# Do circular economy and green investments create value at the regional level? Evidence from Russian regions

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**Abstract.** Green investments and principles of circular development have become one of the prominent dimensions of regional development policies. The purpose of this article is to study the impact of green investments on circular economy indicators and contribution of these indicators to economic growth at the regional level. The study examines two key indicators of the circular economy: the share of captured and neutralized emissions into the atmosphere and the share of recycled water in the regional manufacturing systems. To test the proposed hypotheses, methods of regression analysis are used. Gross regional product is used as a predictor of value creation. The empirical base is Rosstat data for the period from 2015 to 2019. The results show that the circular economy indicators do not have a visible impact on economic growth at the regional level, but green investments increase the volume of resources used in circular manufacturing systems. It is probable that in Russian industrial economy, implementation of the circular economy principles is associated only with an increase in costs, which do not provide linear returns at the macroeconomic level.

## 1 Introduction

Economic development that relies on a linear logic of resource utilization and allocation inevitably faces environmental challenges. Various activities of households and industrial organizations lead to the generation of a significant amount of waste, which, in the context of a rapidly growing population, may leave future generations worse off. Circular economy concept is the product of a synthesis of interdisciplinary scientific thought in economics, industrial design, environmental chemistry and biology. Ideas of a circular economy involve restoration and regeneration of resources within closed flows, where materials are used repeatedly with minimal losses [1]. As a result, the impact of human activities on the environment is significantly reduced, in addition, less valuable non-renewable resources are involved in the manufacturing processes [2]. Despite this, there are a number of barriers to the practical implementation of a circular economy principles and methods. Therefore, a clear demonstration of the value that circular use of resources can offer to regional and

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national economies is an important tool for dealing with objections and justifying the effectiveness of green investments.

The process of creating economic value refers to all positive outcomes created in service and production systems that relate to saving resources, expanding market opportunities and increasing the competitiveness of organizations. Thus, the concept of a circular economy is attractive for both industrial organizations and service sector of the economy, since it makes a significant contribution to maintaining a long-term business development strategy [3]. By introducing the principles of rational recovery and reuse of resources, companies demonstrate socially responsible behaviour that enhances their image and investment attractiveness. Due to the circular nature of resource flows, payments for environmental impact are also reduced. A number of researchers also note that the creation of circular regional clusters allows the development of local manufacturing and processing companies that provide additional jobs [4].

Responsible allocation of capital in the form of green investments is of a strategic importance for Russia, since the country is one of the economies that actively exploit its own resource base [5]. Green investment primarily implies allocating capital for environmental protection, developing assets and business models that support a responsible attitude of consumers and producers towards the environment [6]. In a circular economy, companies are investing in green technologies that are fundamentally changing key business processes, such as renewable energy sources, advanced waste recycling, product sharing, and development of environmentally friendly transport infrastructure. Consumers also participate in green investment initiatives by choosing products that reduce the impact on local ecosystems.

In existing literature there is insufficient evidence of the regional contribution of green investment to perpetuating the principles of recycling and reuse of resources in developing regional economies. In addition, more attention should be paid to the impact of environmental concepts on macroeconomic growth performance. The purpose of this article is to study the impact of green investments on the circular economy indicators and the contribution of these indicators to the gross regional product formation. To identify the degree of circular economy development, the following indicators are considered: the level of captured and neutralized atmospheric emissions and the share of recycled water consumption by households and organizations. Taken together, these indicators may indicate the development of rational use of resources and a decrease in environmental impact.

## 2 The role of the circular economy in sustaining value creation: literature review and hypotheses development

The concept of circular economy originates in the works of the 1960s, when interest in harmonious development of production systems, considering principles of environmental responsibility, increased significantly [3]. Economists have shown that closed models can explain production processes and reflect the movement of resources in an interfirm environment to achieve savings [7]. The concept focuses not only on the reuse and recycling of materials, but also on product and process design, supply chains configurations and consumer behaviour patterns [8]. The process of creating value in a circular economy therefore transcends the internal production system of the company and focuses attention of the responsible parties on the network interaction for non-renewable resources distribution and consumption.

The value proposition is created by applying the circular economy principles. They refer to all positive effects and results that are created in resource supply chains, production systems and consumer behaviour. The increasing complexity of supply chains creates both

threats and opportunities for the regeneration and reuse of resources. At the initial level of environmental maturity, opportunities of a circular economy are closely related to raising awareness among stakeholders, strengthening marketing communication, developing innovative activities of companies, and reducing environmental pressure from the public [3]. The value-creating strategies for the circular economy are, first, based on industrial symbiosis. Its primary aim is to create partnerships in value chains for knowledge sharing. Second, these principles introduce new design principles that encourage engineers to avoid waste and material leakage wherever and whenever possible. Third, the circular economy is characterized by re-use of products, as well as deep processing of waste, which makes it possible to maximize extraction of useful components in accordance with available advanced technologies. Fourth, the production should use environmentally friendly materials that are subject to rapid decomposition or are easily recycled [2].

Among the significant natural resources that are intensively used by industrial and service enterprises, one can single out water resources and the atmosphere. It is predicted that water consumption in the first half of the 21st century will increase by 50% [9]. Therefore, the consistent use of recycled water is an important strategy to support the implementation of a circular economy. Air pollution also has a significant impact on the environment and biodiversity. More than 80% of air emissions are associated with industrial companies, in addition, solid household waste also has a negative impact on atmosphere, since only about 4% of the total volume of waste is sent for processing in Russian regions [10]. For the broad practical implementation of the circular economy principles in Russian conditions, social capital is a significant resource. Raising public awareness of resource reuse, deep recycling and sharing of things is supposed to encourage the value creation process [11].

At present, the widespread implementation of the circular manufacturing principles in the industrially developed regions of the world is at the initial stage of development, especially in the primary sector, which is focused on the extraction of natural resources [12]. Traditionally, it is the primary sector that is associated with a significant impact on the environment and imbalance in ecosystems. Since the Russian economy gains a significant competitive advantage in international markets from the extraction, processing of metal ores, and the sale of oil and gas, the task of developing a circular economy becomes even more complicated. Circular economic models suggest that resources should be used by local producers with maximum efficiency to create added value in a circular chain of production and distribution [8]. Therefore, the expansion of technologies that make it possible to reuse water resources and neutralize emissions into the atmosphere, leads to the emergence of additional income streams in the economy, which in turn provides creation of consumer value. Therefore, the following hypotheses are formulated:

*Hypothesis 1.1*. An increase in the share of captured and neutralized air emissions in the regions has a significant positive impact on the gross regional product.

*Hypothesis 1.2*. An increase in the share of water used in a closed cycle has a significant positive impact on the gross regional product.

Green investment projects are designed to support all types of technological and organizational innovations and improvements that provide a responsible attitude towards the environment [13]. Modern investors demand from companies not only financial performance, but also the development of projects to introduce environmentally friendly technologies [6]. The principles of a circular economy create a stricter framework for environmental activities in companies, they stimulate them to revise the technological underpinnings of business processes, choose strategies for closing resource flows and using renewable energy sources. The main financial results of green investments are lower waste charges and an additional stream of income from the supply of green products to the market. Therefore, the following hypothesis is formulated:

*Hypothesis 2*. Green investments have a significant positive impact on increasing the share of resources used in a closed cycle of production and consumption.

## 3 Methods and data

Multiple linear regression method is used to test the hypotheses put forward. Regression coefficients show the contribution of each indicator to change in dependent variable; the least squares method is used for the assessment. The dependent variable for testing the first hypothesis is the natural logarithm of the gross regional product (GRP) per capita in roubles (LN_GRP). It is assumed that this variable reflects the process of creating value through the additional flows of investment in various types of activities specific for a circular economy. The independent variables include control variables such as the share of innovatively active companies in the region (INN_ACT) and the volume of innovative products shipped (INN_Prod). Target variables, such as the share of captured and neutralized air pollutant emissions (CE_WCap) and the share of recycled sequentially used water in total consumption (CE_Wat_Coef) are used.

To test the second hypothesis, the authors calculate and use the circular economy rating (CE_RATE) as a dependent variable. The proposed indicator reflects the ratio of the amount of materials and water used in closed cycles to the maximum observable value of this indicator for all regions in the current year. The indicator is measured in the range from 0 to 100 units, it reflects the average share of resources that are used in a circular production flow. The target independent variable is the natural logarithm of investments in environmental protection in roubles (LN_CE_Invest). This indicator demonstrates the placement of green investment in the economy and its impact on the implementation of circular production and consumption systems.

## 4 Results and discussion

Descriptive statistics for the variables used in the study are presented in Table 1. From the data presented, it can be concluded that the circular economy rating has not changed significantly over the five years. This is explained by the fact that the share of consistently used water and neutralized emissions into the atmosphere also changed insignificantly over the reviewed period. Despite this, the volume of green investments in the Russian economy has grown significantly.

**Table 1.** Descriptive statistics. Obtained by the authors.

| Variables | 2015 | | 2017 | | 2019 | |
|---|---|---|---|---|---|---|
| | Mean | S.D. | Mean | S.D. | Mean | S.D. |
| LN_GRP – Logarithm of GRP per capita | 12,8 | 0,7 | 12,9 | 0,7 | 13,2 | 0,7 |
| CE_RATE – Circular economy rating | 32,3 | 18,7 | 33,0 | 18,6 | 33,2 | 17,9 |
| INN_Prod – Volume of shipped innovative goods and services as a percentage of the total volume | 5,9 | 6,0 | 5,7 | 5,9 | 4,6 | 4,6 |
| INN_ACT – Share of innovative organizations | 8,6 | 4,5 | 13,1 | 6,3 | 8,4 | 4,3 |
| LN_CE_Invest – Logarithm of environmental protection investments | 21,8 | 1,4 | 21,9 | 1,3 | 22,2 | 1,3 |
| CE_Wat_Coef – Share of recycled and sequentially used water | 54,7 | 29,2 | 55,7 | 28,6 | 56,6 | 28,8 |
| CE_WCap – Share of captured and neutralized air pollutants in the total amount of waste from stationary sources | 55,7 | 27,7 | 54,7 | 27,6 | 53,4 | 27,8 |

The results of regression analysis for testing the first hypotheses are presented in Table 2. The results show that green investments make a significant contribution to the formation of GRP, because they are a component of capital investments of industrial and service companies. The variables reflecting the proportion of recycled water used consistently and the proportion of captured and neutralized air emissions show statistical significance. However, although the regression coefficients have a relatively high statistical significance, their actual contribution to the formation of the final result is relatively insignificant. In addition, the proposed models explain no more than half of the observed variance (the values of the determination coefficients do not exceed 40%). An increase in the share of resources used in a closed production cycle by 1% leads to an increase in GRP by less than 1%. Thus, hypotheses 1.1 and 1.2 are rejected, since the indicators of the circular economy do not make a significant direct contribution to the formation of the financial performance of the regions.

**Table 2.** Non-standardized regression coefficients and t-statistics. Dependent variable is the natural logarithm of GRP per capita. Obtained by the authors.

| **Dependent variables** | **2015** | | **2017** | | **2019** | |
|---|---|---|---|---|---|---|
| | Coeff. | t-stat. | Coeff. | t-stat. | Coeff. | t-stat. |
| Constant | 6,987*** | 6,622 | 6,984*** | 5,968 | 7,675*** | 5,797 |
| INN_Prod | -0,019* | -1,763 | -0,017 | -1,485 | -0,024 | -1,474 |
| LN_CE_Invest | 0,273*** | 5,285 | 0,283*** | 4,962 | 0,264*** | 4,177 |
| CE_Wat_Coef | 0,006*** | 2,420 | 0,004* | 1,673 | 0,004 | 1,458 |
| CE_WCap | -0,007*** | -3,082 | -0,008*** | -3,000 | -0,009*** | -3,466 |
| $R^2$ | 0,411 | | 0,360 | | 0,286 | |
| Adjusted $R^2$ | 0,381 | | 0,328 | | 0,251 | |
| F-statistic | 13,9*** | | 11,3*** | | 8,0*** | |
| Number of observations | 85 | | 85 | | 85 | |

Note. *** – significant at 1% level, ** – significant at 5% level, * – significant at 10% level.

The results of regression analysis for testing the second hypothesis are presented in Table 3. The rating of the circular economy proposed by the authors reflects the share of consistently used water resources and neutralized atmospheric emissions. The high value of the index is typical for the central regions of Russia, while the southern regions show no inclination to introduce closed production flows (Figure 1). The leader in the proposed rating is the Sverdlovsk region, located in the Urals: more than 90% of all water resources in the regional industry are in a closed cycle of consumption, the share of captured and neutralized emissions into the atmosphere is also high.

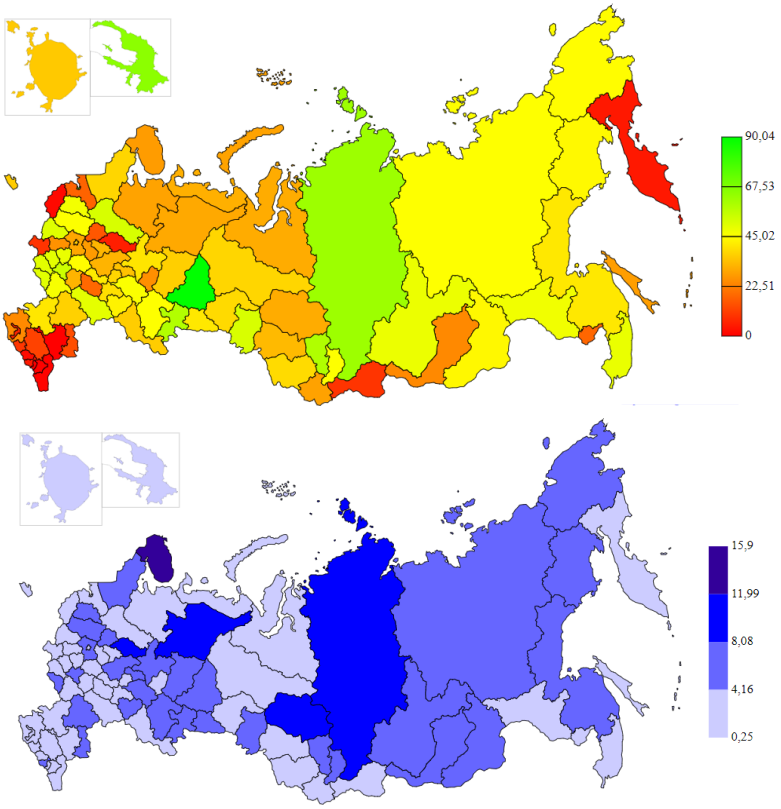


**Fig. 1.** Territorial distribution of the proposed circular economy index in 2019 (top). The share of green investments in the regions of Russia in the total volume of fixed asset investments in 2019 (bottom). Obtained by the authors.

According to the results of regression analysis authors conclude that green investments have a significant positive impact on the use of technologies inherent in the circular economy in the Russian regions. Therefore, the second hypothesis is supported. The innovative activity of companies does not demonstrate a stable relationship with the consistent use of water and the neutralization of atmospheric emissions; a significant positive relationship is observed only in 2019.

**Table 3.** Non-standardized regression coefficients and t-statistics. Dependent variable is the circular economy rating. Obtained by the authors.

| **Dependent variables** | **2015** | | **2017** | | **2019** | |
|---|---|---|---|---|---|---|
| | Coeff. | t-stat. | Coeff. | t-stat. | Coeff. | t-stat. |
| Constant | -148,4*** | -4,5 | -144,0*** | -4,3 | -135,0*** | -4,1 |
| LN_GRP_P | 2,547*** | 0,884 | -0,577 | -0,211 | 0,916 | 0,399 |
| INN_ACT | 0,200 | 0,471 | -0,053 | -0,178 | 1,389*** | 2,764 |
| INN_Prod_D | 0,300 | 0,925 | 0,104 | 0,329 | -0,305 | -0,651 |
| LN_CE_Invest | 6,636*** | 4,349 | 8,415*** | 5,418 | 6,586*** | 4,715 |
| $R^2$ | 0,357 | | 0,353 | | 0,388 | |
| Adjusted $R^2$ | 0,325 | | 0,321 | | 0,357 | |
| F-statistic | 11,1*** | | 10,9*** | | 12,7*** | |
| Number of observations | 85 | | 85 | | 85 | |

## 5 Conclusions

The results show that the principles of a circular economy play a very moderate role in creating direct value at the regional level. The contribution of technologies for the consistent use of recycled water and neutralization of atmospheric emissions does not significantly affect the formation of the gross regional product. Meanwhile, green investments that are attracted in the regions to update and improve environmental technologies have a positive effect on the consistent use of resources in circular production systems. Probably the circular principles do not create value for the industrial economy, because capital investment is seen as an expense rather than an investment for the process of creating value at the regional level. Such costs limit the activities of manufacturing companies under the influence of the authorities and local communities, which express concerns about the emerging situation with the extensive use of resources and the increase in amount of irrecoverable waste.

The results obtained have practical implications, since they can be used to analyse the level of circular economy development in the regions of Russia and to identify the value added. The limitations of the study are related to the application of a broad regional approach that summarizes the contribution of environmental indicators to development.

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