# FACTORS AFFECTING THE DEVELOPMENT OF THE BIOECONOMY IN LATVIA

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**Abstract.** In the European Union, including Latvia, the development of the bioeconomy by exploiting the potential of research, innovation and knowledge transfer is considered to be the basis for economic growth. The research aims to assess the drivers of and barriers to bioeconomic development in Latvia and define actions facilitating the development of the national bioeconomy. The present research employed mostly SWOT analysis in combination with expert judgement. The research concluded that the overall trend in the following strengths of the bioeconomy: *Research infrastructure and modern technical equipment for the development of the bioeconomic knowledge base (3S) and Vast regional coverage of and cooperation among leading research institutions in the field of bioeconomics (1S)* was negative, as the total impact of the threats exceeded the total impact of the opportunities. However, the overall trend in the strength *Extensive initial activities and the knowledge base for bioeconomic research (2S)* was positive, as the total impact of the opportunities exceeded the total impact of the threats. The total impact of exogenous factors on the weaknesses in the development of the bioeconomy was positive; therefore, the total impact of exogenous factors tended to weaken the weaknesses. Since the largest positive impacts on endogenous factors were made by the following opportunities: *Effective support for independent innovation projects implemented by large companies (3O)* and *Stimulation of innovation in the small and medium enterprise sector in active synergy with national research priorities and available funding (2IO)*, it is necessary to increase government and private sector funding for R&D in order to contribute to the development of the bioeconomy in Latvia. The availability of funding should be balanced and predictable in the long term to reduce the impact of the threat *Public policies and insufficient and unpredictable funding for research and development hinder the development of bioeconomy industries and steady growth opportunities (2T)*. To encourage the business sector to invest in R&D, including in the bioeconomy industries, public support and various incentives for entrepreneurs are needed.

**Keywords:** bioeconomy, factors, SWOT analysis, impact assessment, Latvia.

**JEL code:** Q01, Q16.

## Introduction

The Council of the European Union (2020), recognizing that a sustainable bioeconomy has the potential to: (-) raise competitiveness, revitalize European industries, modernize European primary production systems, protect the environment and enhance biodiversity, (-) promote employment, social inclusion and local development in rural areas, (-) generate economic value and increase prosperity, (-) support the creation of new value chains throughout Europe, has emphasized that a sustainable and circular European bioeconomy should be one of the key elements in implementing the European Green Deal.

In Latvia, too, the bioeconomy gives opportunities for the development of the national economy based on its strongest industries – agriculture and forestry. Wood and other organic products have potential to increase added value, replace fossil fuels in energy production, develop future organic products and reduce greenhouse gas emissions (Latvian Bioeconomy Strategy 2030, 2017; Ministry of Agriculture, [s.a.]). The Ministry of Agriculture ([s.a.]) has pointed out that the bioeconomy industries have large potential for innovation, as they make extensive use of scientific advances (in life sciences, agronomy, ecology, food sciences and social sciences), basic and industrial technologies (biotechnology, nanotechnology, information and communication technology, engineering) and national expertise. The Ministry of Education and Science (2020), however, has indicated that activities aimed at ensuring sustainable growth in the bioeconomy by using research, innovation and knowledge transfer potential are especially important for

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Latvia, thereby contributing to industrial competitiveness, growth and renewal, the modernization of primary production systems, environmental protection and the conservation of biodiversity. Since 2013, the knowledge-intensive bioeconomy has been one of the fields of smart specialization in Latvia. **The object of the research** is the development of the bioeconomy by using the potential of research, innovation and knowledge transfer (hereinafter the development of the bioeconomy). **The subject of the research** is factors affecting the development of the bioeconomy.

To effectively manage a process, it is necessary to identify all potential exogenous and endogenous factors that affect its development as well as the interaction of the factors and their impacts on the development of the process; therefore, the research put forward a **hypothesis**: the impact of exogenous factors affecting the development of the bioeconomy on endogenous factors is positive, thereby contributing to the endogenous factors.

**The research aims** to assess the drivers of and barriers to bioeconomic development in Latvia and define actions facilitating the development of the national bioeconomy.

**Two specific research tasks** were set to achieve the aim: (1) to perform a SWOT analysis, which reveals the strengths, weaknesses, opportunities and threats relevant for the bioeconomy in Latvia by doing a qualitative analysis of secondary sources, (2) to assess the quantitative impact of exogenous factors affecting the development of the bioeconomy on the endogenous factors affecting it.

The present research employed mostly SWOT analysis. J. Lee has stated that "SWOT analysis is a type of contextual analysis used to present strategies based on an evaluation of internal capabilities (i.e., strategies, strengths, and weaknesses) together with exogenous factors (i.e., opportunities and threats). This type of analysis has been used to set directions and make strategic decisions in many industries. SWOT analysis has been used to present strategies for some time and continues to be used today" (Lee J. et al., 2021). SWOT analysis as a research method is employed in research in various fields, e.g. in the automotive industry (Halili Z., 2020), the space and satellite industry (Lee J. et al., 2021), the pulp and paper industry (Brunnhofer M. et al., 2020), sustainable ecotourism (Mallick S. K. et al., 2020), sustainable tourism (Chandra P., Kumar J., 2021), the sustainable forest-based bioeconomy (Falcone P. M. et al., 2020) etc.

In research, SWOT analysis is combined with other quantitative research methods, e.g. the Analytic Hierarchy Process (AHP) (Halili Z., 2020; Lee J. et al., 2021; Brunnhofer M. et al., 2020),) and the Quantitative Strategic Planning Matrix (QSPM) method (Mallick S. K. et al., 2021). Ranking the importance of different factors within a SWOT category as well as ranking alternative strategy options is optional and can be done in a qualitative as well as a quantitative way. A simple way is by a judgement of the analyser(s) involved (Rauch P. et al., 2015). In the present research, SWOT analysis was combined with expert judgement.

**The novelty of the research** is an assessment of the impact of exogenous factors affecting the development of the bioeconomy on the endogenous factors affecting it in Latvia.

**Research methodology**

The research consists of **four** successive stages. At the first stage of the research (**Data Collection**), the factors affecting the development of the bioeconomy in Latvia were identified by performing a qualitative analysis of publicly available documents or secondary sources. This stage examined:

- long-term and medium-term national policy documents (Latvia 2030, NDP 2027),

- medium-term policy documents (Guidelines for the National Industrial Policy for 2021-2027, Guidelines for the Development of Science, Technology and Innovation for 2021-2027 (draft), Latvian Bioeconomy Strategy 2030),

- an analytical report on the Smart Specialization Strategy of Latvia (RIS3), specialization in the Research Ecosystem of the Knowledge Intensive Bioeconomy (2014-2018),

- CSB data.

The research identified 21 SWOT items: 5 strengths, 6 weaknesses, 6 opportunities and 4 threats.

At the second stage of the research (**Validation of the SWOT**), the endogenous and exogenous factors affecting the development of the bioeconomy identified by the authors were validated and supplemented by **twenty national experts**: policy makers, i.e. experts authorised by the Ministry of Agriculture as well as experienced scientists and entrepreneurs from various industries of the bioeconomy. The validation of the SWOT results yielded 29 SWOT items: 9 strengths, 5 weaknesses, 8 opportunities and 7 threats. Due to the limited scope of the research, not all the identified 29 SWOT items are presented in the paper.

At the third stage of the research (**Factor Ranking**), the factors included in each category of endogenous factors (SV) and exogenous factors (ID) were ranked in order of importance. The ranking of endogenous and exogenous factors was performed by national experts in the bioeconomic field according to the methodology suggested by Rauch P. et al. (2015). After presenting and discussing the SWOT analysis, each expert individually ranked the three most important factors per SWOT category by allocating points from 3 (rank #1) to 1 (rank #3). Then all factors per SWOT category were ranked according to their score (sum of points allocated by all experts). Additionally, the most important statements within the four matrix sectors were selected, and the less relevant ones were dropped according to their score. After finalising the SWOT, each statement was coded, for example, S1 is shorthand for the highest-ranked, internal strength (Rauch P. et al., 2015).

At the fourth stage of the research (**Impact Assessment**), the quantitative impact of each exogenous factor on each endogenous factor was determined, and each exogenous factor was assigned certain impact significance **Z** for each endogenous factor. The impact significance **Z** was expressed in a five-point system according to the methodology proposed by Silinevica I. (2002): 4 points – very significant; 3 points – significant; 2 points – moderately significant; 1 point – insignificant; 0 – no impact.

The results obtained were arranged in an L-shape diagram as follows: in rows – exogenous factors, in columns – endogenous factors, taking into account their impact significance. Matrix coefficients were obtained by multiplying the significance W of exogenous factors by the significance **Z** of the impact of each exogenous factor on each endogenous factor.

The first three coefficient rows of the matrix describe the positive impacts of exogenous factors on endogenous factors, indicating opportunities for development. The last three coefficient rows of the matrix describe the negative impacts of exogenous factors on endogenous factors, indicating a threat to development.

Opportunities for and threats to development could be calculated in quantitative and comparative terms for each endogenous factor by algebraically summing the coefficients in the columns. In addition, the impacts of opportunities on endogenous factors are marked with a plus sign, whereas the impacts of threats are marked with a minus sign (Silinevica I., 2002)

**Research results and discussion**

The endogenous and exogenous factors that affected the development of the bioeconomy in Latvia were selected and ranked by the experts as follows:

- **STRENGTHS**

Research infrastructure and modern technical equipment for the development of the bioeconomic knowledge base (**3S**).

Extensive initial activities and the knowledge base for bioeconomic research (**2S**).

Vast regional coverage of and cooperation among leading research institutions in the field of bioeconomics (compared with other fields of smart specialization) (**1S**).

- **WEAKNESSES**

1) Insufficient and unpredictable government and private sector funding for research and development (**3W**).

2) Dependence of R&D on the availability of foreign (mainly EU) funding (**2W**).

3) Weak cooperation with researchers from other fields (biometrics, engineering, economics) in interdisciplinary research (**1W**).

- **OPPORTUNITIES**

1) Effective support for independent innovation projects implemented by large companies (**3O**).

2) Stimulation of innovation in the small and medium enterprise sector in active synergy with national research priorities and available funding (**2O**).

3) Ensuring the stability and sustainability of the research system and developing long-term research and innovation capacity (**1O**).

- **THREATS**

1) Insufficient replacement of scientific personnel (**3T**).

2) Public policies and insufficient and unpredictable funding for research and development hinder the development of bioeconomy industries and steady growth opportunities (**2T**).

3) The slow and fragmented development of the technology transfer and innovation system hampers productivity growth and the production and export of high value-added products by the bioeconomy industries (**1T**).

The quantitative impacts of exogenous factors on endogenous factors ranked by the experts are presented in Table 1.

Table 1

**Impacts of the most significant exogenous factors on the most significant endogenous factors affecting the development of the bioeconomy in Latvia**

| 3S | 2S | 1S | 3W | 2W | 1W | Indicator |
|---|---|---|---|---|---|---|
| 6 | 9 | 3 | 12 | 12 | 9 | **3O** |
| 4 | 4 | 2 | 6 | 6 | 8 | **2O** |
| 3 | 4 | 2 | 4 | 4 | 4 | **1O** |
| +13 | +17 | +7 | +22 | +22 | +21 | Total impact of opportunities on endogenous factors |
| 6 | 9 | 6 | 3 | 3 | 6 | **3T** |
| 8 | 4 | 6 | 8 | 8 | 6 | **2T** |
| 1 | 2 | 1 | 3 | 2 | 2 | **1T** |
| -15 | -15 | -13 | -14 | -13 | -12 | Total impact of threats on endogenous factors |
| -2 | +2 | -6 | +8 | +9 | +9 | Total impact of exogenous factors on endogenous factors |

*Source: authors' own compilation*

The results obtained (Table 1) show that:

- the strength *Research infrastructure and modern technical equipment for the development of the bioeconomic knowledge base (3S) was affected the most by the opportunities Effective support for independent innovation projects implemented by large companies (3O) and Stimulation of innovation in the small and medium enterprise sector in active synergy with national research priorities and available funding (2O), yet the most significant treat was caused by Public policies and insufficient and unpredictable funding for research and development hinder the development of bioeconomy industries and steady growth opportunities (2T).* The overall trend in the strength was negative (-2), as the total impact of the threats (-15) exceeded the total impact of the opportunities (+13);

- the strength *Extensive initial activities and the knowledge base for bioeconomic research (2S) was affected the most by the opportunity Effective support for independent innovation projects implemented by large companies (3O), yet the most significant treat was caused by Insufficient replacement of scientific personnel (3T).* The overall trend in the strength was positive (+2), as the total impact of development opportunities exceeded the total impact of the threats;

- the strength *Vast regional coverage of and cooperation among leading research institutions in the field of bioeconomics (1S) was affected the most by the opportunity Effective support for independent innovation projects implemented by large companies (3O), yet the most significant treat was caused by Insufficient replacement of scientific personnel (3T) and Public policies and insufficient and unpredictable funding for research and development hinder the development of bioeconomy industries and steady growth opportunities (2T)*. The overall trend in this endogenous factor was negative (-6);

- the most significant exogenous factors that weakened the three most significant weaknesses *Insufficient and unpredictable government and private sector funding for research and development (3W), Dependence of R&D on the availability of foreign (mainly EU) funding (2W) and Weak cooperation with researchers from other fields in interdisciplinary research (1W) were the opportunities Effective support for independent innovation projects implemented by large companies (3O) and Stimulation of innovation in the small and medium enterprise sector in active synergy with national research priorities and available funding (2O). The threat Public policies and insufficient and unpredictable funding for research*

*and development hinder the development of bioeconomy industries and steady growth opportunities (2T)* made a significant impact on the main weaknesses by exacerbating them. The total impact of exogenous factors on the three main weaknesses was positive; therefore, the total impact of exogenous factors tended to weaken the weaknesses.
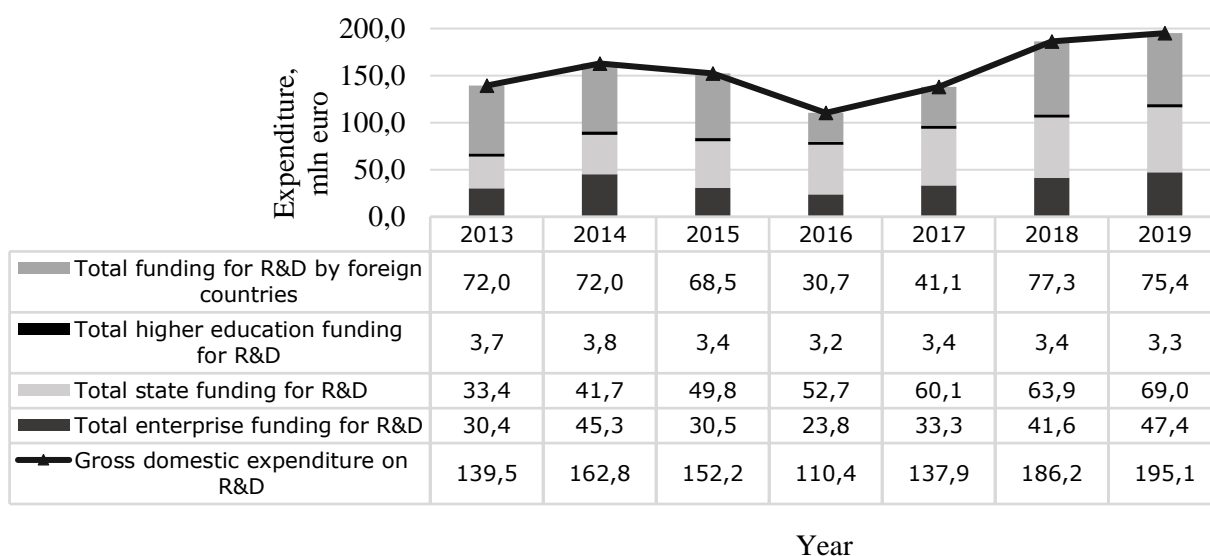
According to the expert assessment, the largest positive impact on endogenous factors were made by the opportunities *Effective support for independent innovation projects implemented by large companies (3O) and Stimulation of innovation in the small and medium enterprise sector in active synergy with national research priorities and available funding (2O).* This means that it is necessary to increase government and private sector funding for research and development in order to contribute to the development of the bioeconomy in the country. In addition, the availability of funding should be balanced and predictable in the long term in order to reduce the impact of the threat *Public policies and insufficient and unpredictable funding for research and development hinder the development of bioeconomy industries and steady growth opportunities (2T).*

The Guidelines for the Development of Science, Technology and Innovation for 2021-2027 (draft) (2020) also point to the need to increase both the proportion of public research funding and the amount of private sector investment in R&D in order to contribute the development of research excellence and innovation in the long term, as the effectiveness "ceiling" has been reached at the current investment level and higher research quality and performance could not be achieved without additional investments in R&D (incl. from the government budget).

The CSB data show that R&D intensity (i.e. investments in research and development as a percentage of GDP) in Latvia moderately increased, yet is insufficient and does not sufficiently contribute to the development of research excellence and innovation (Smart Specialization Strategy…, 2020).

In the period 2013-2019, the R&D intensity in Latvia averaged 0.59 % of GDP, reaching 0.64 % of GDP in 2019, thereby significantly lagged behind the national 2020 target of 1.5 % of GDP (Smart Specialization Strategy…, 2020).

The total expenditure on R&D was EUR 195.1 million in 2019, and compared with 2018, it increased by 4.8 % (Figure 1).



| | 2013 | 2014 | 2015 | 2016 | 2017 | 2018 | 2019 |
|---|---|---|---|---|---|---|---|
| Total funding for R&D by foreign countries | 72,0 | 72,0 | 68,5 | 30,7 | 41,1 | 77,3 | 75,4 |
| Total higher education funding for R&D | 3,7 | 3,8 | 3,4 | 3,2 | 3,4 | 3,4 | 3,3 |
| Total state funding for R&D | 33,4 | 41,7 | 49,8 | 52,7 | 60,1 | 63,9 | 69,0 |
| Total enterprise funding for R&D | 30,4 | 45,3 | 30,5 | 23,8 | 33,3 | 41,6 | 47,4 |
| Gross domestic expenditure on R&D | 139,5 | 162,8 | 152,2 | 110,4 | 137,9 | 186,2 | 195,1 |

Year

*Source: CSB, [s.a.] (table ZIG030)*

Fig. 1. **Expenditure on R&D by type of funding in Latvia in the period 2013-2019, million EUR**

The CSB data show that the increase in investment was determined by an increase in foreign funding. The main sources of foreign funding in Latvia were the EU Structural Funds. The dependence of R&D on foreign funding in Latvia was more than 2.7 times higher than that in EU innovation leaders and on average also higher than in the EU-27 (Smart Specialization Strategy…, 2020). The cyclical fluctuations in available EU structural funding do not contribute to steady and sustainable development of research human capital and continuity of research processes (Guidelines for the Development …, 2020).

Recognizing this problem and taking into account the changing availability of structural funding, allocating more funding for R&D by balancing the amounts of national and EU structural funding and increasing the amount of funding from the government budget was set as one of the priorities of Latvia in the field of science, technology development and innovation policy during the programming period 2021-2027 (Guidelines for the Development…, 2020; Smart Specialization Strategy…, 2020).

The OECD (2019) has indicated that the public sector in Latvia is insufficiently used as a customer of innovation – the government does not act as a customer of innovative, modern solutions (for example, in public procurement) –, as well as innovation capacity and opportunities to implement innovative projects are insufficiently developed. Latvia has a fragmented institutional framework for R&D and innovation support, as there are too many institutions involved in R&D support. At the stage of Validation of the SWOT, the opinions of the experts regarding the development of the bioeconomy were similar.

It should be emphasized that EU funding instruments have contributed to the development of research, technology and innovation in the thematic areas of the knowledge-intensive bioeconomy. Most research and innovation projects under EU funding programmes were implemented in crop production, animal production, forestry, biotechnology, as well as rural development. However, a small number of projects have been implemented in the field of fisheries and aquaculture (Ministry of Education and Science, 2020). The Ministry of Education and Science (2020) has concluded that despite the fact that a significant part of research personnel was employed in the bioeconomic field (about 35 % of total research personnel in Latvia), the funding attracted through various R&D financial instruments was one of the lowest among the areas of the Smart Specialization Strategy of Latvia (i.e. smart materials, biomedicine, smart energy, ICT).

The amount of private sector investment in R&D in Latvia was low and did not have a sustained positive trend. Between 2011 and 2019, the private sector investment in R&D accounted for an average of 23.4 % of total investment in R&D (0.14 % of GDP). This figure lags significantly behind the EU Member States where entrepreneurs provide more than half of the total investment in R&D (in 2018: 58.9 % in the EU-27 and 23.3 % in Latvia). Besides, the private sector investment in the higher education and science sector in Latvia was insignificant, which indicated insufficient cooperation between entrepreneurs and scientists (Ministry of Economics, 2020).

The low activity of national entrepreneurs in the field of R&D was largely influenced by structural factors: the low proportion of high and medium-high technologies in the economy of Latvia, as well as the dominance of micro and small enterprises with limited capacity to invest in research and development. Companies lack entrepreneurial skills and knowledge about the role of innovation in business development and competitiveness. The current economic and business pattern determines both a low demand for R&D by the private sector and the low R&D funding capacity of entrepreneurs (Smart Specialization Strategy…, 2020).

The business strategies of companies in Latvia are not focused on innovation. The profitability of national companies is relatively higher than the profitability of companies in Europe, yet at the same time companies in Latvia invest significantly less in productivity-related projects. At least some national entrepreneurs have free funds that could be invested in increasing productivity, which would mean lower profits in the short

term, but would significantly increase the opportunity to continue operating and successively earning in the long term, thereby ensuring the company's cross-border competitiveness (Cross-Sectoral Coordination Centre, [s.a.]).

The low level of private investment could be explained by the lack of motivation in companies (the availability of EU funding and other foreign financial instruments is considered a disproportionate administrative burden), as well as the lack of qualified labour (European Commission, 2019; OECD, 2019; Guidelines for the Development of Science, Technology and Innovation for 2021-2027, 2020)

In summary, in order to encourage the business sector to invest in R&D, public support and various incentives for entrepreneurs would be necessary, which was in line with the opinions of the experts involved in the research that the largest positive impact on endogenous factors was made by the opportunities *Effective support for independent innovation projects implemented by large companies (3O) and Stimulation of innovation in the small and medium enterprise sector in active synergy with national research priorities and available funding (2O).* The data from the Ministry of Economics (2020) also confirmed this assumption: in 2019, entrepreneurs' investments in R&D activities in Latvia increased by 13.9 %, which was affected by the measures implemented to promote innovation in state-owned companies, as well as measures to promote innovation in SMEs.

**Conclusions, proposals, recommendations**

1) The overall trend in the strengths of the bioeconomy Research infrastructure and modern technical equipment for the development of the bioeconomic knowledge base (3S) and Vast regional coverage of and cooperation among leading research institutions in the field of bioeconomics (1S) was negative, as the total impact of the threats exceeded the total impact of the opportunities. However, the overall trend in the strength Extensive initial activities and the knowledge base for bioeconomic research (2S) was positive, as the total impact of the opportunities exceeded the total impact of the threats.

2) The total impact of exogenous factors on the weaknesses affecting the development of the bioeconomy Insufficient and unpredictable government and private sector funding for research and development (3W), Dependence of R&D on the availability of foreign (mainly EU) funding (2W) and Weak cooperation with researchers from other fields in interdisciplinary research (1W) was positive; therefore, the total impact of exogenous factors tended to weaken the weaknesses.

3) Since the largest positive impact on endogenous factors was made by the opportunities Effective support for independent innovation projects implemented by large companies (3O) and Stimulation of innovation in the small and medium enterprise sector in active synergy with national research priorities and available funding (2IO), it is necessary to increase government and private sector funding for R&D in order to contribute to the development of the bioeconomy in Latvia. The availability of funding should be balanced and predictable in the long term in order to reduce the impact of the threat Public policies and insufficient and unpredictable funding for research and development hinder the development of bioeconomy industries and steady growth opportunities (2T).

4) Public support and various incentives for entrepreneurs are needed to encourage the business sector to invest in R&D, including in the bioeconomy industries.

**Acknowledgements**

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