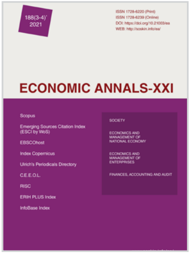

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Circular investments as a key to solving the growth dilemma

Abstract. The rationale for this study is based on the extreme importance of finding a solution to a complex growth dilemma arising from the negative effects of human activity and the limited ability of the ecosystem to regenerate and provide resources required by mankind to ensure sustainable development and the long-term prosperity. The research is aimed at proving a scientific hypothesis that states: when the global raw-materials crisis becomes increasingly noticeable in various countries of the world, including Russia, circular investments may become a driver for long-term economic growth and the launch of far-reaching reforms of the economy in the 21st century. Circular investments in this paper are viewed as a special type of real eco-investment that combines advancements in technology and innovations to ensure renewal and industrial-scale reproduction of resources (raw materials and energy) from industrial and household waste, along with the mitigation and/or elimination of negative effects, on the environment. A multiple linear regression model has been developed to confirm a statistically-relevant connection between circular investments and real GDP. As a methodological foundation for the model, we used the classic Cobb-Douglas production function modified to take into account industrially reproduced raw material resources included in the production process. Further, we have defined major limits for circular investments in Russia today and highlighted the primary measures which are to be taken to launch circular investments in order to find a solution to the complex growth dilemma.
Keywords: Growth Dilemma; Resources; Raw Materials; Crisis; Circular Investments; Waste Resources; Closed Resource Cycle
JEL Classifications: A00; N50; O15
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Циркулярні інвестиції як ключ до вирішення дилеми зростання

Анотація. Це дослідження ґрунтується на необхідності та надзвичайній важливості пошуку вирішення дилеми зростання, що випливає з негативних наслідків людської діяльності та обмеженої здатності екосистеми відновлюватися та забезпечувати ресурси, які необхідні людству для забезпечення сталого розвитку та довгострокового процвітання. Дослідження спрямоване на доведення наукової гіпотези, яка стверджує: коли глобальна сировинна криза стає все більш помітною в різних країнах світу, включаючи Росію, циркулярні інвестиції можуть стати рушієм довгострокового економічного зростання та початку реформ економіки в XXI столітті. У цій статті циркулярні інвестиції розглядаються як особливий вид реальних еко-інвестицій, що поєднує в собі прогрес у технологіях та інноваціях, щоб забезпечити оновлення та відтворення ресурсів (сировини та енергії) у промислових масштабах з промислових та побутових відходів разом із пом'якшенням та/або усуненням негативного впливу на навколишнє середовище. Модель багаторазової лінійної регресії була розроблена для підтвердження статистично релевантного зв'язку між циркулярними інвестиціями та реальним ВВП. У якості методологічної основи моделі автори дослідження використали класичну виробничу функцію Кобба-Дугласа, модифіковану з урахуванням промислово відтворених сировинних ресурсів, включених у виробничий процес. Окрім цього, було визначено основні обмеження для циркулярних інвестицій у Російській Федерації на сучасному етапі та виокремлено основні заходи, які необхідно вжити для запуску циркулярних інвестицій для того, щоб знайти вирішення складної дилеми зростання.

Ключові слова: дилема зростання; криза ресурсів (сировини); кругові інвестиції; відходи; замкнутий цикл ресурсів.

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Циркулярные инвестиции как ключ к решению дилеммы роста

Аннотация. Данное исследование основано на необходимости и чрезвычайной важности поиска решения дилеммы роста, возникающей из-за негативных последствий деятельности человека и ограниченной способности экосистемы восстанавливаться и обеспечивать ресурсы, необходимые человечеству для обеспечения устойчивого развития и долгосрочного процветания. Исследование направлено на доказательство научной гипотезы, которая гласит: когда мировой сырьевой кризис становится все более заметным в различных странах мира, в том числе в России, циркуляционные инвестиции могут стать драйвером долгосрочного экономического роста и запуска долгосрочных инвестиций, а также проведения реформ экономики в XXI веке. В данной статье циркулярные инвестиции рассматриваются как особый тип реальных эко-инвестиций, сочетающих достижения в области технологий и инноваций для обеспечения возобновления и воспроизводства в промышленных масштабах ресурсов (сырья и энергии) из промышленных и бытовых отходов, а также смягчения последствий и/или устранения негативного воздействия на окружающую среду. Модель множественной линейной регрессии была разработана для подтверждения статистически значимой связи между циркулярными инвестициями и реальным ВВП. В качестве методологической основы модели авторами исследования была использована классическая производственная функция Кобба-Дугласа, модифицированная для учета

воспроизводимых в промышленных масштабах сырьевых ресурсов, включенных в производственный процесс. Кроме того, авторами были определены основные ограничения для циркулярных инвестиций в России и обозначены основные меры, которые необходимо предпринять для запуска циркулярных инвестиций, чтобы найти решение сложной дилеммы роста.
Ключевые слова: дилемма роста; ресурсный (сырьевой) кризис; циркулярные инвестиции; нерациональные ресурсы; замкнутый ресурсный цикл.

1. Introduction

The global crisis of 2008-2009 and subsequent «overall inherited low performance of the economy» (Spence, 2012, p. 141), as well as the extremely devastating effect the COVID-19 pandemic has had on business activities and other aspects of social and economic life in various countries around the world, including Russia, may be deemed the catalyst that has made the «complex growth dilemma» a subject for careful study by political economy scientists and other development studies specialists today. To put it simply, the dilemma may be posed as two statements: the first is related to economic growth which is deemed a basis for the development and long-term prosperity of any country; the second statement is related to the ongoing growth of the economy that if continued, will result in extreme environmental constraints (Jackson, 2017, p. 31).

It should be noted that in the current difficult situation that has occurred due to the above-mentioned reasons, even developed countries are programmed to economic growth in the decades to come. It is evident that the «zero growth» or «anti-growth» idea suggested by Meadows et al., (2005) in high-profile papers *The Limits to Growth* and *Beyond the Limits* to the Club of Rome's Project are without foundation. As for the German «green» politician and political writer R. Fuchs, such an idea is delusional and may «... simply result in the collapse of economic activity and recession, the drastic reduction of demand, increase in unemployment and poverty rates, and the loss of any hope for the future» (Fücks, 2016, p. 105).

At the same time, it should be noted that the unchecked growth of the economy (if the type of growth remains unchanged) will result in an increased load on the environment due to the increased consumption of resources, larger environmental footprint and ecological debt left by mankind, as well as the subsequent material deterioration of environmental quality (climate change and the «sink» problem, reduced biodiversity and fresh water supplies, soil degradation, depletion of primary natural resources etc.). Currently, China is the classic example of a dramatic environmental disaster amid impressive industrial growth (Fücks, 2016, p. 104).

In other words, there is a brand new super-global task today that has not been completely understood by society, but that is already calling for a solution. It is the task to develop a new resource base for the economy relying on the industrial-scale reproduction of raw materials (Soros, 2004; Kamenik, 2015; Schwab, 2017), which will allow us to go «beyond natural limits» (Kamenik, 2015; Ryazanova et al., 2020). In our opinion, such a project should become the major project of the XXI century; it is possible to implement the project only through joint efforts of progressive business interests and the state.

This brings us to the evident need for massive advanced investments in the industrial-scale reproduction of resources to manufacture products which will be used as raw materials to overcome the growth dilemma (Soros, 2004). Such investments (we suggest using the term Circular Investments for scientific purposes) (Kormishkinaet al., 2018) may launch radical changes in the economy of the XXI-century economy based on the idea of using «circular» resources in various business hierarchies.

2. Method

To verify the hypothesis about the influence of Circular Investments initially focused on resource conservation, on reducing the volume of waste and its industrial-scale reprocessing into raw materials (recycling), and on the growth of the Russian economy, we applied the Cobb-Douglas production function, modified to take into account the factor mentioned above. A similar approach is based on original assumptions by Pittel et al. (2020) about the possibility of including intermediate inputs that consist of primary resources and recycled waste re-used within the production process in the classic Cobb-Douglas production function. For this purpose, the Cobb-Douglas function is:

$$Y = A \times L^{\alpha} \times K^{\beta}, \quad (1)$$

where:
Y is the total production volume;
A is the input-output ratio;

L is labour input;
K is capital input;
α is the output elasticity of labour;
β is the output elasticity of capital.

We included an additional factor (R), which means waste recycling, in model (1) by transforming this equation into equation (2). The basic assumption is that industrial-scale reproduction of raw materials from waste resources (waste recycling) and economic growth are not just interconnected, but they impose a lagged reciprocal influence. The first impulse shall be GDP growth accompanied by increased income and consumption, as well as waste. At the same time, in response to increased investments resulting from the growth of GDP, new industrially reproduced raw materials or products from industrial and household waste may be obtained many times over.

We have assessed the directions of such impulses through a distributed lag model and by shifting the time of waste recycling values.

In this study we have assessed the parameters of a developed econometric model with 5 options: from $t-2$ to $t+2$ with an interval of one year, where t is a period of one year in which GDP was evaluated (e.g., $(t-1)$ and is used to assess the influence of waste recycling on GDP with a 1-year lag). When formalized, this correspondence may be:

$$Yt = AKt^{\alpha}Lt^{\beta}Rt^{\gamma}, \qquad (2)$$

where:
R is waste recycling (industrial-scale reproduction of raw materials);
γ is the output elasticity of waste recycling.

Our research applies the multiple linear regression model that allows for defining how various factors influence the final result. To calculate the multiple linear regression, formula 2 is presented as follows after taking the logarithm:

$$LnY = LnA + \alpha LnK + \beta\, Ln\, L + \gamma\, Ln\, R. \qquad (3)$$

The remaining parts of the model were subject to a normality test using graphics and computational methods. The first method includes the remaining parts distribution bar chart and the normal and probability chart; the computational method is based on the criteria defined by Kolmogorov-Smirnov and Shapiro-Wilk, as well as on a comparison of values of asymmetry and excess with standard non-sampling errors. Variables used in the model Y: Russian real GDP; K: Major funds in comparable prices; L: Average number of employed people per annum; R: Usage and disposal of industrial and household waste.

3. Results

In terms of the growth dilemma, adequate technologies and new organizational and economic solutions and conditions are required to create a new raw materials base. Consequently, the positioned Circular Investments give a real opportunity to ensure the sustainable disposal of industrial and household waste through the 4R principle (Kormishkina et al., 2018).

The problem for the future of the raw materials base to maintain its economic growth potential is very relevant for Russia, whose economy is characterised by a high level of consumption of natural resources and waste generation. Such a negative trend that prevents the growth dilemma from being solved is defined by the export and raw-material based nature of the Russian economy, as well as by the level of its technological development. Industrial and household waste dynamics in Russia are shown in Figure 1.

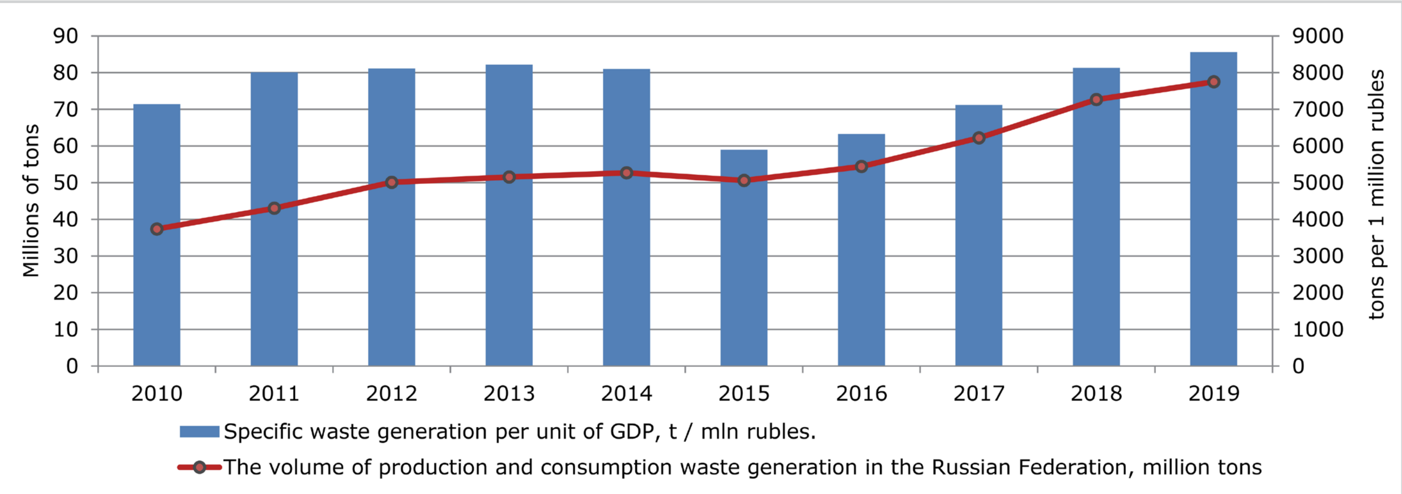
As per Figure 1, the overall industrial and household waste dynamics in Russia show a solid growth in volume annually. In 2010-2019, the overall mass of such waste in the country doubled; a short-term break in growth was seen in 2014-2015 due to a number of measures undertaken (such as implementation of the environmental levy) under the new Federal Law No. 458-FZ dated 29.12.2014 «On Industrial and Household Waste». The quantity of waste per unit of GDP in 2010-2019 also increased (by almost 1/3), which means the growth dilemma is more of an acute issue in Russia today.

In this context, Russia shows an extremely low level of industrial and household waste management (see Figure 2), which for Municipal Solid Waste was just 7% in 2019, against 25% in the USA, 26% in France, 28% in Finland, and 67% in Germany.

While leading countries (such as Japan, Germany, and other EU countries) have already applied mechanisms that provide for implementation of the familiar concept of Zero Waste, Russia remains the world leader in waste dumping (disposal). The data from Figure 2 shows that waste disposal on landfills is still the primary method of industrial and household waste management in Russia. Such an approach may not be deemed rational due to the actual denial of waste's resource value and the negative effect on the environment (landfills are a serious source of pollution of soil, ground water, and the atmosphere with toxic compounds, highly toxic heavy metals, landfill gases, as well as with dioxins, furanes, and biphenols when landfills are burned).

It is obvious that in terms of the growth dilemma, the major effect of solving the industrial and household waste management issue is based on reusing raw materials to the greatest possible extent. In leading countries, the share of waste reused in production is 80-87%, and the Russian economy could use this figure as a guide (Lipina, 2018, p. 146).

Comparable analysis of industrial and household waste generation and disposal in constituent entities of the Russian Federation have identified disproportions in this concern. As the data in Figure 3 show, most constituent entities of the RF currently produce more waste that dispose of it, which results in the actual increment of accumulated waste. Only 6 constituent entities of the RF dispose more waste than generate it, which means that recycling as a business is more or less developed in these regions.



Note: for the period 2011-2015, data in 2011 prices; for 2014 - in prices of 2011 and 2016;
for 2015-2019 - in prices of 2016.

Figure 1:
Industrial and household waste dynamics in Russia and waste volumes per unit of GDP in 2010-2019
Source: Authors' calculations based on data from the Federal State Statistics Service of Russia

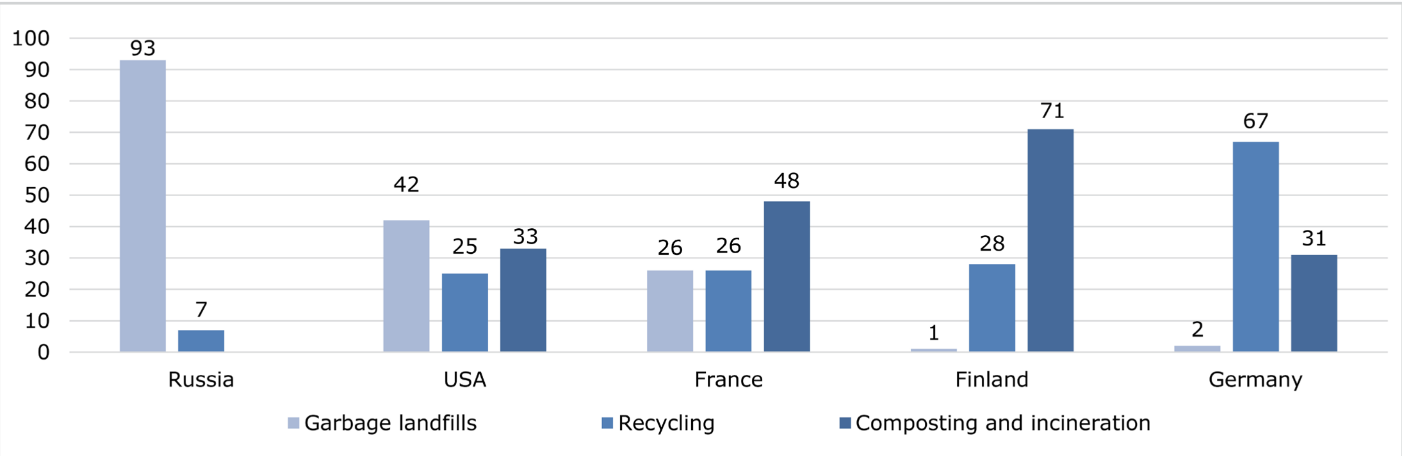


Figure 2:
Waste management levels in Russia and around the world in 2019 (%)
Source: Budanov et al. (2020)

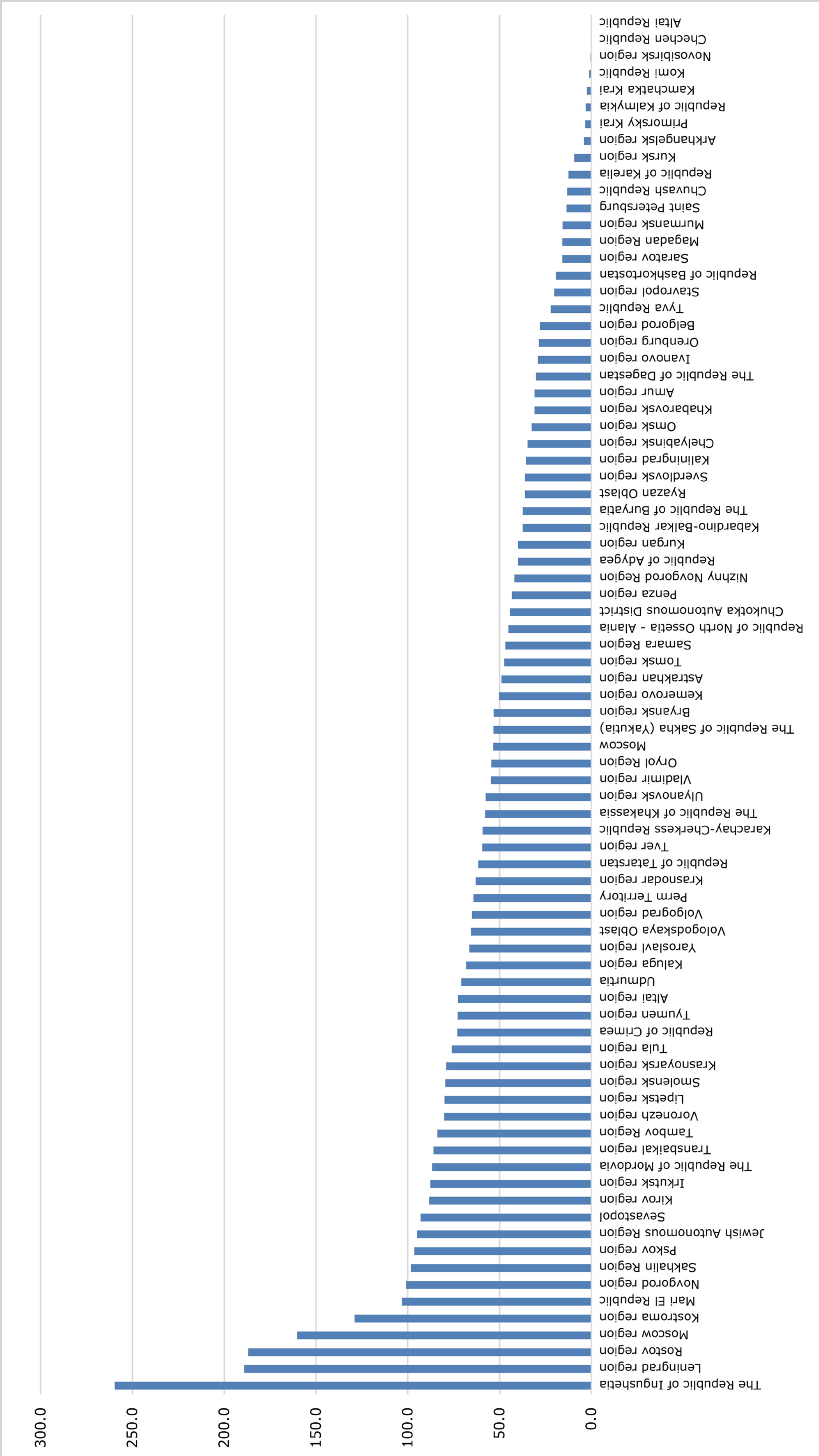


Figure 3:
Disposal and deactivation of industrial and household waste in Russia in 2019 (% of total waste)
Source: Authors' calculations based on data from the Federal State Statistics Service of Russia

The insufficient amount of investment into recycling (Circular Investments as we suggested) is seen by experts of the Accounts Chamber of the Russian Federation as one of major reasons for such low usage of industrial and household waste in business activities within the country. Experts from the Accounts Chamber estimated a required volume of waste management infrastructure to be RUB 428 billion, of which about 80% shall be obtained from investors and the other 20% financed from the federal budget (ACRF Newsletter, p. 43).

It should be acknowledged that in current conditions, when the threat of the global raw materials crisis is growing, Circular Investments shall be given a key role in maintaining the potential for long-term economic growth. This is due to the nature of Circular Investments and compliance with principles of ESC investments. Indeed, to obtain this result from Circular Investments, one should develop super-new innovative technologies in various directions focused on the industrial-scale reproduction of raw materials. One should bear in mind that products manufactured with the use of such technologies will also be high-tech, highly competitive, with export potential.

The lack of a unified approach to the nature of a conceptual framework, uncertainty with terminology, and the imperfection of forms of federal statistical control over waste management and eco-investing (including its circular component) make it harder to run retrospective analytical estimates with regard to this problem. Based on official actual data and assuming that the dynamics of Circular Investments reflect major trends in environmental costs in Russia, we have established that a share of capital investments in waste management has been decreasing within total environmental investment (see Figure 4). If the capital investment share in 2014 was 10%, in 2015 it went down to 8%, and again further down to 6% in 2016 and 4% in 2017. Furthermore, the total growth of such investments functioning in actual applied prices for the period under review is incomparable with the dynamics of waste generated by the economy.

The investment curve shown on Figure 4 is presented in an echelon form; there are two distinct periods during which the amount of investment remained on one level. The first period (2000-2006) when the amount of investment was from 2000 m to 3000 m.; the second period lasted from 2008 to 2017 and saw fluctuations in investment from 7000 m to 8000 m.

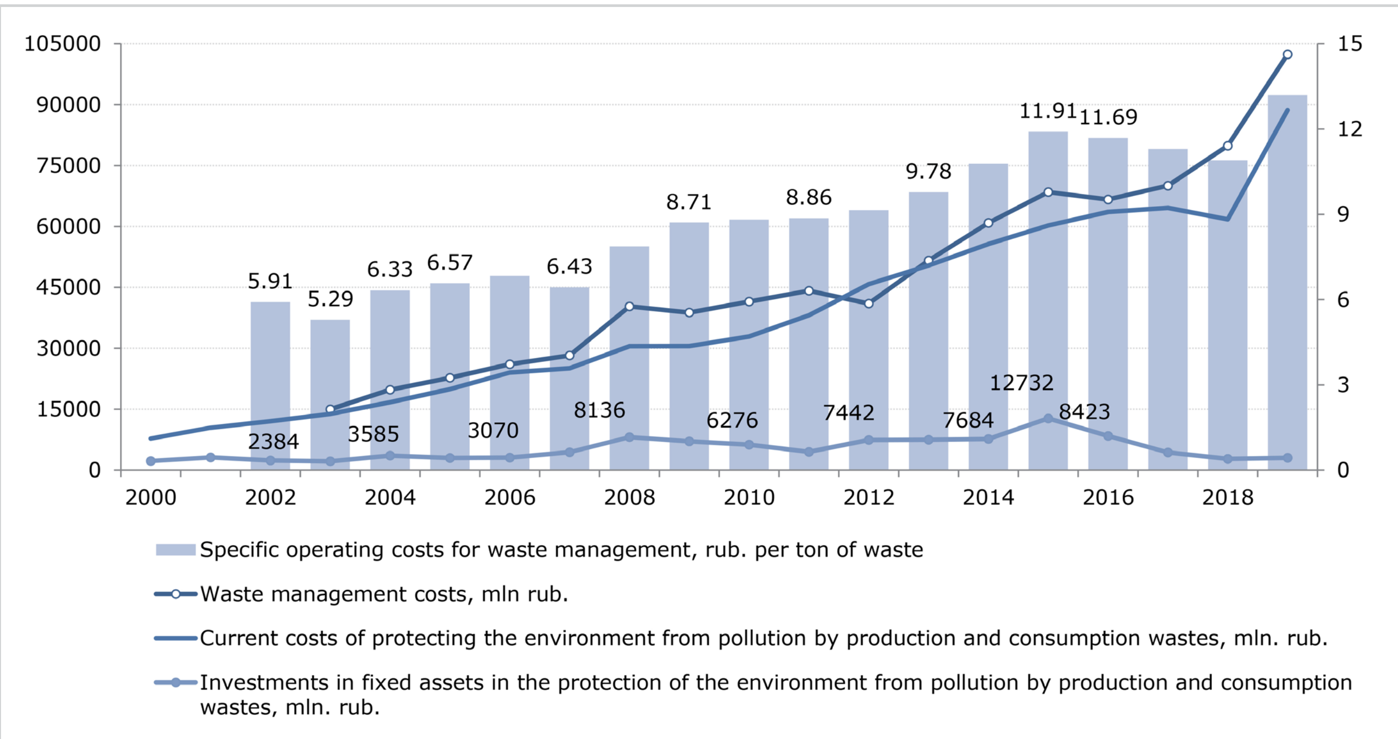


Figure 4:
The dynamics of investment in waste management and current environmental costs in Russia, presented in actual applied prices
Source: Authors' calculations based on data from the Federal State Statistics Service of Russia

Waste management costs have increased sharply, as well as environmental costs for protecting the environment from industrial and household waste starting from 2017 (see Figure 4), which resulted primarily from the adoption of the Environmental Security Strategy of the Russian Federation to 2025. The Strategy provides financial support primarily through the state budget allocated to implement the Environmental Security Strategy, as well as through extra-budgetary resources. Adoption of the Strategy meets new environmental and social requirements and enables the sustainable development of the economy.

However, due to the lack of the required technological base, businesses are not yet ready to develop an effective industrial and household waste management system on their own and create a disposal industry. Capital investment into protection of the environment from industrial and household waste increased in 2015 only by RUB 5048 m. One may assume that this came about as a response to amendments to Federal Law No. 89-FZ dated 24.06.1998 «On Industrial and Household Waste» adopted on 1 January 2014 to implement territorial schemes, regional programs for waste management, investment programs for Municipal Solid Waste operators, the environmental levy, and some other innovations. These amendments also provided for a directive-based enforcement or the fiscal stimulation of waste management system subjects to implement new disposal capacities.

We developed 5 specifications of models with shifted resource recycling values against GDP from -2 to +2 years. Where t period is used, it means that GDP and resource recycling values for the same period were applied; $t-2$ means that the effect of recycling on GDP dynamics was estimated with a 2-year lag. In addition to these specifications, we established that L was missing from the model. Results of the assessment of calculated regression models based on the least square adjustment method are shown in Table 1.

The data in Table 1 show that the best results are obtained when the lag of 2 years between the usage of waste resources and GDP dynamics (regressions 2, 6) is applied, as well as regression model 1 with no lags. It should be noted that the $t-2$ period points to statistically significant negative correlations between resource recycling and GDP volume, whereas when there are no lags, the correlation becomes positive. We believe that the explanation may be as follows.

First of all, $t-2$ is a period when the composition of inputs of production may be subject to significant change; and a negative correlation denotes that businesses take into account environmental rules and regulations when investing (alternative use increases the active part of fixed capital), which may slow down GDP growth in the mid-term. Furthermore, this may mean that the influence of Circular Investments have on GDP dynamics and technology level matching the «4*R*» principle

Table 1:
Regression Models Specifications

Variable	Regression model parameters					
	1	2	3	4	5	6
Constant	8.153*** (2.821)	2.706 (1.584)	4.451 (1.308)	5.451** (2.616)	4.995** (2.698)	1.189*** (3.543)
LnK	0.323* (1.94)	1.113*** (8.379)	0.662*** (3.170)	0.393** (2.694)	0.389** (3.023)	1.067*** (8.791)
LnL	-1.261* (-1.84)	-0.385 (-0.906)	-0.576 (-0.700)	-0.611 (-1.196)	-0.468 (-1.027)	
LnR_t	0.183* (2.07)					
LnR_{t-2}		-0.279*** (-4.66)				-0.286*** (-4.893)
LnR_{t-1}			-0.032 (-0.295)			
LnR_{t+1}				0.059 (0.887)		
LnR_{t+2}					0.024 (0.391)	
Number of cases	15	13	14	14	13	13
F-statistics	22.041**	40.289***	12.094***	18.118***	14.219***	61.14***
R^2	0.857	0.930	0.784	0.845	0.826	0.924
Adjusted R^2	0.818	0.908	0.719	0.798	0.768	0.909

Notes: Statistical significance: 10% – *; 5% – **; 1% – ***; t-value is given in brackets.

Source: Calculated by the authors

are not synchronised. This provides for changes in macroeconomic policy that should be directed not only in the economic facilitation of Circular Investments that are deemed to be a growth driver, «but also on the distribution of investments in such a way as to ensure the technological development of the economy along with changes in development institutions» (Sukharev & Voronchikhina, 2020).

Secondly, the application of model 1 with no lags showed that waste recycling and re-use today brings a positive effect on the GDP dynamics in the relevant year. Waste recycled in the current period is highly likely to be used in the production process in the same period, as it is expensive for the owner to keep recycled waste for a long period.

Thus, the model of the influence of resource recycling on GDP dynamics may be developed into an equation (4). This explains over 80% of response fluctuations, provided that the response is statistically highly significant:

$$LnY_t = 8.153 + 0.323 LnK_t - 1.261 LnL_t + 0.183\ LnR_t . \quad (4)$$

The remaining parts distribution analysis for normality for model (4) was based on graphics and computational methods. The results of a graphics analysis of the remaining parts gave us reasons to state that they are normally distributed, which is confirmed by both the remaining parts distribution bar chart (a) and the normal and probability chart (b). In general, the remaining parts bar chart provides for a hypothetic bell-shaped curve, where some gaps may occur due to the small number of observations (Figure 5).

The normal and probability chart shows that the remaining parts are relatively close to a hypothetic normal curve, which also proves the usability of the model (Figure 6).

To evaluate the normality of the remaining parts distribution, we used computational methods, such as the Kolmogorov-Smirnov test and Shapiro-Wilk test, as well as asymmetry and excess values, and their errors.

Asymmetry in the modulus is 0.094524, the standard non-sampling error amounts to 0.580119, which is more than 6 times larger than asymmetry (minimal threshold value is 3), which supports our assumption about normal distribution. The excess amounts to 0.387037, but the standard non-sampling error is 1.120897; thus, their correlation is less than the threshold value of 3, although it appears to be rather close (2.9). At the same time, the accumulated results of assessment of the

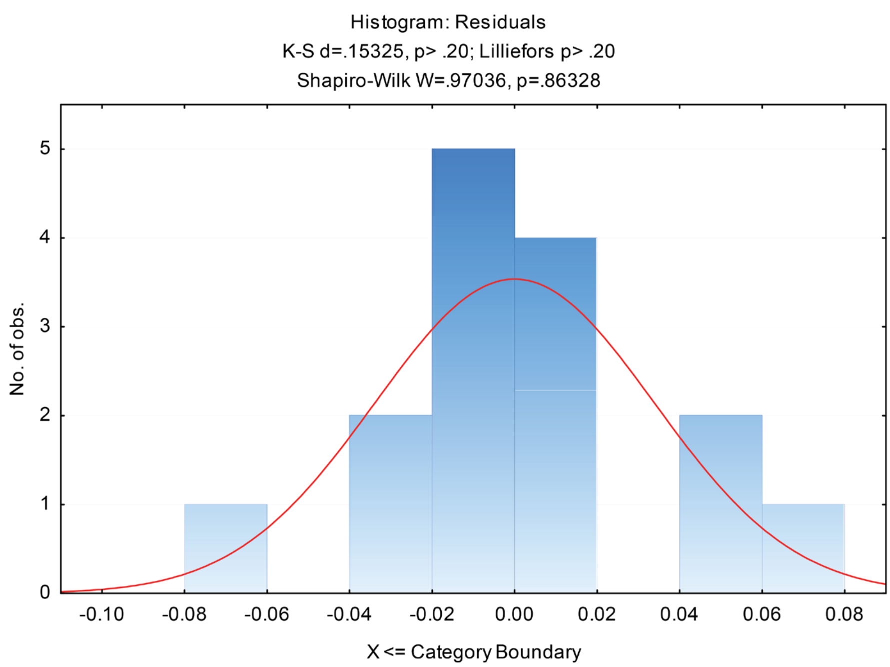


Figure 5:
The Remaining Parts Bar Chart for the Model for the Resource Recycling Influence on GDP Dynamics
Source: Compiled by the authors

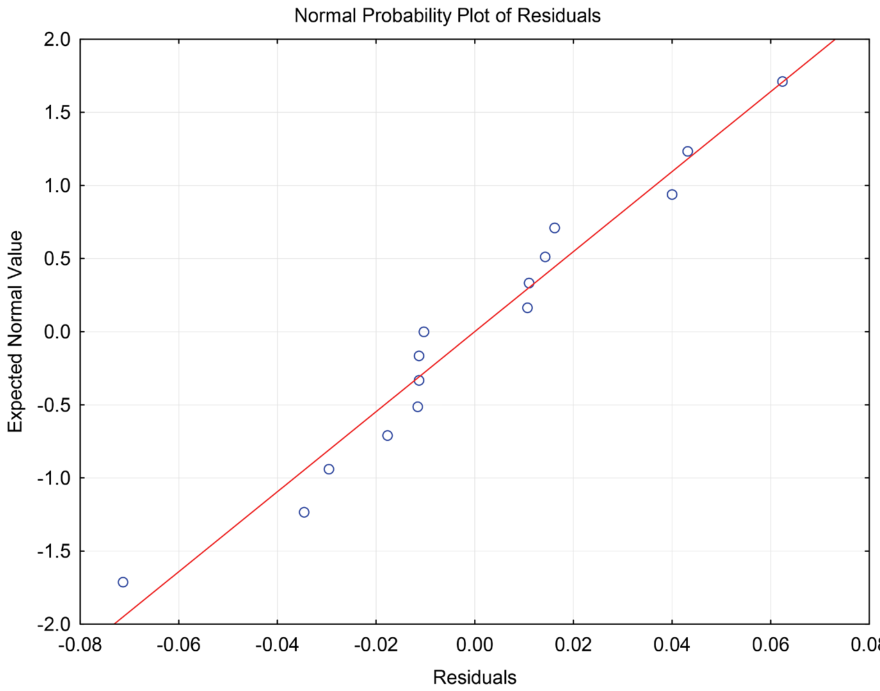


Figure 6:
Normal and Probability Chart of Remaining Parts for the Model for Resource Recycling Influence on GDP Dynamics
Source: Compiled by the authors

asymmetry and excess give reasons to state that the analysis of the remaining pats for normality was also positive.

Thus, the parameters of the model and analysis of its remaining parts give reasons to assume that the model is correct and may be used for further research and executive decision-making. The statistically significant positive correlation between industrial-scale reproduction of resources (resource recycling), on the one hand, and changes in real GDP, on the other, prove the initial hypothesis of the research.

4. Conclusion

World will need to give up its consumption-based economic growth model (for Russia it is an export-based and raw material-based model) in exchange for an investment model that requires technological advancement and the input of the recycling sector of the economy into ensuring a higher pace of economic growth based on a changed investment structure and its advanced dynamics.

Against this background, Circular Investments, initially oriented on resource conservation, maximum usage of resource waste in economic turnover, and the creation of a complex system of environmentally safe industrial and household waste management, becomes a key condition and some sort of a «pillar» for solving the complex growth dilemma. This is what provides impetus to the following positive change in the economy of the XXI century:

- Economic development that no longer depends on the consumption of raw materials;
- Reduced consumption of non-renewable sources of energy (oil, gas, coal);
- Reduced man-made environmental impact;
- Creation of new high-tech work places in the labour market;
- Amended tax system to favour environmentally sustainable production, etc.

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