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Resource productivity in an economy of regions: analysis of foreign experience

Продуктивність ресурсів економіки регіонів: аналіз зарубіжного досвіду

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Abstract

The objective of writing the article is to research existing foreign experience in the field of resource productivity, methods of its assessment in developed countries, in particular in the European Union and Organization for Economic Cooperation and Development members, and the possibility of implementing such experience in Ukraine. The article highlights the main methodical approaches to measuring resource productivity in the countries of the European Union and the OECD. The dynamics of resource productivity in comparison with GDP and DMC in the EU in 2000-2021 were studied. The productivity of resources in the EU in 2021 was analysed in terms of member states, and countries were grouped according to the level of the specified indicator. According to the methodology used in the EU and OECD, the calculation and analysis of resource productivity in Ukraine and the L'viv region in 2017-2020 was carried out.

Keywords: consumption of material resources, productivity, resources, sustainable development.

Анотація

Метою написання статті є дослідження існуючого зарубіжного досвіду в сфері продуктивності ресурсів, методів її оцінки у розвинених країнах, зокрема у Європейському Союзі та країнах, що входять до Організації економічного співробітництва та розвитку та можливості імплементації такого досвіду в Україні. У статті висвітлено основні методичні підходи до вимірювання продуктивності ресурсів у країнах Європейського Союзу та ОЕСР. Досліджено динаміку продуктивності ресурсів у порівнянні з ВВП та ВСМР в ЄС у 2000-2021 рр. Проаналізовано продуктивність ресурсів в ЄС у 2021 році розрізі країн-членів, Здійснено згрупування країн за рівнем зазначеного показника. За методикою ЄС та ОЕСР проведено розрахунок та аналіз продуктивності ресурсів в Україні та Львівській області у 2017-2020 рр.

Ключові слова: продуктивність, ресурси, споживання матеріальних ресурсів, сталий розвиток.

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Introduction

The concept of sustainable development is considered to be one of the dominant ideas of the XXI century. Its appearance was a consequence of the world community's awareness of the need to ensure the coherence of current and future generations' interests in a way that the economic growth should take place taking into account the fundamental limitations of existing resources and the importance of harmonizing the links between ecological, economic and social systems.

Since the signing of the association agreement with the European Union in 2014 and receiving the status of a candidate for EU membership in 2022, Ukraine has started to join the implementation of sustainable development concept priorities and the observation system of their realization. In this context, the problem of evaluating and monitoring resource productivity, which is implemented in the practice of the EU, becomes extremely relevant. We should also note that the issue of productivity is constantly in the field of European science view and practice. To improve the existing methods of assessing resource productivity and deepening knowledge in the field of resource use and its impact on the environment, OECD countries have prepared a number of recommendations for increasing resource productivity. In addition, the organization emphasized its positive attitude to the experience exchange in matters of resource productivity with countries that are not OECD members. At the same time, the mentioned recommendations concerned only those natural resources whose production, processing, and usage have international importance from an ecological and economic point of view, in particular non-metallic minerals, ores, and biomass (OECD, 2008a). Besides, the G7 countries defined an action plan for the implementation of the so-called 3R initiative - reduce, reuse, recycle - which provided for the reduction of resource consumption, their reuse and recycling. The 3R policy is one of the steps aimed at achieving the so-called decoupling, i.e. breaking the linear relationship between economic growth and the number of resources used (G7 Information Centre, 2008). This is extremely important because ensuring sustainable development involves maximizing resource productivity while minimizing resource intensity. Thus, the productivity of using resource potential is one of the key indicators of sustainable development (Zablodska et al., 2020; Shults et al., 2021, Prytula et al 2021).

The full-scale armed aggression of the Russian Federation has caused significant destruction of production facilities as well as infrastructural and logistics facilities and provoked a number of restrictions on Ukraine and the economic development of its regions. These will exacerbate the resource productivity issue. Under the current circumstances, European experience will be useful for Ukraine from the point of view of identifying and improving existing approaches to resource productivity assessment. Adaptation of the methodological approaches of the EU member states in Ukraine and conducting domestic scientific research on the modernization of the methods for assessing resource productivity use is an important and timely task for Ukrainian science.

Methods review

The evaluation of resource productivity in the EU is carried out by the European Commission, which conducts annual monitoring of this indicator based on Eurostat data using methods unified for all EU member states. A similar approach to calculating resource productivity is also used by the Organization for Economic Cooperation and Development. The only difference between these methods is the constituent components that are included in the biomass. While in the EU this category includes materials of organic origin used for the production of biofuel, in the OECD, biomass includes agricultural crops used in the food industry and agriculture, including feed (Eurostat Statisctics Explained, 2023a; OECD, 2015).

According to the specified method, a resource productivity indicator is calculated according to formula 1:

$$RP = \frac{GDP}{DMC + import - export} \qquad (1)$$

where GDP is gross domestic product, DMC is domestic material consumption, while imports and exports are calculated in physical measures (OECD 2008a, Eurostat Statisctics Explained 2023b).

With the aim of comparing EU member states by the level of resource productivity and eliminating the difference between national currencies, calculations are presented in the purchasing power standard (PPS) per kilogram. DMC calculation is carried out for such main categories of resources as ores, fossil energy materials,

biomass, and non-metallic minerals (Eurostat Statisctics Explained, 2023a).

It is worth noting that when assessing resource productivity by EU and OECD countries, water resources are not taken into account and land resources are evaluated indirectly, due to the number of mineral fertilizers used in agriculture (OECD, 2008c, 2015).

Nowadays, Ukraine does not assess resource productivity according to the EU or OECD methods.

The assessment of resource productivity is carried out only at the level of individual enterprises through the prism of accounting. Therefore, natural resources are included into long-term assets for which the depletion rate and depletion costs are calculated according to formulas 2 and 3:

$$N_d = \frac{C_t}{V_t}, \quad (2)$$

where N_d is the rate of depletion; C_t - purchase cost of the resource or field (total cost); V_t – explored reserves or the total volume of the resource;

$$C_e = N_d \times V_e, \quad (3)$$

where C_e is the cost of expenditure; V_e is the volume of extracted resources (Voronko, 2018).

Using formulas 2 and 3, some Ukrainian researchers propose to determine the productivity of resources according to formula 4:

$$RP = \frac{GDP}{C_e}, \quad (4)$$

where GDP is gross domestic product C_e is the cost of expenditure (Bobukh, 2014).

The methods of assessing resource productivity used in Ukraine have several significant drawbacks, particularly, the purchase price does not always correspond to the real value of the resource or deposit; since its own rate of depletion is determined for each individual deposit, it does not allow the calculation of the investigated indicator in a regional or national dimension.

Therefore, we propose to calculate the productivity of resources in the regions of Ukraine as follows:

$$RP_r = \frac{GRP}{RMC + import - export}, \quad (5)$$

where GRP is gross regional product; RMC - regional material consumption.

Results and Discussion

The analysis of the results of resource productivity assessment in the EU according to the current methods proved that resource productivity dynamics in the EU are not stable and shows that:

- The dominance of the share of non-metallic minerals in the structure of DMC. Thus, in 2021, the specific weight of non-metallic minerals was 53%, while the shares of biomass, fossil energy materials, and ores were 23%, 18%, and 6%, respectively (Eurostat Statisctics Explained, 2023a).
- The growth of resource productivity against the background of the upward trend of GDP dynamics and the unstable dynamics of DMC. During the years 2000-2021, we observe two peaks of downward trends in productivity, which are associated with the consequences of the economic crises of 2008 and the COVID-19 pandemic (Figure 1)

We would like to add that from 2000 to 2008 we recorded a parallel growth of GDP and DMC, which was correspondingly reflected in the stability of the resource productivity indicator during this period. The financial crisis of 2008 provoked changes in the dynamics of all the above-mentioned indicators. There was a sharp reduction in consumption in comparison with a relatively small decrease in the GDP indicator. This had a positive effect on the dynamics of the resource productivity indicator, and by 2010, it had increased by 15%. According to the G7 and OECD reports, the financial crisis of 2008 led to a decline in the mining industry in almost all EU member states (OECD, 2008b).

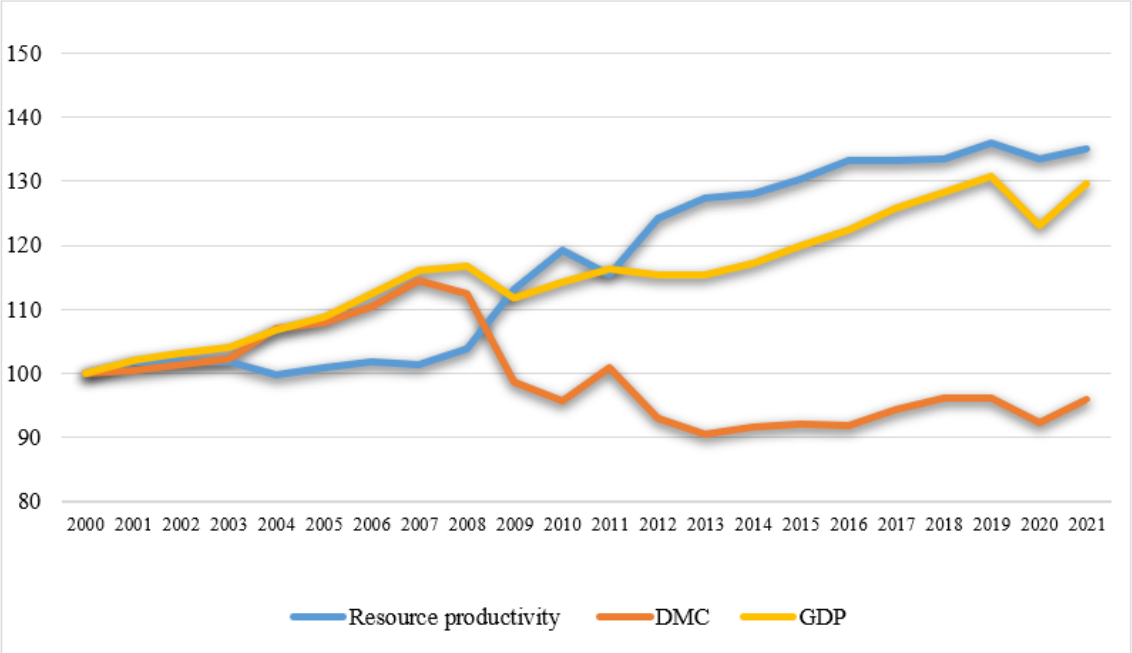

Figure 1. Resource productivity compared to GDP and DMC in the EU in 2000-2021 (Index 2000 = 100%) Source: (Eurostat Statisctics Explained, 2023c)

In addition, there was a drop in the purchasing power of resident citizens, and, accordingly, a drop in the demand for resources themselves. From 2008 to 2016, there was an increase in the GDP of the EU member states and a downward trend in the DMC indicator (except for 2011), which provoked a short-term decrease in the level of resource productivity. During 2016-2019, all three indicators grew up. It is worth noting that the impact of the crisis caused by the COVID-19 pandemic was different from the 2008 crisis: the decrease in resource productivity in the EU was insignificant compared to the previous crisis period. Thus, during the period 2000-2021, the level of resource productivity in the EU increased by 35% (Eurostat Statisctics Explained, 2023c).

Analyzing the indicator of resource productivity in the EU, we note a significant differentiation level of this indicator in EU member states (Table 1). As we can see, the highest resource productivity in 2021 was in the Netherlands (≈ 2.5 times higher than the average), Luxembourg, and Italy (≈ 1.5 times higher than the average). The indicator of Slovenia was the closest to the average value of resource productivity in the EU (2.3 PPS/kg), and in Denmark, Sweden and Hungary it was approximately three-quarters of the average indicator for the EU. The lowest resource productivity in 2021 was in Bulgaria and Romania (≈ 3 times less than the average).

Table 1.
Resource productivity in EU member states in 2021

		GDP_{PPS} per capita	DMC per capita	Resource productivity	
		(PPS per capita)	(tonnes per capita)	(PPS per kilogram)	(Index EU = 100%)
EU	European Union	32 334	14,1	2,3	100,0
NL	Netherlands	42 344	7,4	5,7	249,8
LU	Luxembourg	89 661	25,1	3,6	157,5
IT	Italy	30 636	8,9	3,4	150,2
IE	Ireland	71 186	22,4	3,2	139,0
FR	France	33 734	10,9	3,1	136,3
ES	Spain	27 214	9,1	3,0	130,0
BE	Belgium	39 251	14,0	2,8	123,1
MT	Malta	31 955	11,8	2,7	119,0
DE	Germany	38 630	14,2	2,7	118,5
SI	Slovenia	29 103	12,7	2,3	99,7
EL	Greece	20 878	9,8	2,1	92,8
AT	Austria	38 936	19,1	2,0	89,2
HR	Croatia	22 576	11,3	1,9	84,3
CZ	Czech	29 498	15,5	1,9	83,1
SK	Slovakia	22 016	11,9	1,9	81,0
DK	Denmark	43 300	25,2	1,7	75,0
SE	Sweden	40 145	25,1	1,6	70,2
HU	Hungary	24 529	15,3	1,6	70,0
LV	Latvia	23 007	14,5	1,6	69,0
CY	Cyprus	28 392	19,0	1,5	65,6
PT	Portugal	23 970	16,9	1,4	61,8
PL	Poland	24 961	18,0	1,4	61,0
LT	Lithuania	28 399	21,2	1,3	58,7
FI	Finland	36 495	35,0	1,0	45,6
EE	Estonia	28 155	29,4	1,0	41,8
RO	Romania	23 529	29,0	0,8	35,5
BG	Bulgaria	17 849	22,4	0,8	34,7
CH	Switzerland	47 933	10,5	4,6	199,4
IS	Iceland	35 671	15,0	2,4	103,7
NO	Norway	41 858	23,7	1,8	77,1
TR	Turkey	18 466	10,6	1,7	75,8
MK	North Macedonia	11 172	9,0	1,2	54,2
AL	Albania	9 524	7,9	1,2	52,9
BA	Bosnia and Herzegovina	10 104	11,2	0,9	39,2
	Serbia	12 758	19,0	0,7	29,3

Source: compiled and calculated by the authors based on Eurostat data

Taking into account the significant differentiation of EU member states in terms of resource productivity, we consider it appropriate to single out 4 groups of countries (Table 2).

Table 2.
Grouping of EU member states according to the main trends in the distribution of resource productivity indicators in 2021

Group	States	Average GDP_{PPS} (PPS per capita)	Average DMC (tonnes per capita)	Average resource productivity
I	Netherlands, Luxembourg, Italy, Ireland, France, Spain, Belgium, Malta, Germany	44 957	13,8	3,4
II	Slovenia, Greece, Austria, Croatia, Czech, Slovakia	27 168	13,4	2
III	Denmark, Sweden, Hungary, Latvia, Cyprus, Portugal, Poland, Lithuania	29 588	19,4	1,5
IV	Finland, Estonia, Romania, Bulgaria	26 507	29	0,9

Source: compiled and calculated by the authors based on Eurostat data

- I - Countries where the resource productivity indicator is higher than the European average (> 100%); In particular, this group includes all EU member states that are part of the G7 and Benelux countries;
- II – Countries where the resource productivity indicator is close to the European average (80 - 100%);
- III – Countries where the resource productivity indicator is lower than the European average (60 - 80%);
- IV – Countries with a low level of resource productivity in relation to the European level (< 60%).

The analysis of selected groups of countries allows us to conclude the intensive type of economic growth in the countries of group I and extensive in the countries of group IV. The distribution of the formed groups of countries by the level of resource productivity is presented in Figure 2.

Our calculations of the Pearson correlation coefficient, which ranges from 0.92 to 0.97, proved the existence of a close relationship between the indicators of GDP and DMC in each of the groups.

The resource productivity indicator of Ukraine calculated according to the European methods in 2021 was 0.47€/kg, which indicates that Ukraine belongs to the group of countries with an extensive type of development. It should be noted that in the structure of DMC, we took into account agglomerated iron ores and concentrates, fossil energy materials (hard coal, crude oil, natural gas, peat), non-metallic minerals (construction sands; limestone and limestone flux; other crushed stone, which used as a filler in concrete and also for road surfacing and similar purposes; clays; gypsum and anhydrite; siliceous and quartz sands; chalk; crumb, granules and powder of travertine, granite, porphyry, basalt, sandstone, and other stone; kaolin; salt stone) and biomass (cereal and leguminous crops, sugar beet, sunflower, soybean, rape and rapeseed, potatoes, vegetable crops, fodder root crops, fodder corn, annual grasses for hay, perennial grasses for hay, fruit and berry crops, grapes, flax, meat, milk).

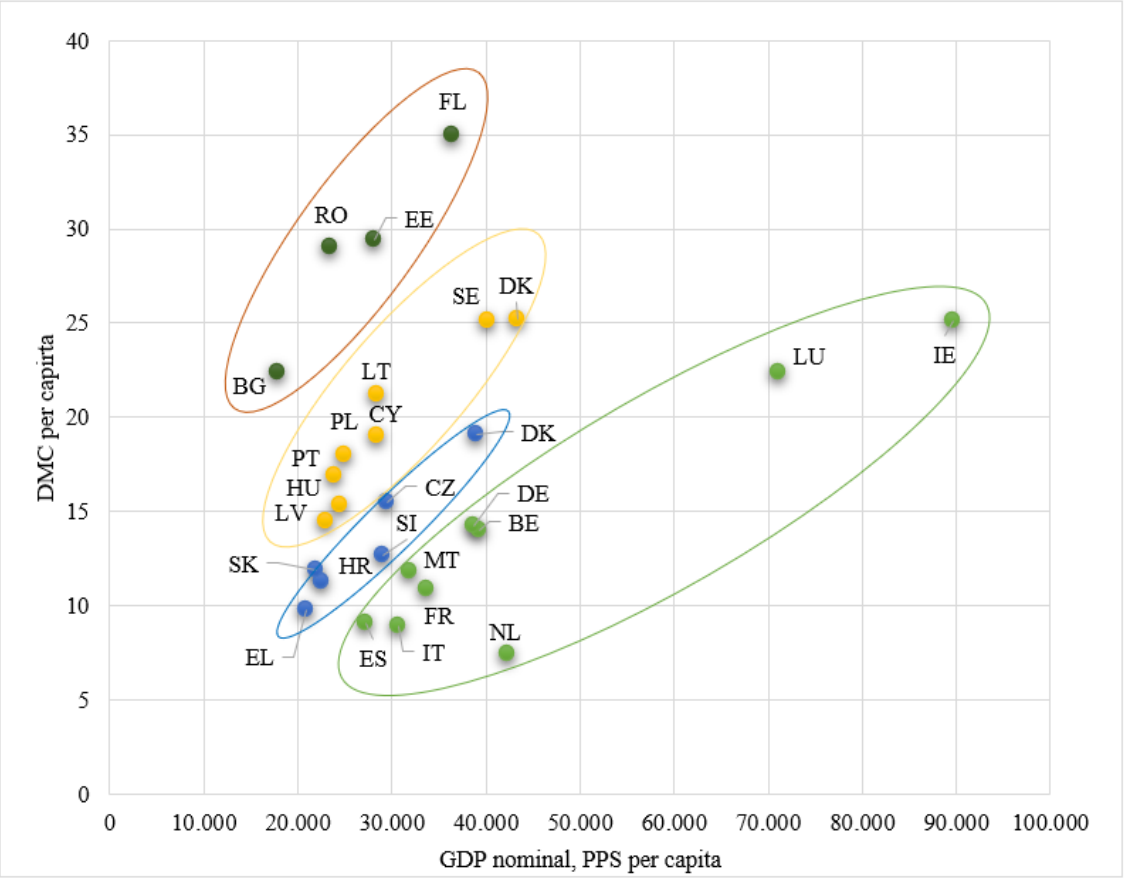

Figure 2. Distribution of EU countries by the level of resource productivity in 2021
[a] – GDP was counted in Euro (per capita)
Source: compiled by the authors based on Eurostat data

During 2017-2022, the resource productivity indicator in Ukraine increased by 38% and was the highest in 2020 (Table 3). This situation was caused by the growth of the country's GDP and the fall in DMC caused by the COVID-19 pandemic. The methodical approach to resource productivity assessment, which is used by the European Commission, should also be used at the regional level. A comparative analysis of the productivity of the use of resource potential and the efficiency of its use in the regions of Ukraine will be useful in making strategic decisions regarding the post-war reconstruction of the country, which will require significant resources.

Table 3.
Resource productivity in Ukraine in 2017-2020

Ukraine	**2017**	**2018**	**2019**	**2020**
GDP in chain-linked volumes, billion UAH	2981,2	3560,3	3977,2	4191,9
DMC, million tonnes	294,2	308,8	305,4	289,1
Resource productivity, UAH per kilogram	10,1	11,5	13,0	14,5
Euro average exchange rate, UAH per €	30	32,1	28,6	30,8
Resource productivity, € per kilogram	0,34	0,36	0,45	0,47

Source: compiled and calculated by the authors based on State Statistics Service of Ukraine data and National Bank of Ukraine data

According to the proposed method, we calculated the corresponding indicators of resource productivity for the L'viv region for the period 2017-2020 (not including imports and exports, due to lack of data in physical measures), which is shown in Table 4. We note that the structure of RMC takes into account the resources that the region possesses, including fossil energy materials (hard coal, crude oil, natural gas), non-metallic minerals (building sand; limestone and

limestone flux, other crushed stone, which is used as a concrete filler and also for road surfacing and similar purposes; clay) and biomass (cereal and leguminous crops, sugar beet, sunflower, soybean, rape and rapeseed, potatoes, vegetable crops, fodder roots, fodder corn, annual grasses for hay, perennial grasses for hay, fruit and berry crops, meat, milk).

Table 4.
Resource productivity in L'viv region in 2017-2020

L'viv region	**2017**	**2018**	**2019**	**2020**
GRP in chain-linked volumes, billion UAH	147,4	177,2	214,5	236,3
RMC, million tonnes	11012,3	11493,6	11330,7	11246,0[a]
Resource productivity, UAH per kilogram	13,4	15,4	18,9	21,0
Euro average exchange rate, UAH per €	30	32,1	28,6	30,8
Resource productivity, € per kilogram	0,45	0,48	0,66	0,68

[a] Categories such as forage corn, annual grasses for hay, perennial grasses for hay, limestone and limestone flux and clays for 2020 were calculated as an arithmetic average for 2017-2019.
Source: compiled and calculated by the authors based on State Statistics Service of Ukraine data

The analysis of the resource productivity dynamics of the L'viv region shows the trend of annual growth of this indicator and the achievement of its maximum value in 2020. We only note that RMC in L'viv region remained practically unchanged, and the growth of the resource productivity indicator is observed due to the growth of the GRP of the region. During 2017-2020, the resource productivity of the region increased by 51%, which is 13% higher than the national indicator.

Comparing the productivity of resources in Ukraine and the L'viv region for the period 2017-2020, we note that the regional indicator over the last three years was higher than its national level (Figure 3). This situation testifies to the significant resource potential of the region and the sufficiently high efficiency of its use.

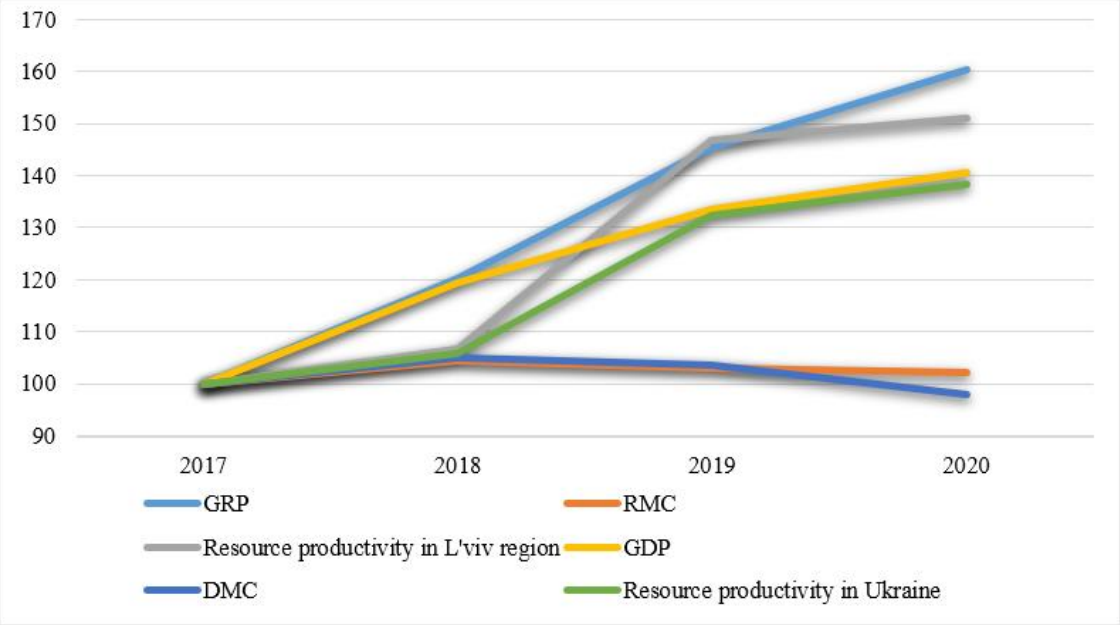

Figure 3. Comparison of resource productivity and its indicators in Ukraine and L'viv region in 2017-2020 (2017 = 100%)
Source: compiled by authors based on Table 3 and Table 4

Conclusions

Therefore, resource productivity is one of the significant indicators characterizing to what extent sustainable development tasks are achieved. Since Ukraine is a candidate for membership in the European Union, the implementation of the methods of calculating

resource productivity is only a matter of time. Therefore, evaluating the productivity of the resources of Ukraine's regions in accordance with European practice should become an important task on the way to the implementation of European integration reforms.

The implementation of resource productivity monitoring of Ukraine regions will allow identifying competitive advantages and problems of preserving and using the resource potential of each region in the process of post-war reconstruction of the country. In addition, such monitoring will make it possible to assess the current state of achieving the goals of sustainable development and suggest solutions to improve the efficiency of regions` resource potential use.

However, in order to accept such monitoring in Ukraine, the system of statistical indicators should be improved, in particular, regarding the accounting of foreign trade in physical measures. This is crucial because a significant share of the products produced is aimed at export markets and cannot be included in the internal consumption of resources.

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