ROLE OF INNOVATION SOURCES FOR EXTERNAL KNOWLEDGE ABSORPTION READINESS FOR LATVIAN ENTERPRISES

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Abstract. This paper investigates the role of different sources of innovation for the Latvian enterprises hindering innovation, analysing the influence of internal knowledge capabilities of the firms' readiness and the ability to absorb external knowledge sources. Despite ongoing efforts to foster innovation, Latvian firms face significant structural challenges, which limit their ability to keep pace with regional competitors. The study addresses two key hypotheses: (1) internal knowledge and competencies are critical for driving innovation, and (2) firms with well-developed internal R&D and personnel development activities are more successful in integrating external knowledge from universities and other partners. The research involves a comparative analysis using the Eurostat innovation survey data on the Baltic states, and Finland and, and available literature. The findings highlight that Latvian firms, like government, compared to their Baltic counterparts, invest less in R&D and rely more on incremental innovations driven by external equipment suppliers, rather than on internally developed technological solutions. The analysis suggests that firms with stronger internal capabilities are better positioned to benefit from external collaborations and achieve higher innovation outcomes. The paper concludes with policy recommendations aimed at strengthening the co-networking and co-innovation interactions within the national innovation ecosystem through a systemic approach. This includes fostering firm-level new knowledge absorption readiness and performance both in-house and external, promoting in a long-term firms' innovation culture and competitiveness via investment in R&D, and deeper collaboration between enterprises and external knowledge providers. Without a coordinated and sufficiently resourced knowledge-based policy framework, the existing innovation gap between Latvia and its regional neighbours is likely to widen further, slowing down economic growth.

Keywords: innovation ecosystem, knowledge absorption, knowledge sources.

1. Introduction

The innovative performance of companies – and consequently, their competitiveness in both domestic and international markets – depends on their employees' ability to perceive ongoing technological changes in the present and future, select the necessary changes and resources for their company, make timely decisions, and initiate mature transformations. Additionally, it hinges on their competence and knowledge to adapt selected technologies in alignment with strategic goals or sub-goals [1]. If we define an individual's *skills* as the ability to effectively and effortlessly apply their knowledge to accomplish a specific task [2], then, within the scope of this study, we define *talent* as a combination of innate and lifelong-developable individual values [3-6].

The developable talent approach [3] suggests that anyone can learn, adapt, or acquire skills and knowledge to excel in a particular environment depending on their potential [7; 8], which can be systematically developed through intensive effort and training, leading to enhanced abilities and skills [9]. However, only a small portion (~10%) of a company's talented employees achieve truly top-tier performance [4; 10; 11], and their role is crucial in internal innovation processes [12; 13]. In literature, *knowledge* is defined as an object, a process, a state of mind, or a capability [14]. In this study, we define *knowledge* as "facts, information, and skills acquired through experience or education" [2]. Knowledge is systematically derived from data and information. Data, when organized in a user-friendly manner and subsequently processed, becomes information, which, if absorbed, understood, and applied by individuals, transforms into knowledge [15]. Ukrainski [1; 16] describes knowledge as a stream of information that can supplement, restructure, or modify existing knowledge. Although a "strong connection" and causal link from information to knowledge are generally accepted, this notion is criticized primarily on two points: (1) in cases of incomplete or inaccurate datasets, information and knowledge may be loosely connected or even separate (meaning that different agents can derive distinct or even contradictory knowledge from the same information), and (2) the nature of information differs, as it consists of a closed dataset, whereas knowledge is indefinite [17].

Knowledge can be acquired individually or collectively [18]. Dosi [19] defines the term *knowledge base* as "a set of informational inputs, knowledge, and capabilities that inventors utilize in their search for innovative solutions." Theories of collective knowledge view companies as knowledge repositories.

In microeconomics, the distinction between knowledge and information, as well as between various information sources, is not considered significant; information is regarded as a production input, with decisions made based on price and cost considerations. Traditional theory does not differentiate between specific categories and sources of knowledge, treating them as interchangeable [14].

In this study, we do not further explore the nature and role of different types of knowledge but instead consider the concept of knowledge at a highly generalized level as a production input, characterized solely by cost/price factors. Therefore, different types of knowledge are interchangeable [18], and can be absorbed from various sources (both internal and external) without further refinement, except within the framework of a limited choice set. It is also common to consider part of the knowledge embedded in artifacts as a residual or unexplained part of the production function [14].

Since individuals face limitations in their decision-making, companies use decision-making rules and procedures to guide their actions, and these routines explain corporate behavior [14]. In their approach, a company functions as a knowledge repository, shaped by its history (through routines where knowledge is stored) and by the factors that differentiate one company from another [17]. A company searches for various alternatives in problem-solving activities and selects them according to its routines.

Companies with higher collective competence can significantly reduce costs, offer superior product performance quality, achieve better alignment between product features and consumer needs, and develop the skills required to adopt new products or technologies [14]. Over time, firms accumulate dynamic skills, which play a crucial role in leveraging technological opportunities or competitive advantages, allowing them to improve in real time [20].

Innovation is the ability to utilize knowledge to develop, deliver, and scale new products, services, processes, and business models for customers [1]. SMEs predominantly focus on incremental product or process innovations, whereas resource-intensive radical (also revolutionary) innovations are mostly undertaken by large corporations. In the short term, incremental innovations have approximately four times the economic impact compared to radical innovations. A significant portion of radical innovations in products or processes may result from the cumulative effect of numerous small or incremental changes, with inventors often unable to reliably recall specific events or sources [1]. However, the knowledge required for these incremental innovations can be highly complex and diverse [21].

Training plays a crucial role in innovative activities, where traditional knowledge is applied in new ways, considering alternatives and various knowledge transfer channels. Two types of knowledge must be considered: tacit or implicit knowledge is knowledge that is difficult to extract or articulate, which consists of personal or group experience and ways of thinking, but explicit, by contrast, refers to conceptualized, formalized, codified data [18].

Tacit knowledge is acquired from both internal and external sources through personal interaction or movement processes, also referred to as an absorption process, where individuals exchange experiences or examples [22] to solve both practical and theoretical problems [23]. Regardless, personnel and the company's overall internal knowledge are significant and can be categorized into several types: knowledge about materials and components, design practices and solutions, technical principles of operation, experimental R&D development, final product characteristics, specialized knowledge, and more [14]. Internal knowledge holds the most value, as acquiring external knowledge requires certain internal competencies, including absorptive capacity [24] and [25]. Internal knowledge is necessary for identifying, selecting, acquiring, and utilizing external knowledge beyond the company's boundaries.

Specialized knowledge [26; 25] is particularly important for R&D and core design activities [27]. The utilization of external knowledge and technology is characterized by absorptive performance [24]. External knowledge sources can include various entities: business partners, clients and product users, suppliers, competitors, associations, collaborative entities, consultants, universities, and R&D institutes.

A literature analysis has been conducted, available in Eurostat CIS data [28] and methodology performed by Kadri Ukrainski in her PhD work [14] allow to formulate two main hypothesis.

- H01: Internal knowledge sources (within the company) are highly significant for innovation processes in Latvian enterprises across various industries.
- H02: Companies with strong internal research and development (R&D) capabilities and employee development activities can absorb external knowledge more effectively.

2. Materials and methods

We carried out an extensive literature review starting with the sources on education systems and innovation ecosystems of around 100 papers and after investing an effort at the first stage, we analysed more than 30 new items concerning innovation sources in Latvia. The papers reflect conceptual and empirical studies, qualitative research, case studies, providing aggregate statistics and data analysis. The methodological challenges in our study were twofold. Firstly, we tried to assemble and aggregate conclusions from available in literature studies to obtain better and deeper understanding in consequences on external knowledge absorption and their adoption as well as the role of digital technologies in the innovation process of local SMEs. Secondly, we tried to compare conclusions made analysing Latvia's, Estonia's, Lithuania's, Poland's (only for company trends) and Finland's SMEs' competitiveness and obtaining understanding about the difference between sources of innovation and the community school based on innovation ecosystem model approach.

In this study, empirical data from several consecutive Community Innovation Surveys (CIS) – "CIS 2008–2010" and respectively for years "2010-2012", "2014-2016", "2016-2018", "2018-2020", "2020-2022" and 2022-2024" are used [28]. These surveys are generally based on the same methodology, respectively, developed by the European Commission and Eurostat and were conducted by the Central Statistical Offices in all EU countries, including the Central Statistical Bureau (CSB) of Latvia and, general economic indicators for Latvia collected by CSB of Latvia in its Electronic Database. Not all surveys cover all data sections of interest to the study in all periods. Sources of innovative information were reviewed in the 2016 survey, but the trends for firms we analysed for the period 2008-2022, for R&D activities - for 2016-2022.

3. Results and discussion

Importance of internal and external knowledge

In Latvia, as in Estonia, internal knowledge within companies is a significant factor in innovation development. Innovations are often based on employees' competencies, research and technological development processes, as well as the knowledge and skills accumulated within the company. The effective utilization of internal resources largely depends on the strategic decisions of management and their ability to mobilize the company's potential for innovation.

Ukrainski [14] has emphasized the importance of internal knowledge sources in business competitiveness and innovation processes in her research. The Eurostat data indicate that in the Baltic states and Finland, the primary sources of innovation are the companies themselves, as well as technology suppliers providing equipment and materials [28] (Eurostat, 2012–2020).

Table 1

Expenditures in 2020 of innovative enterprises by area of expenditure, ths EUR [28]

Expenditure	Country			
	Estonia	**Latvia**	**Lithuania**	**Finland**
Expenditure on innovation (including R&D)	856 618	162 371	1 528 743	6 797 635
Expenditure on R&D activities	356 200	64 271	295 883	5 550 073
Expenditure on R&D performed in-house	304 326	55 326	272 053	4 770 420
Expenditure on R&D contracted out	51 875	8 945	23 830	779 653
Expenditure on innovation (excluding R&D)	500 418	98 099	1 232 859	1 247 561
Own personnel working on innovation	50 545	33 138	88 542	467 362
Capital goods for innovation (acquisition of machinery, equipment, software, IPRs, buildings, etc.)	391 134	43 500	1 069 487	388 534
Services, materials, supplies purchased for innovation	27 005	21 461	74 830	391 666

Table 1 shows that Finnish companies invest the most in in-house R&D, followed by new machinery and equipment purchases. In contrast, the Baltic states prioritize investments in innovative equipment, while external R&D spending remains minimal, except in Finland, where it is significant.

Latvia and Finland allocate a larger share to personnel development, and R&D importance is growing. Companies engaging in R&D activities are more receptive to external knowledge. Studies suggest that the impact depends less on industry specifics and more on the scale and continuity of R&D projects in recent years.

The data presented in Table 1 and Table 2 provide a comparison of investments in innovation by innovative enterprises in the Baltic states and allow for the following conclusions:

1. Product and process innovative firms in Estonia exhibit lower usage of information for their innovation activities than those in Latvia and Lithuania, possibly due higher performance using such channels as conferences, trade fairs and exhibitions, and professional industrial associations (CIS2016 data are missing. CIS2018 data show% of total firms acquiring relevant information for innovation for EE and LT respectively, as%: 67.4 and 58.3; 40.8 and 33.9) [28].
2. Latvian companies invest less in innovation compared to Lithuanian and Estonian firms, which can be partly explained by a more conservative management approach, a less developed innovation culture, and a limited share of high-tech and startup enterprises in the economy.
3. Finnish companies invest more in R&D, both internally and through collaboration with external partners, due to a more developed innovation ecosystem and a higher-quality education system.
4. Investments in new machinery and equipment dominate in the Baltic states, particularly in Lithuania, fostering incremental and process innovations. In Latvia, foreign investors tend to value low labour costs rather than innovation potential.
5. Companies with stronger internal R&D and personnel development are more likely to rely on their internal knowledge for innovation and can more effectively absorb and adapt external knowledge, creating a favourable environment for collaborative innovation projects.

Firms with strong internal R&D and personnel development tend to rely more on internal knowledge for innovation. However, robust internal capabilities also enhance technology absorption and facilitate the adoption of external knowledge, fostering a collaborative innovation environment.

Table 2

Product and/or process innovative enterprises in 2016 which used information for their innovation activities, by source of information, level of importance of the source is high, selected NACE Rev. 2 activity (2016), *%* [28]

Sector	Country	Enterprises within the enterprise group	Suppliers of equipment, ma-erials, comp. or software	Clients or customers, private sector	Clients or customers, public sector	Competitors of the same sector	Universities or other HEIs	Public research institutes	Conferences, trade fairs or exhibitions
All sectors	LVA	51.7	28.6	18.7	12.8	19.5	5.1	3.2	22.4
	EST	14.1	19.0	5.4	17.1	10.2	3.3	1.8	6.8
	LTU	47.9	28.6	20.0	7.8	17.7	5.6	4.2	17.1
	FIN	62.1	22.6	24.8	9.2	8.8	4.5	3.2	9.4
Manufacturing	LVA	49.3	26.3	16.6	9.4	16.5	4.9	2.9	22.9
	EST	12.7	23.3	4.0	16.1	11.2	2.9	1.5	6.6
	LTU	43.4	30.4	17.6	7.3	15.1	4.8	4.4	21.3
	FIN	60.5	27.4	27.1	6.4	7.9	4.4	2.8	10.2
Manufacture of food products; beverages and tobacco	LVA	55.3	24.1	22.1	16.8	24.0.	3.2	3.2	22.4
	EST	15.7	30.7	7.1	21.3	14.2	4.7	7.1	11.8
	LTU	44.6	39.6	30	8.5	27.3	10.8	13.1	25.0
	FIN	62.8	39.8	34.1	6.5	2.7	3.4	2.3	13.8
Manufacture of computer, electronic and optical products	LVA	80.4	32.6	26.1	13.0	26.1	13.0	6.5	60.9
	EST	20.7	17.2	3.4	13.8	3.4	6.9	0	3.4
	LTU	61.0	29.3	24.4	0	12.2	12.2	4.9	34.1
	FIN	80.6	26.6	34.7	12.1	12.9	8.1	2.4	2.4
Manufacture of machinery and equipment	LVA	64.4	22.6	0	0	8.4	4.2	0	37.7
	EST	11.5	11.5	0	15.4	3.8	0	0	7.7
	LTU	49.0	23.5	9.8	2.0	9.8	0	0	33.3
	FIN	62.6	25.8	43.8	8.1	14.8	5.5	5.8	11.0
Computer programming, consultancy	LVA	80.8	44.0	33.4	33.4	27.8	9.4	5.5	20.7
	EST	18.8	18.8	15.6	45.8	8.3	6.3	1.0	15.6
	LTU	63.1	20.8	34.2	12.8	14.1	17.4	12.8	19.5
	FIN	82.3	10.9	41.3	19.2	15.3	6.0	4.8	15.5

This can be illustrated by Table 2. Companies obtain the most valuable information for innovation from their internal R&D, technology development, and product development departments, especially in Finland. The second most important source is equipment and material suppliers, which dominate in the Baltic states, where innovation relies more on external solutions. Finland, with higher labour costs, invests more in next-generation equipment, while motivation for such investments is lower in the Baltic states. Latvian companies utilize available information sources less than their Baltic and Finnish competitors, primarily due to insufficient investment in science and higher education over the past 30 years. This has resulted in lower R&D sector performance and slower technological advancement. Sector analysis (manufacturing, IT, electronics, etc.) does not reveal significant differences in innovation approaches between the Baltic states and Finland. A general observation from Table 2 is that:

1. The higher the level of technology used in a company and the greater the annual R&D investment, the better the company performs in terms of exports, productivity, innovation, and competitiveness.
2. Table 2 shows that innovative companies are more effective in utilizing all information channels analyzed in the Eurostat survey across all countries, compared to non-innovative companies.
3. In Latvia, the role of suppliers as a source of innovation information is significantly greater in the IT sector compared to Lithuania and Estonia.

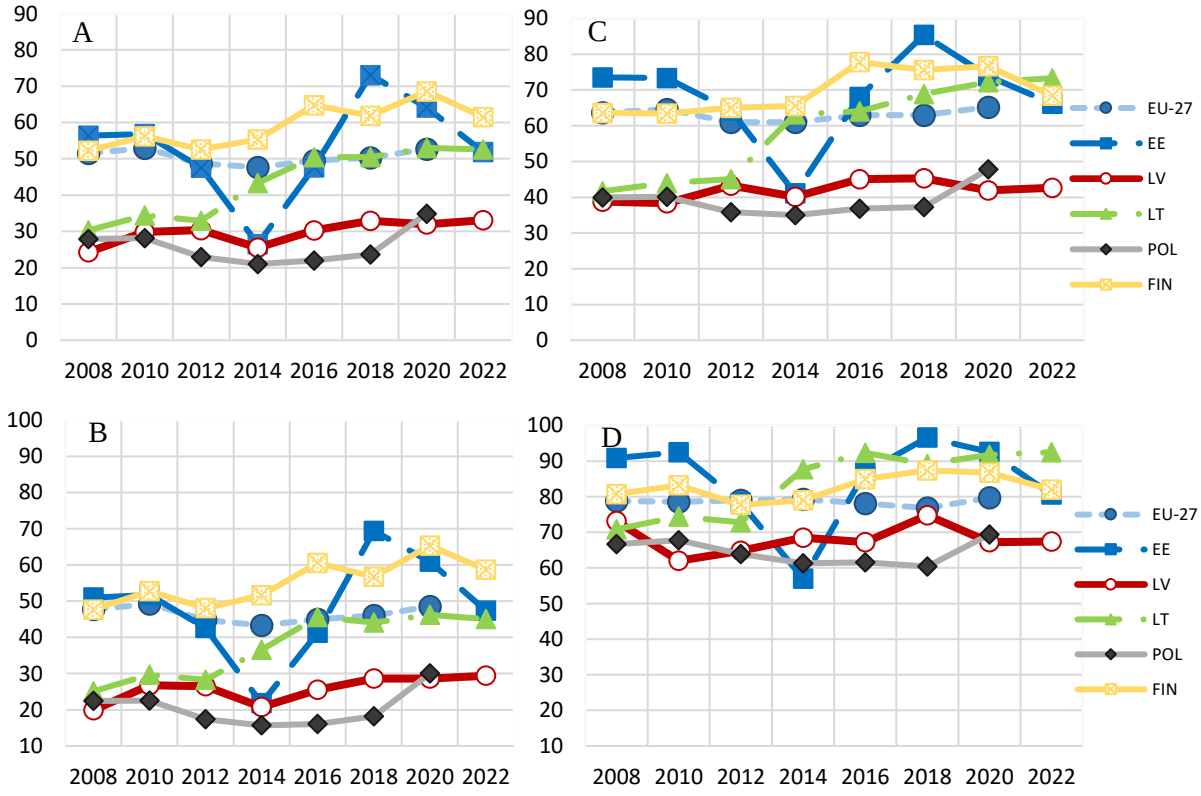

Fig. 1. **Share of innovative enterprises, % in the Baltic states and selected EU countries:** A – by year in total; B – firms with 10-49; C – firms with 50-249; D – firms with 250 + employees; source – Eurostat innovation surveys 2008-2022 [28]

The Baltic states patent less and struggle with commercializing their intellectual property compared to Finland [28]. However, Lithuania stands out in areas like social media and crowdsourcing. No specific data on information channels for innovation are available for Latvia (Eurostat 2018), but its figures are likely similar to those of the other Baltic states. Companies engage in various innovation activities, often combining product and process innovations, while “soft” innovations remain less common. Firms that collaborate with competitors or educational institutions tend to share knowledge more actively. Clients mainly receive product design insights, while suppliers provide technical details on machinery and materials (see Table 2, [28]). Other partners contribute market insights, equipment know-how, certification, and regulatory knowledge. Unlike traditional innovation systems, which rely on one-way knowledge flow, Innovation Ecosystems (IES) foster two-way knowledge exchange [29], allowing for role reversals between partners. The greater the dual involvement of stakeholders, the broader and more

impactful the innovation benefits. This model is more advanced in Finland, while Latvia and the Baltic region remain in its early stages, with some variations across countries. H01 is confirmed.

Conclusion on the importance of two-way information exchange – the more effectively an innovation ecosystem functions, the more actively knowledge and information flow bidirectionally, fostering interaction and leading to greater returns from adopted external knowledge. We will examine this in the context of H02 as the first hypothesis examined the role of internal knowledge in innovation. The second hypothesis will assess the impact of external knowledge sources on Latvian firms.

Fig. 1 shows that small enterprises play a key role in social stability by creating jobs, yet their share of innovative firms is the lowest. Latvia's average innovation rate is only slightly above that of SMEs with 10-49 employees (Fig. 1B), making this group a significant factor in national figures. Larger companies (50-249 in Fig. 1C and 250 + employees in Fig.1D) have a higher share of innovative firms, which is expected, as greater revenue enables more investment in innovation.

From Fig. 1 A-D, the following conclusions can be drawn [28]:

1. Latvia has the lowest share of innovative enterprises among the EU-27 and selected countries. In 2022, 33.1% of Latvian firms were innovative, compared to 52.6% in Lithuania and Estonia, and 61.5% in Finland – nearly twice as much as in Latvia.
2. This trend remains consistent over time across all company sizes, with only Poland showing lower figures in some years.
3. Fig. 1B-D shows that Lithuania leads in innovation among mid-sized (50-249) and large (250+) firms, while in the small business segment (10-49 employees) it lags behind Finland but has caught up with Estonia.
4. Between 2008 and 2022, Lithuania experienced strong growth in innovation, whereas Latvia's progress has been slower, with only minor increases.

Among large enterprises (250 + employees, Fig.1D), country differences are minimal, with Estonia occasionally surpassing Finland. Innovation processes are reflected in distinct innovation events, including product and process innovations, though their significance varies for firms. Fig. 2 shows that Poland has overtaken Latvia, placing it last among analysed countries. Finland consistently leads, while Lithuania, despite a weaker starting position in 2008, showed rapid growth between 2014-2020. In 2022, the share of product-innovative firms was 14.8% in Latvia, 23.6% in Lithuania, and 29.9% in Estonia (see Fig. 2B).

Regarding process innovations, 79% of firms focused on major technological improvements, while all implemented minor upgrades. Organizational innovations appeared in 32% of firms, marketing innovations in 26%, and 16% introduced IT-related improvements. Further analysis is needed on external knowledge sources for product and technological process innovations.

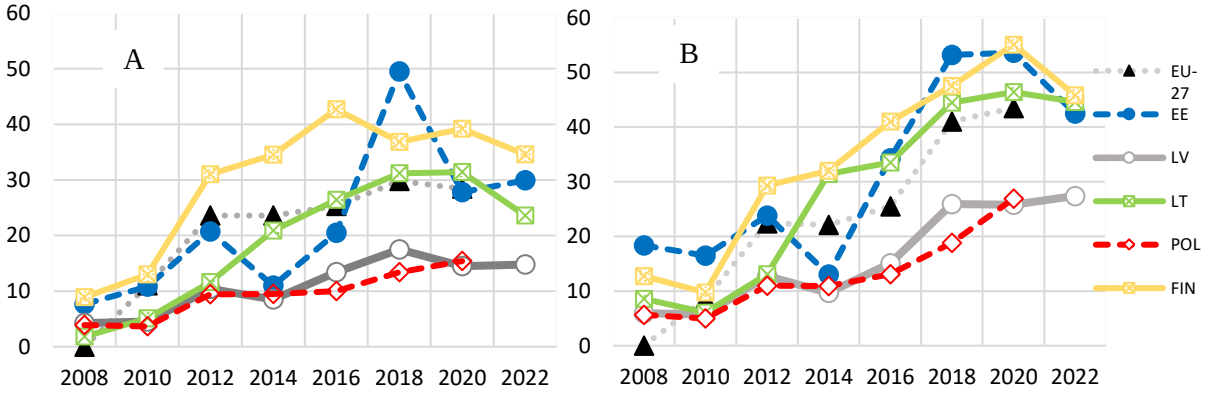

Fig. 2. **Share of product innovative (A) and process innovative (B) firms from total in Baltic and selected EU countries:** source – Eurostat innovation surveys 2008-2022 [28]

Innovative Baltic firms with strong internal knowledge absorption resources engaged more with external partners. This trend could benefit small Latvian businesses seeking to innovate by combining internal strengths with external expertise from consultants, suppliers, clients, or academic institutions.

Data in Figure 2 show that key business partners for product and process innovation in Estonia, Lithuania, and Finland include suppliers, private and public sector clients, and competitors. In Latvia, industry associations also play a significant role as information sources for innovation. Other sources were rarely mentioned; in Estonia, 53% of firms attempted collaboration with universities, but in most cases, it was too general to impact innovation or was even considered unsuccessful by half of the managers [14].

Customers play a key role in product innovation, as companies with higher sales of new-to-market products tend to engage more in knowledge exchange with them. This suggests a strategic approach to high-level innovation while minimizing risks through cooperation [14; 30; 31]. Notably, suppliers are also recognized as important contributors to product development alongside customers, though this is less relevant for the wood industry. While product and process innovations are closely linked, they rely on different knowledge sources, as acknowledged by 37% of managers surveyed in Estonia [14].

Fig. 2 confirms that process innovations have grown rapidly in recent years across the Baltic states and selected EU countries. Data from H01 in Table 2 show that in Latvia and Lithuania, the majority of innovation expenditures go toward acquiring capital goods such as machinery, software, and IPR assets. These investments enhance production efficiency and overall business performance, driving faster growth. However, Latvia's share of process-innovative firms (27.2%) lags behind Lithuania, Estonia, and Finland, where the average is around 45% (Table 2). Additionally, process innovations often involve software, data exchange, marketing, and organizational improvements, as well as evolving skill requirements for employees. Latvia has the lowest share of firms innovating in business and organizational processes (15.3%), compared to 23.1% in Lithuania and 33.8% in Estonia [28].

Trends in the share of product and process innovative firms in the Baltic states and the EU clearly highlight Latvia's lag. Growth is slower, divergence is increasing, and the gap continues to widen. This reflects a broader stagnation pattern – companies with weak internal innovation capacity struggle to absorb external knowledge and expertise effectively. A company's ability to leverage internal knowledge and innovation competence determines its readiness to absorb external knowledge and technology. In Latvia's low-cost, low-tech, low-export, low-productivity economy, firms primarily imitate and adapt rather than effectively absorb incremental innovations. While some exceptions exist, companies often struggle to translate observed opportunities into market-driven growth. This challenge was already highlighted by the World Bank experts in 2003 [32]. In the 5.0 innovation model, universities should play a key role as regional innovation drivers. Therefore, it is essential to analyze university-industry collaboration and the challenges in absorbing academic knowledge into innovative enterprises in Latvia (see Fig.3 and Table 2).

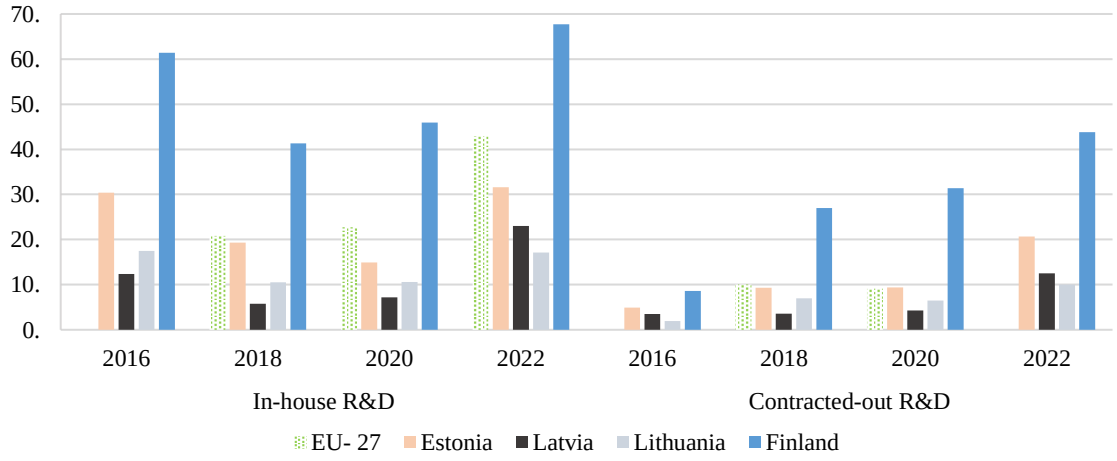

Fig. 3. **Enterprises with research and development (R&D) activities, % from total:** source – Eurostat innovation surveys 2016-2022

While more than 30% of firms in Estonia (62.1% in Finland) recognize internal knowledge as a primary innovation source, only ~10% of Latvian firms do so (see Fig. 3), relying instead on suppliers (28.6%) and public/private sector clients (31.5%) (see Table 2). This suggests a weak awareness among Latvian entrepreneurs about where to seek critical innovation-related information. As a result,

consultants, government institutions, universities, and research institutes play a minimal role in fostering innovation. Fig. 3 highlights a link between in-house R&D and outsourced research. Countries like Finland with greater internal R&D investment also engage more in contracted research. Latvia ranks the lowest in performing contracted-out research for period 2018-2022, while Lithuania has improved performance since 2018.

Several authors highlight that in small countries like Estonia and Latvia, grant funding accounts for 70-90% of total research financing [33; 34]. This forces researchers to operate like quasi-businesses, competing in every available call [35]. Such a system threatens university sustainability and limits their ability to achieve long-term societal goals. In Latvia, short-term contracts dominate the academic sector, as research grants remain the primary funding source. Most scientists face job insecurity, uncertain if they will receive funding or salaries next year. Strict work-hour limits (160 hours per month) prevent proper tracking of preparation, administrative, and teaching-related tasks. University administrations often only count in-class teaching hours, disregarding preparation time [34]. These issues should be further analysed in the next research project. Another cyclical challenge is the dependency of EU SF-funded research on slow bureaucratic planning by ministries and policymakers. Typically, 2-3 years pass before new EU funding cycles translate into available grants, delaying project implementation. Consequently, established firms often opt for bank loans instead, despite repayment obligations, to avoid excessive bureaucracy and administrative burdens [34].

Overall, it can be concluded that H02 is confirmed, and Latvia significantly lags behind other Baltic states (Table 2) in its ability to absorb and adapt both internal and external information, as well as publicly available documented or academic knowledge. Latvian enterprises lag their Baltic and Finnish counterparts in internal knowledge development and external knowledge absorption, with only 33.1% classified as innovative in 2022, compared to 52.6% in Lithuania and Estonia, and 61.5% in Finland. Latvian firms rely heavily on external equipment suppliers for innovation, while internal R&D investment remains low. Finnish firms prioritize in-house R&D, whereas Latvian companies focus on capital goods acquisition, reflecting an incremental innovation strategy that limits long-term competitiveness. Larger firms (50-249 and 250 + employees) demonstrate higher innovation activity, while small enterprises (10-49 employees) contribute to social stability but innovate less. Lithuania has shown stronger innovation growth since 2016, whereas Latvia's progress remains slow. University-industry collaboration is weak, with firms seeking knowledge primarily from suppliers (19%) and clients (22.5%), while only 14.1% cooperate with academia.

Findings confirm hypothesis H02, showing that firms with strong internal R&D and personnel development better absorb external knowledge. Latvian firms lacking internal capabilities struggle to integrate external expertise. Process innovations have grown in the Baltic states, but Latvia's share of process-innovative firms (27.2%) remains below the regional average of 45%. Business process and organizational innovation rates are also the lowest, at 15.3%, compared to 23.1% in Lithuania and 33.8% in Estonia. Latvia faces structural weaknesses in R&D funding, with heavy reliance on competitive grants. This creates financial instability in universities and hinders business collaboration.

Conclusions

1. Latvia significantly lags behind Baltic and Finnish firms in innovation intensity, internal R&D investment, and external knowledge absorption.
2. Large firms exhibit stronger innovation activity, while small enterprises contribute to social stability but show lower innovation rates.
3. Latvian firms rely more on external equipment suppliers than on internal technological development, resulting in incremental rather than breakthrough innovations.
4. University-industry collaboration is weak, with firms primarily seeking innovative knowledge from suppliers and clients rather than academia.
5. Structural funding weaknesses and short-term contracts in R&D create financial instability in universities, discouraging long-term innovation development.

Future research should explore policy interventions that strengthen Latvia's innovation ecosystem, promote deeper industry-academia collaboration, and enhance internal R&D capabilities to foster sustainable growth.

Author contributions

Conceptualization, V.B.; methodology, A.O. and V.A.; validation, A.O.; formal analysis, all authors; investigation, A.O., V.A.; data curation, A.O., writing – original draft preparation, A.O.; writing – review and editing, all authors; visualization, A.O.; project administration, V.A.; funding acquisition, E.G.-S. All authors have read and agreed to the published version of the manuscript.

References

[1] Tidd J., Bessant J.R Managing innovation: integrating technological, market and organizational change. Seventh edition, Hoboken, John Willey & Sons, Inc., 2021.
[2] Oxford University Press. In: Oxford English dictionary. [online] [30.12.2024]. Available at: https://www.oed.com/information/about-the-oed/
[3] Meyers M., Woerkom M., Dries N. Talent - innate or acquired? Theoretical considerations and their implications for talent management, Human Resource Management Review, vol.23, Issue 4, 2013, pp. 305-321. DOI: 10.1016/j.hrmr.2013.05.003
[4] Meyers M., van Woerkom M. The influence of underlying philosophies on talent management: Theory, implications for practice, and research agenda, Journal of World Business, vol. 49, 2014, pp. 192-203.
[5] Weiss A., Mackay N. The talent advantage: How to attract and retain the best and the brightest, New Jersey: John Willey & Sons, Inc., 2009.
[6] Ulrich D. The talent trifecta, Development and Learning in Organizations, Vol. 22 No. 2., 2008. DOI: 10.1108/dlo.2008.08122bad.003
[7] Avotins V., Sloka B., Jarohnovich N. Global talent war: differences in small emerging country. Proceedings of the 15th Int.Sci.Conf. Engineering for rural development. Latvian University of Agriculture, Faculty of Engineering, Jelgava, vol.15, 2016, pp.1230-1237. [online] [19.03.2025]. Available at: https://www.iitf.lbtu.lv/conference/proceedings2016/Papers/N243.pdf
[8] Vinkhuyzen A., van der Sluis S., Posthuma D., Boomsma D. The heritability of aptitude and exceptional talent across different domains in adolescents and young adults, Behavior Genetics, vol. 39, 2009, pp. 380-392.
[9] Gallardo-Gallardo E., Dries N., Gonzales-Cruz T. What is the meaning of "talent" in the world of work?, Human Resource Management Review, vol.23, Issue 4, 2013, pp.290-300. DOI: 10.1016/j.hrmr.2013.05.002
[10] Groysberg B., A. Nanda A., Nohria N. The risky business of hiring stars, Harvard Business Review, vol. 82, No. 5, 2004, pp. 92-100.
[11] Docquier F., Marfouk A. International migration by education attainment 1990-2000, Release 1.1. International Migration, Remittances & the Brain Drain, G. Ozden un M. Schiff, Red., Washington, World Bank and Palgrave Macmillan, 2006, pp. 151-199.
[12] Beechler S., Woodward I.C. The global "war for talent". Journal of International Management, vol.15, 2009, pp.273-285. DOI: 10.1016/j.intman.2009.01.002
[13] Ulrich D., Smallwood N. What is talent?, Leader to leader, vol. 63, 2012, pp. 55-61.
[14] Ukrainski K. Sources of knowledge used in innovation: an example of Estonian wood industries. PhD Dissertation, Tartu University Press, 2008, 265 p.
[15] Bolisani, E., and Bratianu, C. (2018). The elusive definition of knowledge.In Bolisani, E. and Bratianu, C. (2018). Emergent knowledge strategies:Strategic thinking in knowledge management (pp. 1-22). Cham: Springer International Publishing. [online] [20.04.2025] Available at: https://www.researchgate.net/publication/318235014_The_Elusive_Definition_of_Knowledge.
[16] Ukrainski K., Kanep H., Timpmann K. Developing Research Organisations Towards Knowledge Triangle with Project Funding Instruments: An Example from Estonia. In: Meissner D., Gokhberg L., Kuzminov Y., Cervantes M., Schwaag Serger S. (eds) The Knowledge Triangle. Science, Technology and Innovation Studies. Springer, Cham., 2021. DOI: 10.1007/978-3-030-81346-8_7
[17] Buckley P.J., Carter M.J. Governing knowledge sharing in multinational enterprises. Management International Review, vol.43, No.3, 2003, pp.7-25. [online] [20.04.2025]. Available at: https://www.jstor.org/stable/40835965

[18] Kimmerle J., Cress U., Held C. The interplay between individual and collective knowledge: technologies for organisational learning and knowledge building. Knowledge Management Research & Practice, vol.8, Issue 1, 2010, pp. 33-44. DOI: 10.1057/kmrp.2009.36
[19] Dosi G. Sources, Procedures and Microeconomic Effects of Innovation, Journal of Economic Literature, vol.26, 1988, pp.1120-1171.
[20] Nguyen D. How firms accumulate knowledge to innovate - an empirical study of Vietnamese firms. Management Decision, vol.60, Issue 5, 2021, pp.1413-1437. DOI: 10.1108/md-11-2020-1546/full/html
[21] Houessou A.M., Aoudji A.K.N., Biaou G., Floquet A. Tacit knowledge acquisition and incremental innovation capability: proximity perspective. Journal of Open Innovation: Technology, Market, and Complexity, vol.9, Issue 3, 2023, 100085, 13 p. DOI: 10.1016/j.joitmc.2023.100085
[22] Castaneda D.I., Cuellar S. Knowledge sharing and innovation: a systematic review. Knowledge and Process Management, vol.27, Issue 5, 2020, pp.1-15. DOI: 10.1002/kpm.1637
[23] Lundvall B.-Å. The Economics of Knowledge and Learning, pp. 21-42 in Christensen J.L., Lundvall B.-Å., (Eds.), Product Innovation, Interactive Learning and Economic Performance, London: Frances Pinter, 2004.
[24] Koch A., Strotmann H. Absorptive capacity and innovation in the knowledge intensive business service sector. Economics of Innovation and New Technology, vol.17, Issue 6, 2008, pp.511-531. DOI: 10.1080/10438590701222987
[25] Dosi G. Sources, Procedures and Microeconomic Effects of Innovation, Journal of Economic Literature, vol.26, 1988, pp. 1120-1171.
[26] Pavitt K. Sectoral Patterns of Technical Change: Towards a Taxonomy and a Theory, Research Policy, vol. 13, No. 6, 1984, 343-374.
[27] Boon M. How science is applied in technology. International Studies in the Philosophy of Science, vol.20, Issue 1, 2006 pp.27-47. DOI: 10.1080/02698590600640992
[28] Eurostat CIS data. [online] [30.12.2024]. Available at: https://ec.europa.eu/eurostat/web/science-technology-innovation/database.
[29] Ozols V., Gaile-Sarkane E., Avotiņš V. Innovation ecosystem university model as a new generation 5.0 model. Proceedings of XXXV ISPIM Conference, Tallinn, Estonia, 9-12 June, 2024, available for ISPIM members at www.ispim.org.
[30] Tether B. Who co-operates for innovation, and why: an empirical analysis, Research Policy, vol. 31, 2002, pp. 947-967.
[31] Faria P., Lima F., Santos R. Cooperation in innovation activities: the importance of partners. Research Policy, vol.39, Issue 8, 2010, pp.1082-1092. DOI: 10.1016/j.respol.2010.05.003
[32] Watkins A., Agapitova N. Creating a 21st Century National Innovation System for a 21st Century Latvian Economy. Policy Research Working Paper; No.3457, World Bank, Washington, D.C. [online] [30.12.2024]. Available at: http://hdl.handle.net/10986/14186
[33] Masso J., Ukrainski K. Private Sector Interaction in the decision making processes of Public Research in Estonia, 2006, unpublished manuscript.
[34] Avotins V., Resele L. RIO Country Report Latvia 2014, JRC Research Reports JRC96489, 2015, [online] [10.03.2025]. Available at: https://ideas.repec.org/p/ipt/iptwpa/jrc96489.html
[35] Etzkowitz H. Research groups as 'quasi-firms': the invention of the entrepreneurial university. Research policy, vol.32, No.1, 2003, pp.109-121.