541	41.23420419	47.38401553
Finland(FI)	Mean	42461.3529	924287447	3525834189
	CV	8.68776206	25.36735606	15.77528775
France(FR)	Mean	502126	22851285043	44655955850
	CV	10.8416326	9.368188074	9.182690175

Germany(DE)	Mean	681062.647	27765468609	77043058235
	CV	12.2334676	49.15499298	29.559007
Greece(EL)	Mean	80153.3529	611600048.1	1517404230
	CV	10.49216	102.7360347	39.57087344
Hungary(HU)	Mean	109720.647	925875092.4	2578360966
	CV	8.25180718	38.45311426	29.95769582
Ireland(IE)	Mean	34972.1765	787651597.6	15155804251
	CV	12.0831358	40.12734456	11.59788686
Italy(IT)	Mean	519554.882	9027254595	32381036681
	CV	3.8557074	31.11266757	15.52611229
Latvia(LV)	Mean	36051.2353	242746319.7	527938966.7
	CV	7.8954658	36.29094454	29.06757899
Lithuania(LT)	Mean	55208.3529	356557650.4	925127837.5
	CV	10.0775867	51.27421613	50.71830283
Luxembourg(LU)	Mean	10801.6471	782147517.7	885586594.9
	CV	53.5850954	47.83116238	32.32024513
Malta(MT)	Mean	7438.17647	66231376.27	331663088.2
	CV	16.1054782	37.68216596	43.42295716
Netherlands(NL)	Mean	106456.941	9182837116	16602915501
	CV	5.83698044	30.56272162	12.95690397
Poland(PL)	Mean	395023.588	3445736719	9886968420
	CV	6.1420545	32.98382734	23.85287368
Portugal(PT)	Mean	116222.176	1890889264	3282619213
	CV	8.21733387	25.78794034	15.45207598
Romania(RO)	Mean	203162.765	1166996481	2448572896
	CV	5.34060935	33.57931079	37.64632939
Slovakia(SK)	Mean	62663.9412	547211623.3	1371471555
	CV	14.1074362	20.77375288	25.07905545
Slovenia(SL)	Mean	23692.8235	147977154.5	744368688.6
	CV	18.1648451	23.70097502	23.53015429
Spain(ES)	Mean	392403.294	5224844516	21691559841
	CV	12.9321081	41.35653599	19.15381428
Sweden(SE)	Mean	77868.4118	2177892675	7053532469
	CV	5.7764269	17.09781894	14.91144168

Source : Authors' computation