Economic Insights – Trends and Challenges	Vol.V(LXVIII) No. 4/2016	73 - 81

The Correlation between Resource Productivity and Economic Activity in Romania

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Abstract

The growth of world population caused increased consumption of raw materials with direct implications on the environment, which required rethinking the policy of exploitation of natural resources in order to use them more efficiently, with emphasis on increasing resource productivity and, therefore, to achieve sustainable development. Governments favours maintaining high and stable levels of economic growth, by "decoupling" economic growth from increased use of resources. The purpose of this article is to analyse the correlation between productivity and business resources to answer the question: does resource productivity dynamics influence economic activity? The results show that economic growth necessarily involves a continued increase in resource productivity. The study was based on Eurostat data, interpreted using regression analysis and correlation coefficient.

Keywords*: economic growth; resource productivity; price of resources; eco-efficiency; sustainable development*

Jel Classification: *O44; Q01*.

Introduction

Sustainable development, priority objective of the European Union based on socio-economic and environmental objectives, intends to improve the quality of live, reduction of greenhouse gas emission, protecting natural resources, biodiversity conservation and pollution prevention by increasing resource productivity.

Sustainable development requires appropriate strategies to integrate environmental, economic and social issues, as well as improving natural resources management, changing consumption patterns, improving manufacturing processes, methods of waste management. This requires taking into consideration the needs of a growing population, the need for human prosperity and fairness and the need to preserve and transfer of appropriate environmental goods and services for future generations.

"Sustainable development is development that meets the needs of the present without compromising the ability of future generations to meet their own needs", as it was first defined in 1987 in the Brundtland Report.

Resource productivity is central to sustainable development strategy. It is a strategy that allows a "cleaner environment" without jeopardizing macroeconomic priorities in any way.

Continued diversification of social needs in terms of limited resources means finding new ways of managing them effectively.

Many economists, including Paul Hawken and Raimund Bleischwitz say that the fulfilment of economic and social objectives requires increasing resources productivity.

OECD Deputy Secretary General Rintaro Tamaki said that a key objective of the XXI century is "to create more value from fewer natural resources."

Resource Productivity - Sustainable Development Indicator

Resource productivity is an important factor for increasing competitiveness, innovation development, environmental protection and employment.

Resource productivity is an indicator of environmental sustainability and is calculated as a ratio of gross domestic product (GDP) per capita and input of resources (measured in tonnes).

Resource productivity is quantified by getting the most out of finite resources, using renewable energy resources and minimizing waste. This means improved efficiency, lower production costs and reduce dependence on finite resources.

Eco-efficiency means doing "more with less" - the use of environmental resources more efficiently in economic processes.

Eco-efficiency provides a way of thinking about breaking the link between economic activity and environmental impact, and therefore achieves sustainable development. Eco-efficiency is achieved by delivering goods and services that satisfy human needs and lead to increased quality of life while reducing progressively ecological impacts and the use intensity of the resource throughout the life cycle.

Increasing resource productivity means making the resources cycles "more flexible" in the future - except for the recycling, which should become "more consistent" - thereby reducing the net flow of resources.

In order to increase resource productivity it is necessary to reduce the net quantity of natural resources used per unit of consumption of material with the corresponding reduction in the amount of emissions and waste and, thus, reducing the environmental impact per unit of consumption.

The main goal is to use fewer resources per unit of output and reduce emissions and waste during production, product use and end of life.

Increasing resource productivity (or eco-efficiency) means reducing the amount of natural resources used per unit of consumption, using the latest generation technologies.

The whole concept of resource productivity resonate strongly with the modernization of production capacities, high-tech and business-friendly orientation.

Access to technology and local capacity will be essential for eco-innovation, together with external financing for businesses that choose to implement resource efficiency measures.

In addition to increase efficiency, increasing resource productivity reduces material consumption levels.

The impact of consumption on the environment can be quantified using the equation of Paul Ehrlich.

$$I = P \times A \times T \quad (1)$$

where:
I is the impact on the environment resulting from consumption;
P is the population;
A is the consumption per capita T is the technology factor.

Resource efficiency as a concept was introduced into the lexicon of business via the World Business Council for Sustainable Development. Wuppertal Institute in Germany believes that developed countries need to improve resource productivity by ten to factor in the next generation, by encouraging concepts such as industrial ecology, environmental design, and tools such as life cycle assessment, environmental auditing, accounting and risk assessment at full cost, improve resource efficiency.

Increasing resource productivity becomes the central element of technological progress in the future, with incentives for those who are more productive with limited resources.

Resource productivity must become a central element of technological progress in the future, with incentives for those who are more productive with limited resources.

In a knowledge economy, higher productivity of resources will increase employment and wages without reducing profits.

Productivity growth depends on capital, innovation and structural change as well as an increase in the intensity of labour productivity.

Labour productivity has increased twenty-fold in the last 200 years, while resources productivity experienced a low growth rate, following a relatively constant price of resources.

As long as environmental resources are cheap compared to other production factors companies will improve their competitive position by increasing environmental impact. This idea is met in the paper "Boosting resource productivity: Creating ping-pong dynamics between resource productivity and resource prices" written by Ernst U. von Weiszäckerand Robert U. Ayres (Weiszäcker, 2013).

Innovation, in recent decades, has focused mainly on labour productivity growth, without at the same time promoting resources and capital productivity to lead to lower economic growth impact on the environment.

"Green growth" means complying with environmental and natural capital as constraints that must be respected, but also new opportunities for sustainable economic development.

Material resources are becoming increasingly scarce and the world population continues to grow, achieving increasing resource efficiency is more important than ever. It must save the planet's ecosystems and protect natural resources.

Green industry refers to industrial production methods that do not harm ecosystems and improve the quality of human life, as Frank M Gollop and Gregory P. Swinandsays (Frank & Gregory, 2001).

By making industrial activities environmental-friendly and creating new sustainable modes of production, we can protect the environment, create new jobs, which in turn help to reducing poverty and increase living standards.

"Green Economy", "green growth" and "green industry" are the most important concepts of development, aimed at improving human wellbeing and social equity and increased resource productivity, to ensure more sustainable growth and industrial development.

"Green growth" should be understood as a target for national, regional and global policies with implications for structural change and transition to intensive activities that consume fewer resources.

Such a vision should combine the environmental, social and economic dimensions of sustainability, with the effective use of resources.

The Dynamics of the Resource Productivity in the European Union

Article 11 of the Treaty on the Functioning of the European Union states that "environmental protection requirements must be integrated into the definition and implementation of Union policies and activities, in particular through achieving sustainable development".

Moving to a circular economy is the foundation of the Europe 2020 strategy for a sustainable economy based on efficient use of resources. One of the objectives of this strategy aims to reduce greenhouse gas emissions by at least 20% compared to 1990, increasing to 20% the share of renewable energy in final energy consumption and increase energy efficiency by 20%.

Thus, to achieve this objective, sustainable development policies of the member states relied mainly on increasing resource productivity while maintaining high rates of economic growth through intensive use of resources and minimization of waste.

Achieving this goal involved developing schemes to support resource efficient systems, investments in green technologies, financial incentives for those who are more productive with fewer resources.

Also, it aimed at discouraging productive activities harmful to the environment through environmental taxes, reduce subsidies to polluting industries and the elimination of state aid schemes for energy-intensive industries.

The interest to increase resource productivity among the member states was due to increasing commodity prices in recent years.

An analysis of the dynamics of resource productivity in the European Union in the period 2000-2015, reveals its growth with 35.13% in 2015 compared to 2000, from 1.48 euro/kg, 2 euro /kg as illustrated in Figure 1.

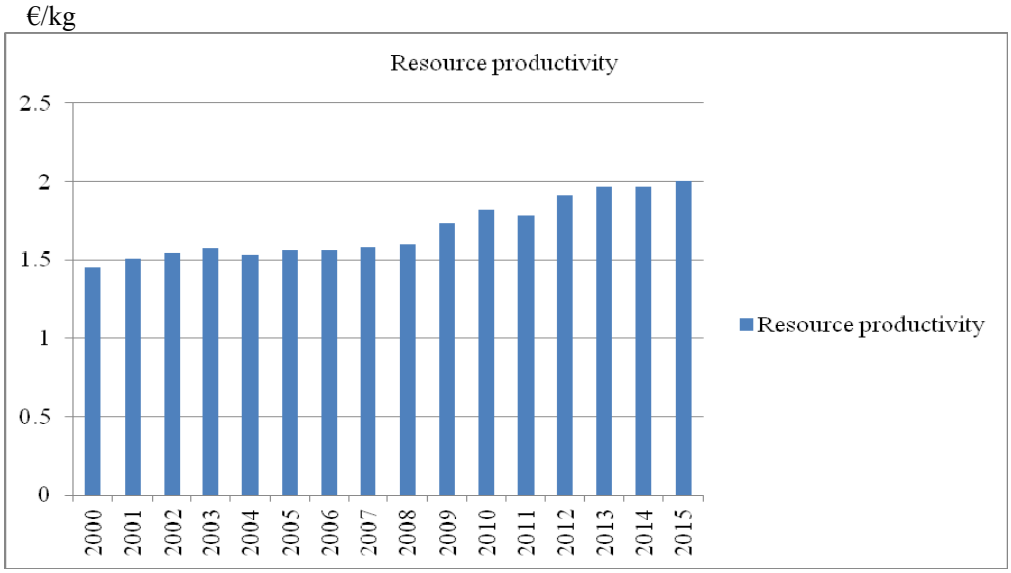

Fig. 1. The dynamic of resource productivity in the European Union in the period 2000-2015

Source: own processing based on data provided by EUROSTAT

This increase in resource productivity was due to shrinking domestic material consumption and stronger economic activity, measured by GDP.

The level of resource productivity varies across member states, depending on the natural resources available to them, the intensity of economic activity (measured by GDP), the level of environmental taxes, the share of the tertiary sector in the economy, the level of technological development models production and consumption and waste management methods.

Regarding the dynamic of resource productivity among member states, data from Eurostat shows that high levels of it was recorded in the Netherlands, the UK and Luxembourg.

On the opposite side, there were Bulgaria, Romania, Estonia, Latvia, Poland, Lithuania and Hungary, with a productivity of resources less than 1 euro per kilogram, as shown in Table no. 1.

Table 1. Resource productivity among Member States over the period 2000-2015

€/kg

EU countries	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
Austria	1.371	1.428	1.352	1.431	1.402	1.391	1.391	1.428	1.531	1.58	1.604	1.572	1.616	1.666	1.6186	1.6503
Belgium	2.0352	2.0074	2.0808	2.1521	2.173	2.1897	1.9788	2.011	2.0169	2.1858	2.228	2.1435	2.3792	2.4407	2.325	2.4497
Bulgaria	0.242	0.2362	0.2453	0.2549	0.2419	0.256	0.2515	0.2622	0.257	0.308	0.3124	0.2867	0.2925	0.3049	0.2821	0.2759
Croatia	1.0509	0.8936	0.8106	0.806	0.7425	0.7983	0.7896	0.8266	0.7352	0.8676	1.0088	1.016	1.0908	1.0258	1.0968	1.1049
Cyprus	0.84	0.87	0.8276	0.967	0.9051	0.9206	0.9726	0.8864	0.6103	0.761	0.828	0.8472	1.1262	1.4647	1.7413	1.8503
Czech Republic	0.6254	0.6374	0.6906	0.6957	0.6877	0.738	0.7647	0.7953	0.8298	0.8651	0.9318	0.9009	1.0047	1.0157	1.0123	1.026
Denmark	1.7905	1.8457	1.9386	1.8853	1.8249	1.7045	1.6657	1.7443	1.8145	2.0907	2.2674	1.9763	2.01	2.1474	2.1755	2.2605
Estonia	0.6121	0.6582	0.581	0.4805	0.465	0.5197	0.5158	0.4579	0.4774	0.435	0.4416	0.4455	0.4689	0.4465	0.4697	0.4953
Finland	0.9055	0.9099	0.9231	0.8993	0.925	0.934	0.9295	0.9594	0.9545	1.0624	1.0128	1.0283	1.0599	1.02	1.0984	1.1174
France	2.0039	2.1245	2.1354	2.2905	2.1397	2.2442	2.2477	2.211	2.2625	2.4544	2.5519	2.5293	2.6075	2.6172	2.6967	2.8167
Germany	1.6214	1.7449	1.7867	1.7952	1.7901	1.8623	1.8815	1.9416	1.9763	1.9587	2.0384	1.9543	2.0185	2.0435	2.0309	2.1159
Greece	1.2386	1.2147	1.2293	1.1826	1.2652	1.2706	1.3722	1.0232	1.074	1.2102	1.2783	1.2916	1.309	1.3666	1.326	1.3473
Hungary	0.6539	0.6009	0.6464	0.6595	0.5738	0.5234	0.6694	0.8479	0.7626	0.8919	0.982	1.007	1.1388	1.0115	0.8288	0.8836
Ireland	0.9505	0.9964	1.0447	0.9589	0.9205	0.9679	0.9567	0.9809	1.0786	1.3295	1.549	1.6855	1.8423	1.6938	1.8319	1.8841
Italy	1.6407	1.7134	1.8376	2.0441	1.9329	1.8908	1.9072	2.0364	2.0732	2.1794	2.3536	2.4413	2.7983	3.1488	3.0517	3.0422
Latvia	0.3536	0.3905	0.3906	0.4199	0.4287	0.4252	0.4446	0.4542	0.518	0.5767	0.4807	0.4609	0.4981	0.4843	0.5073	0.5039
Lithuania	0.628	0.7451	0.6603	0.6226	0.6209	0.6464	0.6894	0.6472	0.6252	0.7899	0.7287	0.7123	0.8061	0.6895	0.7569	0.7983
Luxembourg	2.7108	2.9635	2.8521	2.8182	2.7961	2.9162	2.8126	3.1327	3.5586	3.4543	3.6405	3.7288	3.6739	3.5977	3.5517	3.3865
Malta	1.477	1.5417	1.6541	1.4264	1.4148	1.6837	1.4083	1.779	2.0728	1.9003	2.2946	1.7832	1.601	1.8809	1.4213	1.3641
Netherlands	2.7358	2.7981	3.06	3.178	3.0987	3.1986	3.2548	3.185	3.1095	3.2017	3.2699	3.4008	3.4938	3.7443	3.7089	3.4365
Poland	0.4566	0.4808	0.5141	0.5167	0.5099	0.5197	0.5405	0.5182	0.5277	0.565	0.561	0.4761	0.5548	0.5946	0.6166	0.6413
Portugal	0.8338	0.8087	0.8402	0.9415	0.8803	0.8909	0.8241	0.8132	0.7763	0.8372	0.9165	0.9695	1.0139	1.1492	1.1373	1.1005
Romania	0.4811	0.32	0.3514	0.3401	0.3444	0.3278	0.3288	0.2953	0.2494	0.295	0.317	0.2848	0.2942	0.3028	0.3272	0.3087
Slovak Republic	0.7719	0.7472	0.7483	0.8086	0.7118	0.7122	0.7798	0.8918	0.8176	0.8767	0.9376	0.9325	1.0923	1.1597	1.0748	1.0382
Slovenia	0.8159	0.8545	0.8552	0.813	0.839	0.8986	0.8152	0.7875	0.9242	1.0313	1.1045	1.2342	1.3858	1.3982	1.3409	1.3538
Spain	1.258	1.2707	1.1998	1.1726	1.1751	1.181	1.1742	1.1897	1.3738	1.6254	1.8297	2.0542	2.4915	2.6049	2.7568	2.7717
Sweden	1.6738	1.7314	1.7402	1.773	1.7889	1.6969	1.9149	1.7931	1.7925	1.9615	1.8487	1.7992	1.7844	1.7587	1.7499	1.7442
United Kingdom	2.1205	2.1643	2.2816	2.3576	2.3242	2.4563	2.5478	2.6317	2.7848	3.0333	3.1766	3.1958	3.3466	3.3704	3.3687	3.4627

Source: EUROSTAT - Sustainable consumption and production

These countries have relied on extensive growth, with a high level of domestic material consumption, as we see in Table no 2.

Table 2. Domestic material consumption in the Member States during the period 2000-2015

tonnes per capita

EU countries	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
Austria	23.098	22.38	23.90	22.65	23.61	24.12	24.81	24.97	23.57	21.92	21.96	22.95	22.39	21.62	22.24	21.77
Belgium	14.92	15.20	14.86	14.42	14.739	14.85	16.73	16.90	16.843	15.06	15.04	15.69	14.06	13.63	14.47	13.872
Bulgaria	12.35	13.46	14.04	14.31	16.191	16.53	18.099	18.834	20.44	16.44	16.32	18.18	17.97	17.56	19.38	20.541
Croatia	7.515	9.498	11.007	11.68	13.19	12.77	13.52	13.58	15.59	12.254	10.384	10.31	9.426	9.951	9.314	9.46
Cyprus	24.31	24.05	25.80	22.43	24.739	24.90	24.23	27.313	40.10	30.67	27.83	26.627	19.244	13.951	11.56	11.12
Czech Republic	17.8	18.1	17.0	17.5	18.57	18.4	18.93	19.09	18.64	16.91	16.02	16.86	14.98	14.74	15.18	15.62
Denmark	23.57	22.97	21.90	22.55	23.85	26.088	27.62	26.47	25.12	20.58	19.2	22.19	21.72	20.19	20.08	19.38
Estonia	12.4	12.3	14.9	19.5	21.6	21.2	23.7	29.01	26.39	24.74	25.0	26.7	26.8	28.74	28.193	27.02
Finland	33.7	34.33	34.3	35.8	36.1	36.66	38.1	38.7	39.0	32.0	34.44	34.6	32.9	33.82	31.0	30.5
France	14.55	13.89	13.87	12.95	14.147	13.603	13.80	14.28	13.90	12.38	12.08	12.384	11.978	11.94	11.596	11.17
Germany	17.695	16.693	16.275	16.07	16.312	15.79	16.236	16.26	16.18	15.45	15.478	16.73	16.54	16.343	16.638	16.10
Greece	14.189	14.98	15.33	16.82	16.479	16.459	16.05	22.17	21.00	17.79	15.9	14.32	13.169	12.29	12.84	12.68
Hungary	12.044	13.64	13.28	13.564	16.396	18.794	15.27	12.13	13.62	10.90	10	9.951	8.696	10.00	12.69	12.28
Ireland	34.177	33.95	33.73	37.55	40.102	39.682	41.54	41.544	36.217	27.446	23.51	22.09	20.20	22.23	21.53	22.447
Italy	16.65	16.21	15.13	13.567	14.48	14.87	14.99	14.17	13.68	12.251	11.501	11.13	9.413	8.124	8.278	8.375
Latvia	14.643	14.299	15.49	15.77	16.92	19.09	20.627	22.382	19.122	14.955	17.625	19.883	19.373	20.75	20.46	21.344
Lithuania	8.336	7.547	9.164	10.831	11.703	12.309	12.59	15.082	16.19	11.037	12.41	13.77	12.813	15.669	14.83	14.428
Luxembourg	25.575	23.61	25.16	25.50	26.46	25.79	27.66	26.51	22.73	21.75	21.41	20.97	20.60	21.456	22.092	23.72
Malta	9.572	8.952	8.529	10.075	10.135	8.782	10.653	8.736	7.701	8.131	6.939	9.056	10.296	9.054	12.28	13.485
Netherlands	12.73	12.61	11.47	11.02	11.50	11.35	11.53	12.19	12.65	11.767	11.62	11.309	10.852	10.077	10.28	11.26
Poland	14.094	13.55	12.942	13.34	14.22	14.45	14.762	16.491	16.879	16.19	16.95	20.96	18.26	17.27	17.21	17.168
Portugal	19.48	20.332	19.612	17.275	18.76	18.64	20.43	21.18	22.20	19.958	18.56	17.257	15.902	13.94	14.29	15.05
Romania	7.684	12.372	12.06	13.25	14.26	15.70	17.02	20.557	26.84	21.26	19.74	22.32	21.84	22.05	21.09	23.30
Slovak Republic	10.072	10.77	11.24	10.97	13.129	13.958	13.83	13.39	15.429	13.58	13.33	13.76	11.91	11.36	12.56	13.46
Slovenia	17.185	16.866	17.478	18.89	19.09	18.51	21.48	23.658	20.79	17.024	16.02	14.402	12.45	12.19	13.08	13.32
Spain	17.13	17.43	18.68	19.37	19.6	19.88	20.491	20.601	17.75	14.34	12.68	11.14	8.942	8.438	8.105	8.327
Sweden	20.17	19.76	20.00	20.02	20.62	22.26	20.54	22.515	22.223	19.09	21.287	22.287	22.24	22.65	23.05	23.84
United Kingdom	12.542	12.57	12.162	12.12	12.535	12.13	11.89	11.722	10.922	9.521	9.193	9.204	8.843	8.888	9.105	8.988

Source: EUROSTAT, Sustainable consumption and production

Resource Productivity Developments in Romania during 2000-2015

An analysis of the dynamics of resource productivity in Romania during 2000-2015 reveals its decrease by 35.83% in 2015 compared to 2000, from 0.4811 euro / kg at 0.3087 euro / kg.

In 2015, in terms of the size of resource productivity, Romania is the second lowest among member countries as illustrated in Figure 2.

This was due to domestic material consumption growth in the period under review from 7,684 tonnes per capita in 2000 to 23,30tonnes per capita in 2015, a percentage increase of 203.22%.

According to Eurostat data, in terms of domestic consumption of the raw materials in 2015, Romania ranks 5th among European Union countries, being surpassed only by Finland with 30.50 tonnes per capita, Estonia with 27.02 tonnes per capita, Sweden at 27.02 tonnes per capita and Luxembourg with 23.72 tonnes per capita.

In the same period GDP per capita has increased, but its growth was surpassed by the domestic consumption of material, which illustrates the extensive nature of economic activities carried out in Romania, based on unskilled labour and equipment outdated in terms of technology involving high consumption of raw materials.

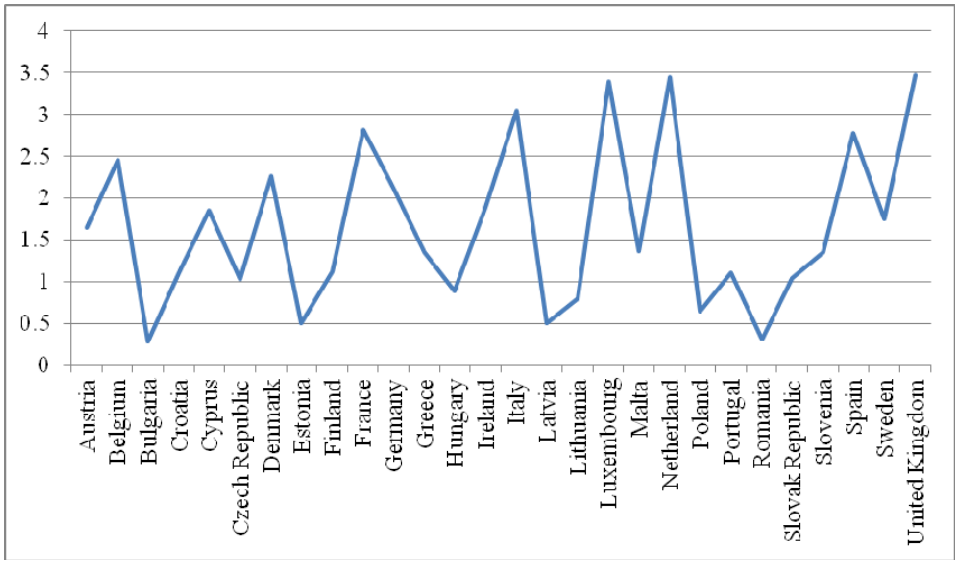

Fig. 2. Resource productivity in member countries in 2015

Source: Own processing based on data provided by EUROSTAT

The Correlation between the Intensity of Economic Activity and Resource Productivity in Romania

The method applied to analyse the association between economic activity and resource productivity in Romania is the correlation that measures the direction and degree of association between two variables, without implying a causal relationship. The data used in the analysis are provided by Eurostat, for the period 2003-2015.

The two variables considered are:

- Resource productivity calculated as a ratio of gross domestic product (GDP) per capita and domestic material consumption (tonnes);
- GDP per capita as a measure of the intensity of economic activity.

Table 3. The coefficient of correlation between resource productivity and GDP

	Resource productivity	GDP
Resource productivity	1	
GDP	-0,5171	1

Source: author's own computation.

Its value is -0.5171 which shows a moderate correlation between resource productivity and gross domestic product.

Moderate correlation between resource productivity and gross domestic product is illustrated by the point cloud distribution in Figure no. 3.

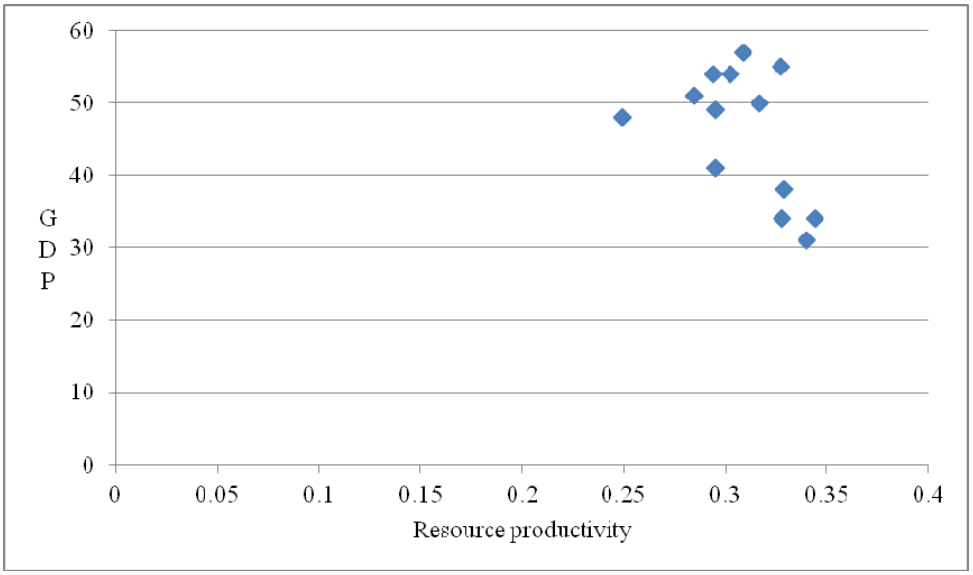

Fig. 3. Bivariate distribution graph

Source: author's own processing.

To determine whether the correlation between the two variables is statistically significant we will use regression.

Table 4. Model on the impact of economic activity on resource productivity

Explanatory variable	Coefficient	P-value
GDP	-0,00149	0,070354
R Square 0,51		

Source: author's own computation.

The value of R Square shows that only 51.11% of the variation in resource productivity is due to variation of intensity of economic activity, which caused extensive economic development with emphasis based on increasing domestic consumption of material.

For $\alpha = 0.05$ materiality we cannot reject the null hypothesis because 0.070354 is greater than 0.05.

Conclusions

Sustainable production and consumption is the foundation of sustainable development, with impact on the welfare and quality of life.

Moving to a circular economy is imperative for Romania, given that our country is using more and more natural resources, therewith producing a lower economic value, which ranks us second to last in the European Union in terms of resource productivity.

An effective policy in the use of resources should be aimed at reducing consumption in the context of the volatility of commodity prices in recent years.

This can be achieved by reducing subsidies to counterproductive production structures and support resource efficiency systems through financial incentives.

Other issues to be considered concerns the delimitation of economic growth from resource use by shifting from manufacturing to services, increase labour productivity and capital given that

they offer stimulations for investment and reduce consumption of natural resources, improving manufacturing processes using the latest generation technologies by promoting technological innovation in resource efficiency, improving waste management and increasing environmental taxes, in order to ensure sustainable development.

In conclusion, efficient use of material resources will lead to a high standard of living, reduce the consumption of natural resources in ecological limits and consequently to an inclusive and competitive economy.

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