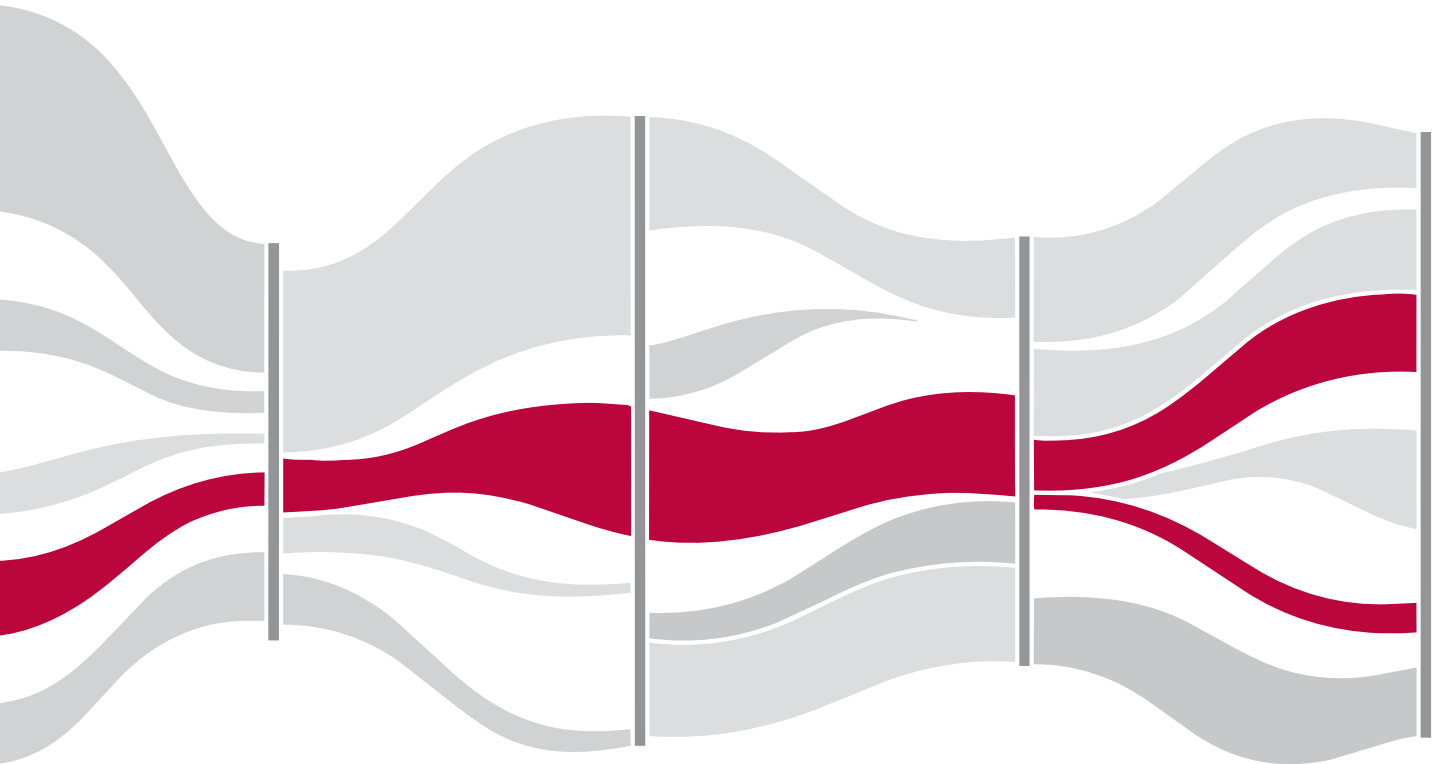
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Patent Commercialization in Poland

A Pilot Study of National Patents Granted Between 2019 and 2023



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PATENT OFFICE
OF THE REPUBLIC OF POLAND

Abstract

In this paper, we examine the extent, pathways, and economic outcomes of patent commercialization in Poland, focusing on institutional and technological differences. The study results from research collaboration between SGH Warsaw School of Economics and the Patent Office of the Republic of Poland. We use administrative patent records and survey data collected by Statistics Poland. Based on 1 588 completed questionnaires, Statistics Poland applied statistical estimation procedures to generalize the results to the population of 11 526 national patents granted between 2019 and 2023. We find that 24.9% of patents were undergoing commercialization, predominantly through independent arrangements, while most remaining patents had no plans for future commercialization. Strategic blocking accounted for 3.1% of the patent population. Insufficient market demand and limited investor interest were the most frequently reported commercialization barriers. Substantial institutional differences emerged: enterprises, particularly those operating in NACE sections A-F, exhibited higher commercialization intensity and accounted for most reported commercialization revenues, whereas research-oriented institutions relied relatively more on external partners. We also find that technological specialization was not consistently associated with higher commercialization intensity.

Our findings provide new patent-level evidence on commercialization in Poland and highlight the importance of distinguishing patenting activity, involvement in commercialization processes, and realized economic outcomes.

Keywords: Patent commercialization; Technology transfer; Patent utilization; Innovation; Poland
JEL Classification: O31, O32, O34

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1 Introduction

Patents play an important role in protecting technological inventions and facilitating the appropriation of economic benefits from innovation. However, the granting of a patent does not necessarily lead to its commercial exploitation or the generation of revenues. Patented inventions may be used internally, commercialized through cooperation with external partners, licensed, sold, or retained for strategic purposes. Some remain unused because of technological, financial, organizational, or market-related barriers. Consequently, patenting activity alone provides an incomplete picture of the economic utilization of technological knowledge (Gambardella et al., 2008; Giuri et al., 2007; Teece, 1986).

Despite the extensive use of patent statistics in innovation research, relatively little systematic information is available on the commercialization trajectories of individual patents. Administrative patent records document legal protection but generally do not capture commercialization arrangements, barriers to exploitation, or realized economic outcomes. Addressing these limitations requires combining patent statistics with information collected directly from organizations involved in developing and commercializing patented inventions.

This paper presents the results of a pilot study examining the commercialization of national patents granted by the Patent Office of the Republic of Poland (UPRP) between 2019 and 2023. The study was initiated and commissioned by the Patent Office of the Republic of Poland, based on a research concept developed by Mariusz-Jan Radło, professor of the SGH Warsaw School of Economics. The research was carried out by Statistics Poland, with the Statistical Office in Szczecin responsible for its implementation. Administrative patent records provided by the UPRP were combined with survey information collected directly from the original patent applicants. The study covered a population of 11 526 patents associated with 2 527 entities. A sample of 4 018 patents was selected, and completed questionnaires were obtained for 1 588 patents from 843 entities. The results were subsequently generalized to the study population using statistical estimation procedures applied by Statistics Poland.

The main objective of this paper is to assess the extent and characteristics of patent commercialization in Poland, identify the factors associated with non-commercialization, and examine differences across institutional categories and technological fields. Particular attention is paid to differences between the research sector and enterprises. The institutional analysis distinguishes higher education institutions, research institutes, and other entities operating in NACE sections A-F and G-U. As approximately 99% of the entities in the latter two categories are enterprises, these groups are also referred to as enterprises when interpreting the findings.

The analysis addresses six interrelated research questions:

1. What proportion of patents undergo commercialization, and which commercialization pathways are most frequently used?
2. How do commercialization patterns differ between higher education institutions, research institutes, and enterprises?
3. What role do strategic patent holding and barriers to commercialization play in explaining the non-commercialization of patented inventions?
4. To what extent is future commercialization planned for patents not currently undergoing commercialization?
5. What economic and operational outcomes are reported from patent commercialization, and how do they differ across institutional categories?
6. How do patenting activity and commercialization intensity differ across technological fields and institutional categories?

The study adopts a broad, process-oriented definition of commercialization, encompassing activities extending from the identification of market opportunities and technological development to the introduction of products or processes into the market. Accordingly, patents reported as undergoing commercialization have not necessarily reached the stage of market implementation or generated revenues. Commercialization status, commercialization pathways, and economic outcomes are therefore examined as distinct but related dimensions of patent utilization.

The paper makes three contributions to the empirical literature on patent commercialization. First, it provides patent-level evidence on the utilization of national patents in Poland by combining administrative patent records with survey data on their subsequent commercialization. Second, it examines commercialization as a differentiated process,

distinguishing internal exploitation, cooperation with external partners, strategic blocking, planned commercialization, and barriers to market utilization. Third, it investigates institutional and technological differences in patent commercialization, with particular emphasis on the research sector-enterprise divide and the distinction between patenting activity, commercialization intensity, and reported economic outcomes. In doing so, the study provides new evidence on the relationship between the creation of protected technological knowledge and its subsequent economic utilization. Given its exploratory and descriptive character, the analysis identifies patterns and differences rather than establishing causal relationships.

The remainder of the paper is organized as follows. Section 2 reviews the relevant literature and develops the analytical framework. Section 3 presents the research design, data, sampling strategy, and methodology. Section 4 examines patent commercialization trajectories. Section 5 analyzes strategic non-commercialization and barriers to patent exploitation. Section 6 examines the reported economic outcomes of commercialization. Section 7 investigates differences in patenting activity and commercialization intensity across technological fields and institutional categories. Finally, Section 8 discusses the findings, their implications, and the main limitations of the study.

2 Literature review and analytical framework

2.1. Patent commercialization and economic value

Patents perform several economic functions: they protect technological inventions, facilitate the appropriation of returns from innovation, constitute strategic organizational assets, and enable transactions in markets for technology. Their economic significance can be understood through several complementary theoretical perspectives.

Although Robinson (1933) did not directly address patent commercialization, her theory of imperfect competition provides a foundation for interpreting patents as instruments of temporary market exclusivity and potential economic rents. From this perspective, patent protection may create opportunities to appropriate returns from technological innovation, although it does not guarantee commercial exploitation. A complementary perspective can be derived from Coase's (1937) theory of the firm. His analysis of organizational boundaries and transaction costs provides a framework for understanding the choice between exploiting patented technologies internally and transferring them through market transactions, such as licensing or patent sales.

The resource-based view, developed by Penrose (1959), Wernerfelt (1984), and Barney (1991) emphasizes that the value of organizational assets depends on their combination with other resources and capabilities. Applied to patented inventions, this perspective suggests that technological knowledge alone is insufficient to ensure commercial success. Teece (1986) demonstrates that appropriating returns from innovation requires access to complementary assets, including manufacturing, distribution, marketing, financing, and other specialized capabilities.

Markets for technology provide an alternative mechanism for exploiting inventions. Arora et al. (2001) show that technological knowledge and intellectual property rights can be licensed or sold independently of the products in which technologies are ultimately incorporated. Patents therefore function not only as instruments of protection but also as transferable assets facilitating the allocation of technologies between organizations with different resources and capabilities.

The economic value of patents is nevertheless highly heterogeneous. Gambardella et al. (2008) demonstrate that patent values follow a strongly skewed distribution and that conventional indicators of patent quality explain only part of their variation. This heterogeneity highlights the limitations of using patent counts or patent quality indicators as proxies for the economic outcomes of commercialization.

A further distinction concerns commercialization, implementation, and technology transfer. Following Radło et al. (2020), commercialization is a profit-oriented process through which R&D outcomes become, or are intended to become, objects of market transactions. Implementation refers to their practical application in economic or social activities, while technology transfer involves the movement of technology or related knowledge between entities for further development or use. These processes may overlap but are not synonymous. Commercialization may accompany market-oriented implementation or take the form of a technology transfer transaction, such as licensing or patent sales. Importantly, commercializing a patent as a legal right does not necessarily imply market implementation of the underlying technology.

These distinctions are particularly relevant to the present study, which adopts a broad, process-oriented definition of commercialization encompassing activities from the identification of market opportunities and R&D to the creation and market introduction of new products.

2.2. Patent commercialization pathways

Patent commercialization has traditionally been represented as a linear process progressing from research and invention through intellectual property protection to market implementation. However, such models do not adequately capture the diversity of commercialization activities and organizational arrangements.

Dzakiy et al. (2023) emphasize that technology commercialization involves multiple stages, feedback mech-

anisms, and interactions between technological, organizational, financial, and market factors. Technologies may require further development or market validation, while commercialization strategies may change as new information and partners become available.

A multi-pathway perspective therefore provides a more appropriate framework. Commercialization may involve internal exploitation, licensing, patent sales, contractual cooperation, joint ventures, or the establishment of new firms. Dzakiy et al. (2024) identify licensing, spin-offs, joint operations, and joint ventures as alternative strategies for university technology commercialization, emphasizing the relationships between research organizations, intermediaries, and industry.

These pathways reflect differences in the distribution of technological knowledge and complementary resources. As Arora et al. (2001) demonstrate, technology transactions enable inventions to be transferred to organizations better equipped for their exploitation. However, commercialization cannot be reduced to the completion of a licensing or patent sale transaction. Feller and Feldman (2010) emphasize that technological development, manufacturing preparation, market adaptation, and activities undertaken by industrial partners often separate intellectual property transactions from final market outcomes.

Empirical research also demonstrates that patents may perform functions other than direct commercialization. Giuri et al. (2007) identify internal use, licensing and cross-licensing, blocking competitors, and unused or sleeping patents among the principal patterns of patent utilization.

Drawing on the Knowledge-Based View, Hamilton and Philbin (2020) highlight the role of organizational capabilities in university technology transfer. Their systematic literature review and meta-analysis emphasizes knowledge management and knowledge deployment as key factors shaping technology transfer outcomes, particularly the performance of university spin-offs and start-ups.

The literature thus supports a multi-pathway approach that distinguishes between commercialization processes, strategic patent holding, and different forms of non-commercialization. This perspective provides the basis for examining the alternative trajectories of patents covered by the present study.

2.3. Determinants of patent commercialization

Patent commercialization depends on interacting technological, organizational, resource-related, and institutional factors. Four groups of determinants can be distinguished: patent and technology characteristics, patent holder and inventor characteristics, complementary assets and external partners, and institutional and market conditions.

2.3.1. Patent and technology characteristics

The first group concerns the economic and technological characteristics of patented inventions, including their potential market value, technological maturity, scope of protection, and applicability.

Patents vary considerably in economic significance. Gambardella et al. (2008) show that patent values are highly unevenly distributed and that conventional indicators, such as citations, claims, and geographical protection, explain only part of their variation.

Technological maturity also influences commercialization opportunities. Some inventions may be ready for integration into existing products or processes, while others require further research, testing, demonstration, or certification. Dzakiy et al. (2023) identify technology-related characteristics, including feasibility and development requirements, as important factors in commercialization.

The technological field may further affect the process through differences in capital intensity, regulatory requirements, development cycles, and potential markets. Consequently, inventions with similar formal patent characteristics may follow different commercialization trajectories.

2.3.2. Patent holder and inventor characteristics

The second group concerns the organizational characteristics, objectives, capabilities, and experience of patent holders and inventors.

The resource-based perspective suggests that commercialization depends on the ability to combine technological knowledge with organizational resources and capabilities (Barney, 1991; Penrose, 1959; Wernerfelt, 1984). Organizations may differ in their capacity to identify market opportunities, manage intellectual property, attract partners, and develop patented technologies.

Institutional affiliation is particularly relevant. Enterprises, universities, and research institutes operate under different objectives, incentive systems, and resource constraints. Evidence from Giuri et al. (2007) indicates that patent utilization patterns vary across organizational categories, including differences in internal exploitation, licensing, and strategic uses.

Inventor characteristics may also influence commercialization. Dzakiy et al. (2023) highlight the importance of entrepreneurial orientation, commercialization experience, and the ability to establish relationships with external partners.

Hamilton and Philbin (2020) further emphasize the importance of organizational knowledge management and deployment capabilities in technology transfer. Previous patenting experience, intellectual property management practices, and established relationships with industry may therefore influence commercialization strategies.

2.3.3. Complementary assets and external partners

The third group concerns access to resources required for the development and commercial exploitation of patented technologies.

Teece (1986) demonstrates that successful innovation depends on complementary assets such as manufacturing capabilities, distribution networks, marketing resources, financing, and specialized expertise. Organizations possessing these assets may exploit inventions internally, while those lacking them may rely on external partners.

Arora et al. (2001) show that licensing and technology transactions facilitate the transfer of inventions between organizations with different resource endowments. However, transaction costs, contractual uncertainty, and difficulties in transferring technological knowledge may restrict such arrangements.

Financing is particularly important when commercialization requires additional R&D, prototypes, testing, certification, or production investments. Dzakiy et al. (2023) identify financial resources and intermediary support as relevant factors in technology commercialization.

External partners and intermediary organizations may provide resources unavailable within the patent-holding organization. Dzakiy et al. (2024) emphasize the role of relationships between research institutions, technology transfer intermediaries, and industrial partners in determining commercialization strategies.

2.3.4. Institutional and market conditions

The fourth group encompasses market demand, competition, public policies, institutional incentives, and the broader innovation environment.

Commercialization opportunities depend on the existence of potential customers, licensees, investors, and organizations capable of adopting new technologies. Dzakiy et al. (2023) identify market conditions, institutional support, and the availability of innovation infrastructure among the factors affecting technology commercialization.

Public policies and institutional arrangements may influence innovation through financing instruments, intellectual property regulations, and incentive systems. Czarnitzki and Hussinger (2004), using data on German manufacturing firms, find that public R&D subsidies stimulated additional private research expenditure and increased patenting activity. In research organizations, institutional support for commercialization may include revenue-sharing policies, academic entrepreneurship programs, and proof-of-concept funding.

Intermediary organizations can facilitate technology transfer, although their effectiveness depends on organizational capabilities rather than the mere existence of support infrastructure. Hamilton and Philbin (2020) emphasize the role of knowledge management and deployment capabilities in this context. Research on Polish innovation support organizations also highlights the differentiation of their activities and capabilities (Chwiałkowski et al., 2025).

Market and institutional conditions may additionally vary across sectors and regions, reflecting differences in technological intensity, industrial structure, financing opportunities, and regulatory requirements.

2.3.5. Synthesis of commercialization determinants

The four groups of determinants are interrelated. Technological characteristics influence commercialization potential, organizational capabilities shape commercialization decisions, complementary assets determine access to essential resources, and institutional and market conditions affect available opportunities and constraints.

Table 1. Determinants of Patent Commercialization and Their Analytical Implications

GROUP OF DETERMINANTS	MAIN CHARACTERISTICS	IMPLICATIONS FOR COMMERCIALIZATION
Patent and technology characteristics	Technological maturity, patent quality, potential economic value, technological field	Influence commercialization potential, development requirements, and market applicability
Patent holder and inventor characteristics	Institutional type, organizational capabilities, entrepreneurial orientation, commercialization experience	Shape commercialization decisions, organizational capacity, and the choice of pathways
Complementary assets and external partners	Financing, production capabilities, marketing, distribution, external partnerships	Determine access to resources required for internal exploitation or technology transfer
Institutional and market conditions	Market demand, competition, policy instruments, intermediary support, sectoral and regional environment	Influence commercialization opportunities, incentives, and barriers

Source: Authors' synthesis based on the literature reviewed in Section 2.3.

This framework provides a basis for interpreting differences in commercialization patterns across institutional and sectoral categories. In the present study, it serves primarily as an analytical framework rather than a causal model, since the survey data do not directly measure all the determinants identified in the literature.

2.4. Measuring patent commercialization and its outcomes

Measuring patent commercialization requires distinguishing between patenting activity, patent value, patent utilization, and realized economic outcomes.

Patent counts measure the creation and legal protection of inventions but do not establish whether patented technologies are commercially exploited. Patent citations and related indicators provide information about technological importance and economic value, yet remain indirect measures. Hall et al. (2005) demonstrate the relationship between patent citations and market valuation, while Gambardella et al. (2008) show the limited explanatory power of conventional patent indicators. Kogan et al. (2017) develop an alternative measure of innovation value based on financial market responses to patent grants, but this approach does not directly capture commercialization pathways.

Patent use constitutes a separate dimension. Giuri et al. (2007) distinguish between patents used internally, licensed patents, blocking patents, and sleeping patents. Their findings indicate that patents not directly exploited commercially may still serve strategic purposes or retain option value for their owners. Patent ownership transfers represent another form of patent utilization, with their occurrence depending on patent characteristics, age, and transfer history (Serrano, 2010). Wagner and Wakeman (2016), drawing on evidence from the pharmaceutical industry, further show that patent-based measures of value and uncertainty are related to product commercialization but cannot substitute for direct evidence of market outcomes.

The relationship between intellectual property protection and market outcomes may involve substantial intermediate activities. Feller and Feldman (2010) emphasize that licensing, technology development, and industrial implementation represent distinct stages that conventional transfer indicators do not fully capture.

Survey-based evidence can address some of these measurement limitations by collecting information directly from patent holders. Svensson (2022) illustrates the importance of combining patent indicators with evidence concerning technological innovation and commercial exploitation. Bottai et al. (2025) propose a complementary approach based on web evidence of invention commercialization.

For the present study, these findings justify distinguishing between four analytical dimensions: patenting activity, patent value, commercialization status and pathways, and economic outcomes. The broad definition adopted in the questionnaire means that commercialization may include activities preceding completed market introduction or revenue generation.

Furthermore, economic outcomes may differ according to the patent holder's position in the commercialization process. Research institutions may obtain revenues from licensing or patent sales, while enterprises may generate revenues from products incorporating the underlying technologies. These outcomes represent different mechanisms of value creation and appropriation and should not automatically be treated as equivalent measures of commercialization performance.

Accordingly, the empirical analysis examines commercialization status, pathways, barriers, and reported economic outcomes as distinct but related dimensions of patent utilization. This approach provides the conceptual foundation for the research design and methodology presented in Section 3.

3 Research design, data and methodology

3.1. Research scope and design

The study examines the commercialization trajectories of national patents granted by the Patent Office of the Republic of Poland between 2019 and 2023. Its objective is to establish whether and how patented inventions have entered commercialization processes, identify the pathways through which commercialization has been pursued, and examine the reasons for non-commercialization and the economic outcomes reported by patent holders.

The study employs a patent-level survey design. Administrative patent records provide information about the granting of protection and the entities associated with individual patents but do not systematically document their subsequent use, commercialization arrangements, or economic outcomes. The study therefore combines administrative data from the UPRP with information obtained through questionnaires concerning individual patents.

The unit of analysis is the individual patent rather than the patent-holding organization or R&D project. This approach allows patents associated with the same organization to be classified according to their different commercialization statuses, pathways, and reported outcomes.

The study addresses six interrelated research questions concerning: (1) commercialization status and pathways; (2) institutional differences in commercialization patterns; (3) strategic patent holding and barriers to commercialization; (4) future commercialization plans; (5) reported economic and operational outcomes across institutional categories; and (6) patenting activity and commercialization intensity across technological fields and institutional categories.

The empirical analysis is descriptive and comparative. Results are presented for the population of patents covered by the study and across institutional and sectoral categories of patent holders.

The study includes patents meeting three criteria: the applicant originated from Poland, the patent was granted by the UPRP between 2019 and 2023, and the applicant was not a natural person.

For the purposes of defining the reference period, the grant date was determined by the entry of the patent into the UPRP register, following the decision to grant protection and payment of the fee for the first protection period, rather than by the date of the conditional grant decision.

The study uses information concerning the original applicant rather than the current patent holder. This approach was intended to minimize the risk of directing the survey to an entity that had acquired a patent instead of the entity that had commercialized it, for example through its sale.

The principal data sources were the UPRP's patent database and patent register.

3.2. Population and sampling strategy

3.2.1. Sampling frame and survey register

In the study *Commercialization of Solutions Protected by Patents in Poland in 2019–2023*, owing to its specific characteristics, the REGON identification number was of secondary importance and served only an auxiliary function in the data collection tool, namely the Statistics Poland Reporting Portal. The most important elements in constructing the survey register (the list of units participating in the study) were the granted patents. Consequently, if one entity had obtained several patents, it was required to complete several questionnaires.

The initial sampling frame consisted of a patent database provided by the UPRP, containing fields describing granted patents. The database reflected the situation as of 25 October 2024. The initial UPRP database contained 11 817 patents assigned to 3 256 entities.

The database was reviewed to supplement and update information concerning individual entities. To prepare standard breakdowns of the resulting information, it was necessary to develop additional characteristics describing the entities based on the standards used in official statistics. Moreover, some information was incomplete (e.g., missing

REGON identification numbers), while other data were outdated.

The database review also revealed that some patent numbers appeared more than once because multiple applicants were associated with the same patent. Therefore, it was decided to limit the database to first applicants only, in order to avoid duplicate questionnaires concerning the same patents. Accordingly, the Patent Office of the Republic of Poland prepared an appropriate database containing only patents identified by the first applicant. This database became the basis for further work on the study.

Information concerning the entities participating in the study was updated once again (using the most recent available data), and a survey register was generated containing entities classified as economically active according to current Statistics Poland data.

The final survey register contained 2 527 entities. This register was subsequently matched with the UPRP patent database to create a sampling frame comprising 11 526 patent records.

3.2.2. Sampling strata

Stratification was planned for entities with large numbers of patents, for which participation in the survey would require a substantial amount of work. It was decided that a sample would be drawn for entities holding more than five patents.

The following strata were established:

- **Stratum 1** – entities holding up to and including five patents. The first stratum was covered by a complete enumeration. It comprised 3 408 patents held by 2 338 entities.
- **Stratum 2 (A, B, C)** – entities holding more than five patents. This stratum comprised 189 entities holding 8 118 patents. A sample was drawn separately for each entity in the second stratum. In Stratum 2A, comprising entities holding 6–10 patents, the sampling fraction was 20%; in Stratum 2B, comprising entities holding 11–99 patents, it was 10%; and in Stratum 2C, comprising entities holding 100 or more patents, it was 5%.

The sampling frame prepared in this way formed the basis for sample selection.

Following sampling, the final sample comprised 4 018 patents (3 408 from Stratum 1 and 610 from Stratum 2) within 2 527 entities. During the survey, data were collected for 1 588 patents (completed questionnaires) from 843 entities.

Results were generalized across 2 527 domains, taking into account first-order inclusion probabilities and adjustments reflecting completeness within each domain, in accordance with the procedures applied by Statistics Poland.

Source: Statistical Office in Szczecin.

3.3. Data collection and survey methodology

The information initially provided to the Statistical Office included application and patent numbers, grant dates, names and locations of domestic applicants, and REGON and NIP identification numbers available in the UPRP databases. Patent registration information is publicly accessible through the UPRP's search systems, whereas REGON and NIP identification data can also be obtained through the relevant Statistics Poland registers.

The questionnaire was assigned to an individual patent. Organizations associated with several patents selected for the study were therefore asked to complete separate questionnaires for each patent.

The questionnaire followed a conditional structure determined initially by commercialization status as of 31 October 2024. A positive response directed respondents to questions concerning commercialization pathways and outcomes. A negative response directed them to questions addressing non-commercialization, strategic blocking, future commercialization plans, and relevant barriers.

For patents undergoing commercialization, the questionnaire collected information about independent commercialization, cooperation with external partners, licensing, patent sales, and related organizational arrangements. The economic outcomes module covered reported financial and operational benefits.

The survey also collected identifying and contextual information, including patent numbers and sources of financing for the R&D activities leading to the patented inventions.

Because responses concerned individual patents, the resulting data could be linked to the patent-level sampling frame. The survey thus supplemented administrative information with evidence about commercialization activities and outcomes that could not be reconstructed from patent registers alone.

3.4. Operational definitions and classification of patent commercialization

The analytical categories used in the study follow the definitions and conditional structure of the questionnaire. This is particularly important because commercialization, implementation, and technology transfer are not synonymous concepts, as discussed in Chapter 2.

The questionnaire adopted a broad, process-oriented definition of commercialization. It encompassed not only the sale of products and services based on research outcomes but also the entire process extending from the identification of market opportunities, through research

activities, to the creation and market introduction of new products.

Consequently, a patent classified as undergoing commercialization was not necessarily associated with completed market introduction or realized revenues.

Commercialization status was determined by the respondent's answer to whether the patent was undergoing commercialization as of 31 October 2024. This binary classification governed the subsequent questionnaire modules.

Commercialization pathways were reconstructed from responses concerning the organization of commercialization activities. The questionnaire distinguished between independent commercialization and commercialization involving external partners. Independent commercialization included development within the original organization, exploitation through related organizational structures, and the establishment of new companies. External commercialization arrangements included contractual cooperation, exclusive and non-exclusive licensing, and equity-based cooperation, including spin-off/spin-out and joint venture arrangements. The questionnaire also separately identified patent sales, including different payment arrangements.

Non-commercialization was treated as a differentiated category. The questionnaire identified strategic or blocking patents, defined as patents protecting products or technologies without an intention to implement them, with the objective of preventing their use by competitors. It also distinguished patents planned for future commercialization from cases in which respondents reported barriers or other reasons for the absence of commercialization.

Economic outcomes comprised respondents' assessments of the costs and benefits associated with patenting, reported direct and indirect revenues where estimable, expected future revenues, and operational or market effects attributed to commercialization.

These categories distinguish involvement in a commercialization process from its organizational pathway and reported economic outcomes. This distinction is maintained throughout the empirical analysis.

3.5. Institutional and sectoral classification of patent holders

The empirical analysis compares commercialization patterns across institutional and sectoral categories of patent holders. These categories reflect differences in organizational objectives, technological activities, and the economic environments in which patented inventions may be exploited.

Results are presented for the total population covered by the study and for four categories:

1. **Higher Education Institutions** – universities and other higher education institutions.
2. **Research institutes** – research institutes, including institutes of the Polish Academy of Sciences.
3. **Other entities: NACE A-F** – other entities operating in agriculture, industry, and construction.
4. **Other entities: NACE G-U** – other entities operating in service activities.

The last two categories are defined by economic activity rather than exclusively by enterprise status. Accordingly, they are referred to as *other entities* rather than simply *enterprises*.

This classification allows the analysis to examine differences in commercialization status, pathways, barriers, and reported economic outcomes across broad organizational groups.

The comparisons are descriptive. Institutional affiliation and sectoral classification may be associated with differences in resources, commercialization objectives, and mechanisms of value appropriation, but the available data do not establish their independent causal effects.

3.6. Analytical approach and research limitations

The analysis is primarily descriptive and comparative. It examines the estimated distribution of commercialization status, pathways, forms of non-commercialization, and reported economic outcomes for the population covered by the study and across the categories defined in Section 3.5.

The presentation of results follows a consistent structure: overall findings are reported first, followed by institutional and sectoral comparisons. Percentages are interpreted in relation to the population covered by each questionnaire module. For questions permitting multiple responses, individual percentages need not sum to 100%.

Population estimates are based on the generalization procedure described in Section 3.2.

Several limitations should be considered.

First, the study covers national patents granted by the UPRP between 2019 and 2023 rather than all forms of intellectual property or technology transfer undertaken by Polish organizations. It does not encompass commercialization based exclusively on European patents, know-how, copyright-protected software, or other forms of intellectual property outside the defined patent population.

Second, the grant period does not necessarily correspond to the period in which inventions were developed or commercialization activities began. Technology development and commercial exploitation may precede patent grants, while economic outcomes may emerge considerably later.

Third, the broad questionnaire definition includes commercialization activities preceding completed market introduction and revenue generation. The reported share of patents undergoing commercialization therefore should not be equated with the share of patents generating revenues or achieving commercial success.

Fourth, the survey relies on information reported by patent holders. Respondents may differ in their knowledge of commercialization activities and in their ability to attribute revenues or other benefits to individual patents. Although the estimation procedure takes account of the sampling design and response completeness, potential non-response bias and statistical uncertainty remain relevant.

Fifth, comparisons of commercialization revenues across institutional categories require caution. Universities, research institutes, and other organizations may participate in different stages of technology development and capture economic value through different mechanisms. Licensing or patent-sale revenues received by a research institution are not directly equivalent to revenues from products and services subsequently generated by an organization exploiting the technology.

Finally, the study does not provide a comprehensive assessment of the effectiveness of Polish technology transfer organizations or the national innovation system. The empirical findings describe commercialization patterns within the defined population of patents and the dimensions measured by the questionnaire.

Despite these limitations, combining administrative patent data with patent-level survey responses provides information about commercialization pathways, strategic patent uses, barriers, and economic outcomes that conventional patent statistics do not capture.

4 Patent trajectories and commercialization pathways

4.1. Overall patent trajectories

The patent trajectories presented in Figure 1 illustrate the commercialization status and current or planned commercialization pathways of patents granted in 2019–2023. Of the 11 526 patents covered by the study, 2 868 were undergoing commercialization, while 8 658 were not. Among patents not undergoing commercialization, 7 460 had no future commercialization plans, 838 were planned for future commercialization, and 360 were classified as blocking patents.

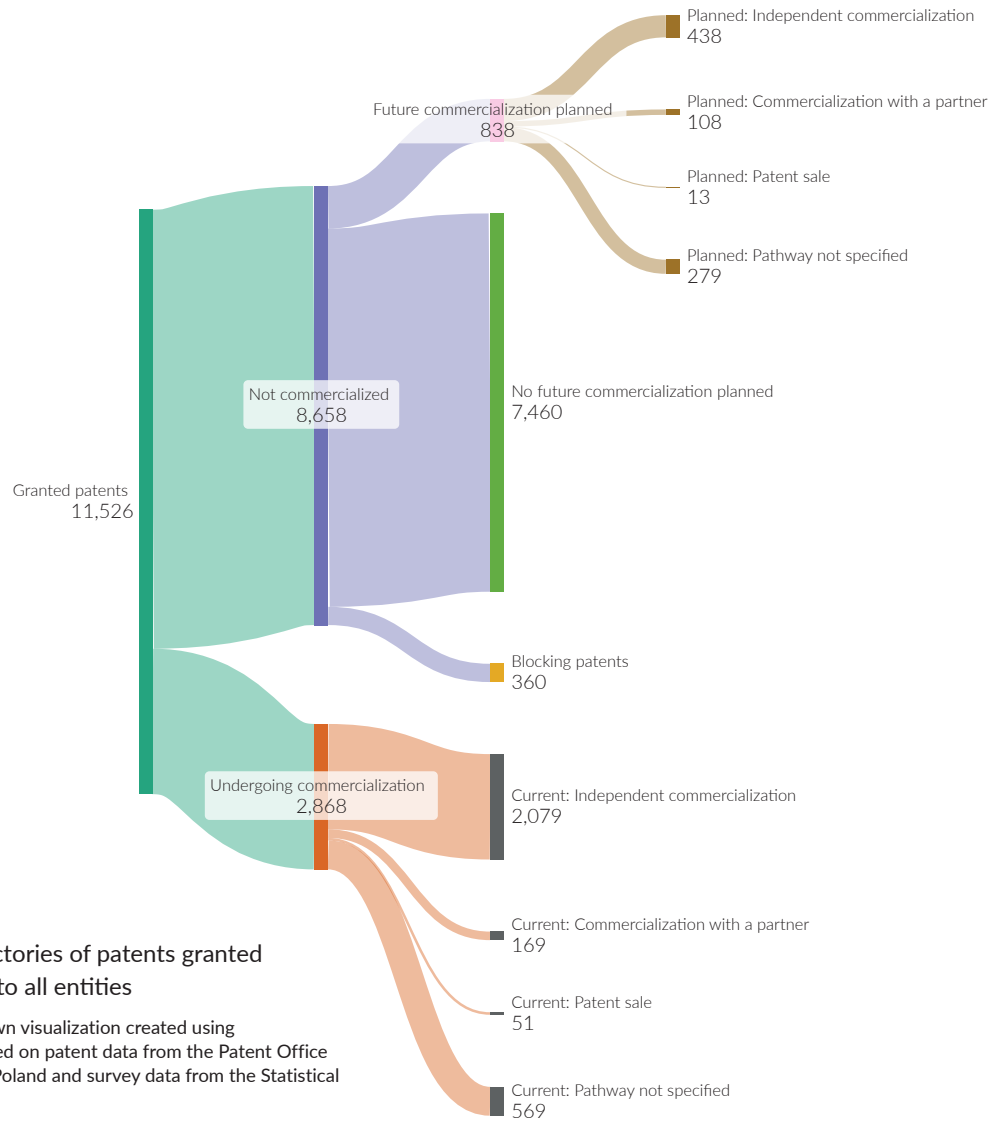


Figure 1. Trajectories of patents granted in 2019–2023 to all entities

Source: Authors' own visualization created using SankeyMATIC, based on patent data from the Patent Office of the Republic of Poland and survey data from the Statistical Office in Szczecin.

Independent commercialization was the dominant pathway among patents undergoing commercialization, accounting for 2 079 patents, compared with 169 involving external partners and 51 patent sales. For another 569 patents, the commercialization pathway was not specified. A similar pattern was observed among patents planned for future commercialization, with 438 expected to follow an independent pathway, 108 involving external partners, and 13 planned for sale. For the remaining 279 patents, no specific commercialization pathway had been selected. Overall, the results indicate that Independent commercialization predominates in both current and planned activities, while the large number of patents without future commercialization plans highlights the limited extent of commercialization and the relatively minor role of blocking patents as a form of strategic non-commercialization. The following figures provide a more detailed comparison of patent trajectories across institutional categories.

4.2. Patent trajectories in higher education institutions

As presented in Figure 2, higher education institutions accounted for 6 515 patents, of which 1 215 were undergoing commercialization and 5 300 were not. Among patents not undergoing commercialization, 4 708 had no future commercialization plans, 508 were planned for commercialization, and 84 were classified as blocking patents. Independent commercialization was the most frequently reported pathway (592 patents), although for a substantial number of patents undergoing commercialization (494), the pathway was not specified. Among patents planned for future commercialization, independent commercialization also predominated (235 patents).

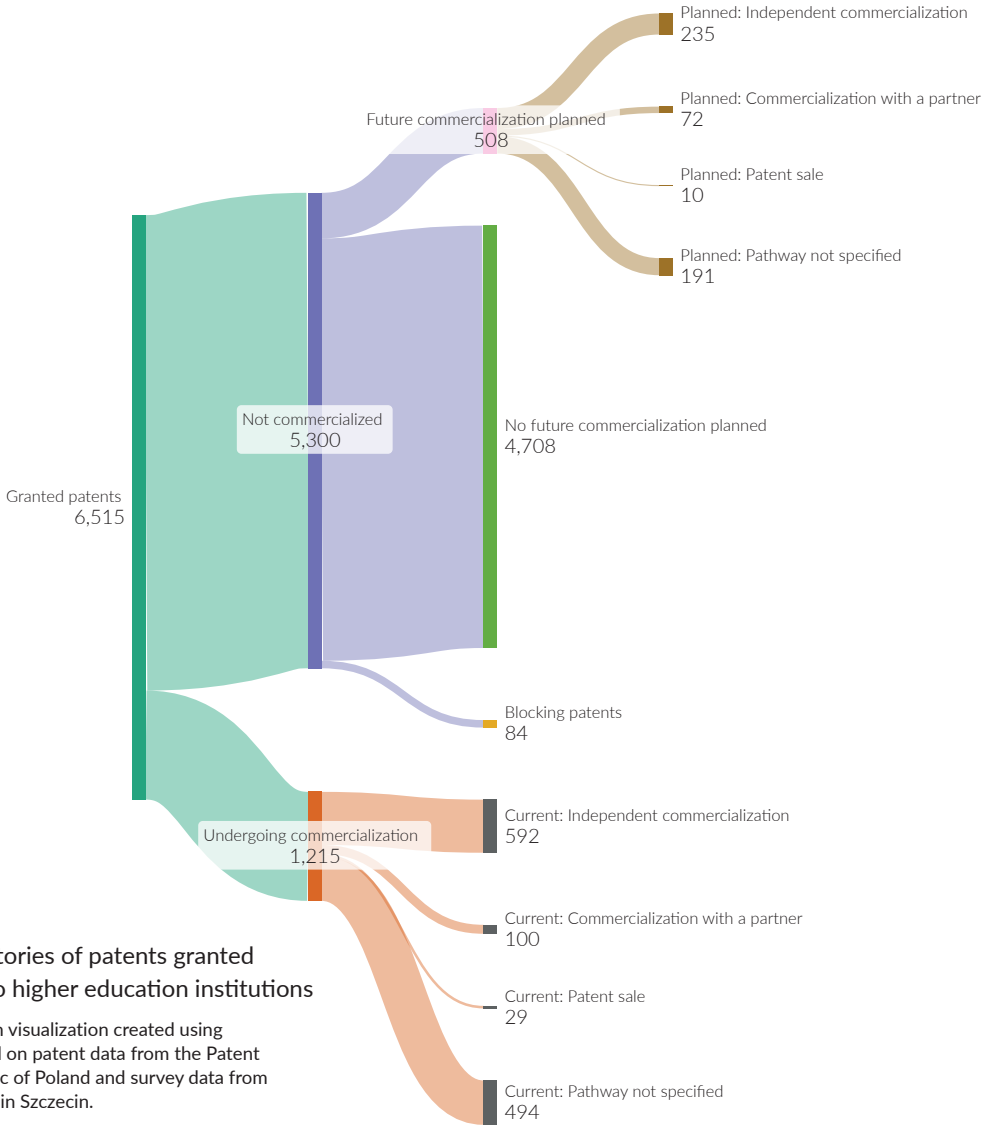


Figure 2. Trajectories of patents granted in 2019–2023 to higher education institutions

Source: Authors' own visualization created using SankeyMATIC, based on patent data from the Patent Office of the Republic of Poland and survey data from the Statistical Office in Szczecin.

4.3. Patent trajectories in research institutes

The trajectories of patents granted to research institutes, illustrated in Figure 3, reveal a relatively low level of commercialization. Of the 1 337 patents, 183 were undergoing commercialization, while 1 154 were not. Among the latter, 151 were planned for future commercialization and 60 were classified as blocking patents. Independent commercialization accounted for 71 patents, while 48 involved external partners and 13 patent sales. Compared with other institutional categories, research institutes showed a relatively greater role of commercialization through external partners.

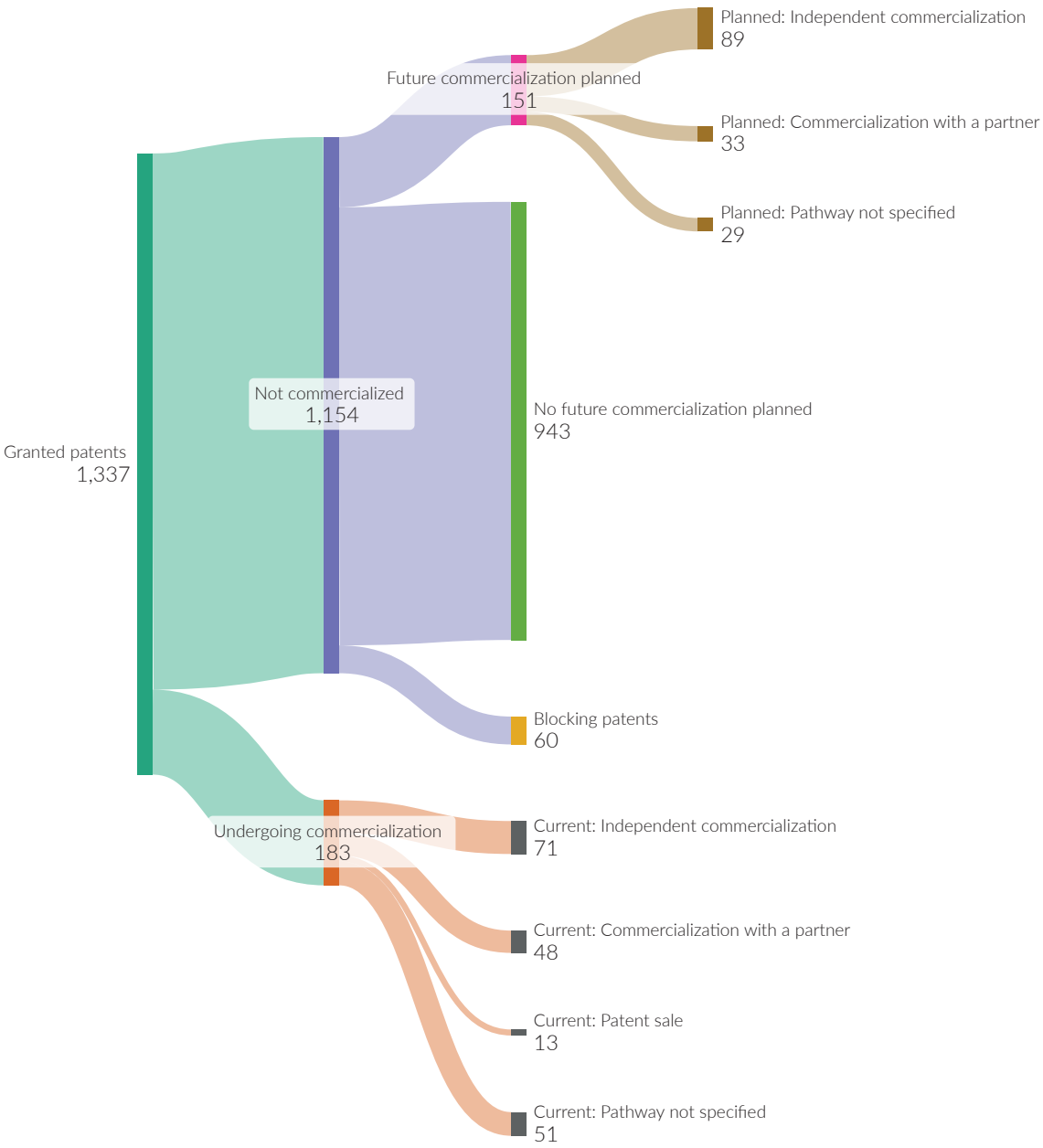


Figure 3. Trajectories of patents granted in 2019–2023 to research institutes

Source: Authors' own visualization created using SankeyMATIC, based on patent data from the Patent Office of the Republic of Poland and survey data from the Statistical Office in Szczecin.

4.4. Patent trajectories in other entities: NACE Sections A-F

Figure 4 illustrates a different pattern among other entities operating in NACE sections A-F. Of the 2 914 patents, 1 261 were undergoing commercialization, predominantly through independent arrangements (1 225 patents). Among the 1 653 patents not undergoing commercialization, 1 365 had no future commercialization plans, 183 were classified as blocking patents, and 105 were planned for future commercialization. These results indicate a strong predominance of independent commercialization and a relatively limited role of external commercialization pathways.

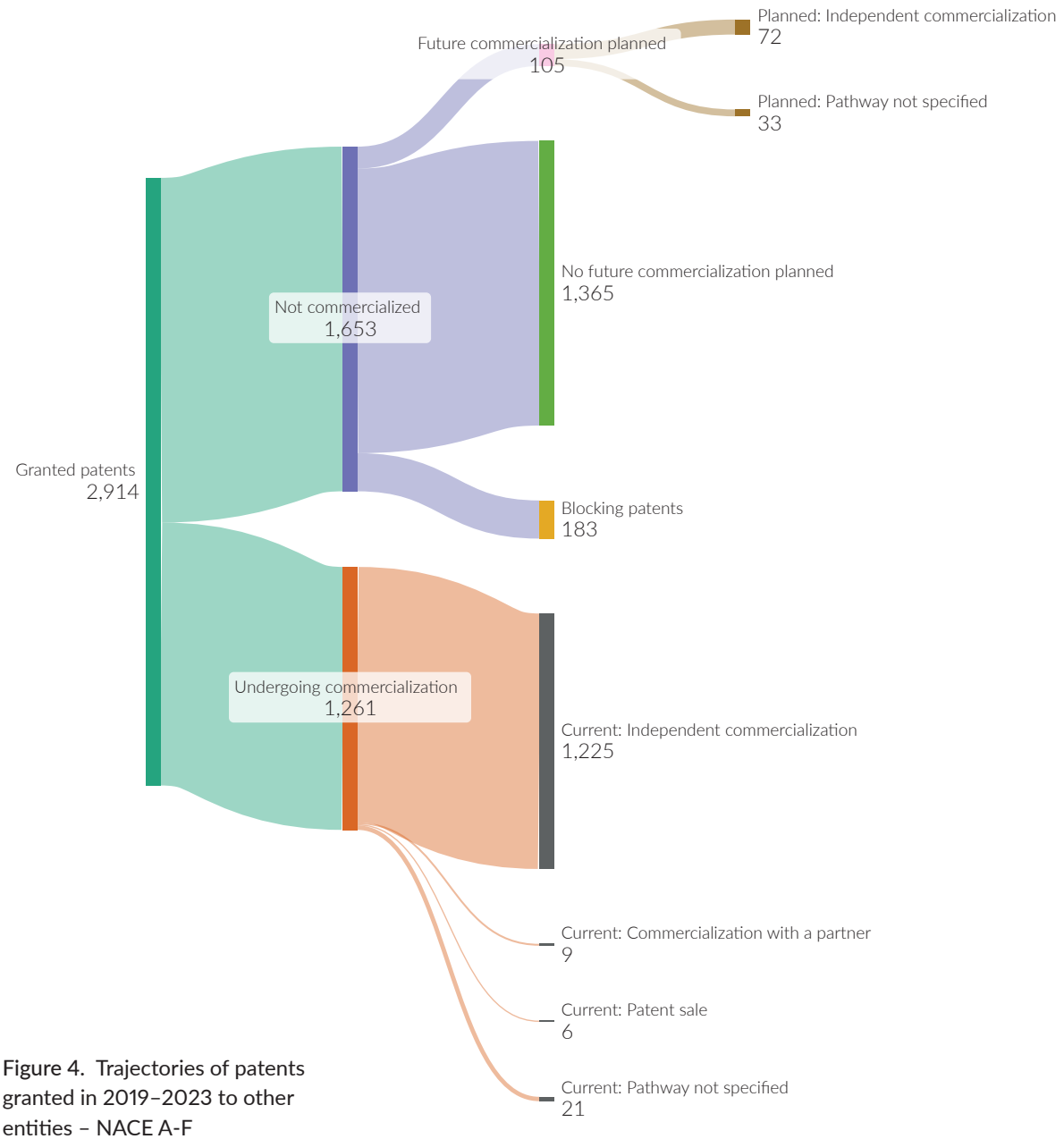


Figure 4. Trajectories of patents granted in 2019–2023 to other entities – NACE A-F

Source: Authors' own visualization created using SankeyMATIC, based on patent data from the Patent Office of the Republic of Poland and survey data from the Statistical Office in Szczecin.

4.5. Patent trajectories in other entities: NACE Sections G-U

A similar pattern is observed among other entities in NACE sections G-U (Figure 5). Of the 760 patents, 209 were undergoing commercialization, including 191 through independent arrangements. Among the 551 patents not undergoing commercialization, 444 had no future commercialization plans, 74 were planned for future commercialization, and 33 were classified as blocking patents. Independent commercialization also predominated among planned activities, accounting for 42 patents.

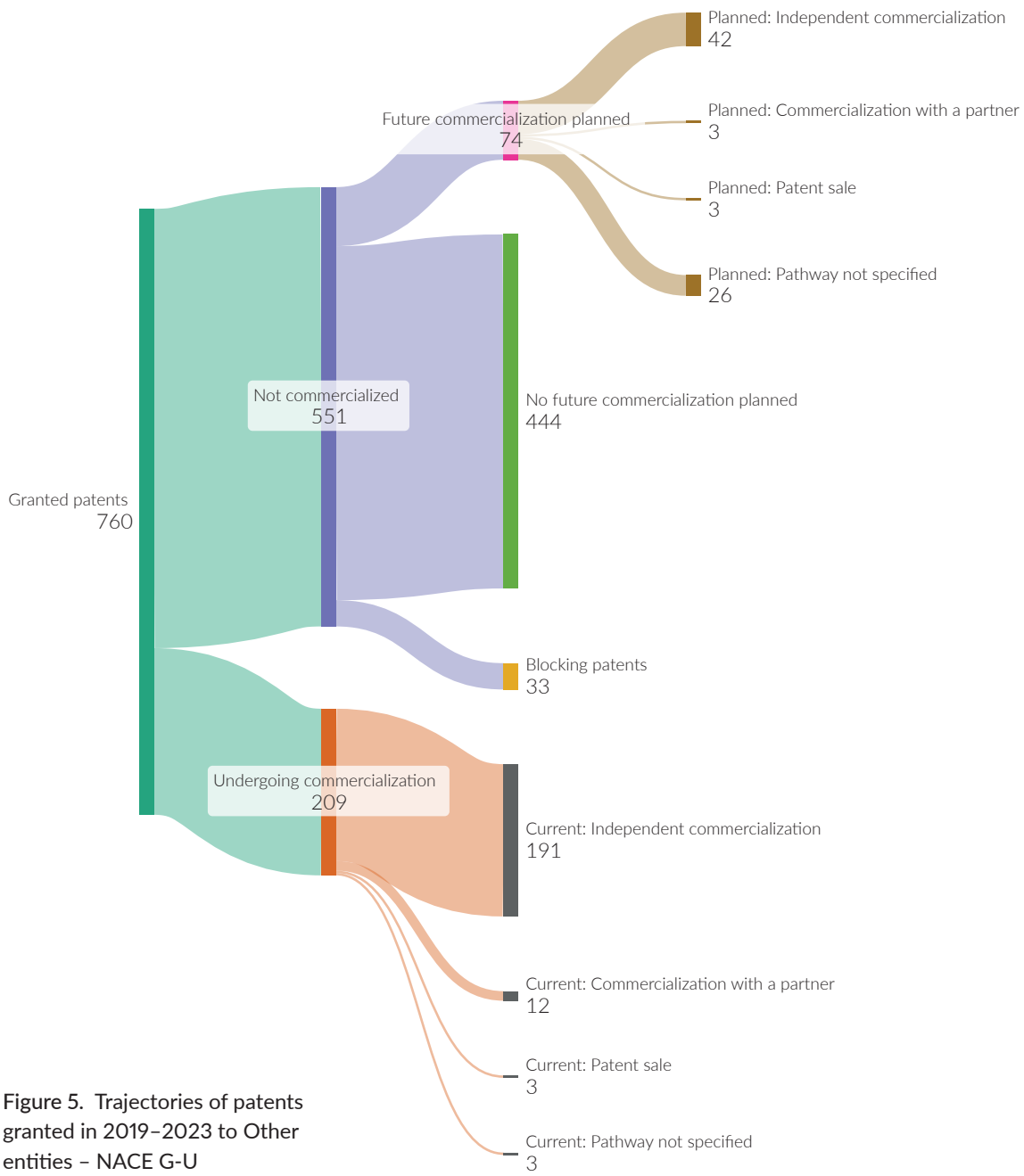


Figure 5. Trajectories of patents granted in 2019–2023 to Other entities – NACE G-U

Source: Authors' own visualization created using SankeyMATIC, based on patent data from the Patent Office of the Republic of Poland and survey data from the Statistical Office in Szczecin.

4.6. Comparative analysis of patent trajectories across institutional categories

Overall, patent trajectories differed substantially across institutional categories. The highest commercialization rate was recorded among entities in NACE sections A-F (43.3%), followed by NACE G-U (27.5%), higher education institutions (18.6%), and research institutes (13.7%). Independent commercialization predominated across all categories, particularly among other entities, while research institutes relied relatively more on external partners and patent sales. Future commercialization plans also varied. Among patents not undergoing commercialization, future exploitation was planned for 13.1% in research institutes, 13.4% in NACE G-U, and 9.6% in higher education institutions, compared with 6.4% in NACE A-F. Blocking patents were most prevalent among non-commercialized patents in NACE A-F (11.1%) and least prevalent in higher education institutions (1.6%). These findings highlight institutional differences in commercialization pathways, future plans, and strategic patent uses, reflecting distinct patterns of patent utilization and non-commercialization.

5 Strategic non-commercialization and barriers to patent commercialization

5.1. Prevalence of blocking patents

As shown in Table 2, blocking patents accounted for 360 out of 11 526 patents covered by the study (3.1%), representing 4.2% of patents not undergoing commercialization. This indicates that strategic blocking was a relatively uncommon form of patent non-commercialization.

Table 2. Prevalence of blocking patents by institutional and sectoral category

INSTITUTIONAL AND SECTORAL CATEGORY	% OF ALL GRANTED PATENTS	% OF NON-COMMERCIALIZED PATENTS
All entities	3.1	4.2
Higher education institutions	1.3	1.6
Research institutes	4.5	5.2
Other entities – NACE A-F	6.3	11.1
Other entities – NACE G-U	4.3	6.0

Note: A total of 360 blocking patents were identified among 11 526 patents covered by the study. Percentages are calculated relative to all granted patents and non-commercialized patents within each institutional and sectoral category, respectively. Figures are rounded to one decimal place.

Source: Authors' calculations based on data from the Patent Office of the Republic of Poland and the Statistical Office in Szczecin.

However, its prevalence differed considerably across institutional and sectoral categories. The highest share of blocking patents among non-commercialized patents was observed in other entities operating in NACE sections A-F (11.1%), followed by entities in NACE sections G-U (6.0%), research institutes, including institutes of the Polish Academy of Sciences (5.2%), and higher education institutions (1.6%). When measured against all granted patents, blocking was most prevalent among entities in NACE A-F (6.3%), followed by research institutes (4.5%), entities in NACE G-U (4.3%), and higher education institutions (1.3%).

These differences suggest that strategic blocking is more frequently reported among entities operating in agriculture, industry, and construction than among research-oriented institutions, particularly higher education institutions. This pattern is consistent with the use of patents to protect competitive positions and restrict competitors' technological options. Nevertheless, the relatively low overall prevalence of blocking patents indicates that strategic blocking accounts for only a small proportion of patent non-commercialization in Poland.

5.2. Competitive position and market protection

As shown in Table 3, blocking patents are widely perceived as instruments for maintaining competitive advantage, with 90.8% of responses indicating *agree* or *strongly agree*. Research institutes recorded the highest share of *strongly agree* responses (61.7%), compared with 33.3% among higher education institutions and 17.5% among entities in NACE A-F. In NACE G-U, 90.9% agreed, although none strongly agreed.

Protection against copying or imitation received the strongest support, with 98.3% of responses indicating agreement. All patents in higher education institutions, research institutes, and NACE G-U received positive assessments, compared with 96.7% in NACE A-F. Strong agreement was particularly prevalent among research institutes (71.7%) and entities in NACE A-F (49.2%), highlighting the perceived importance of protecting proprietary technologies.

Reducing the risk of losing market share received somewhat lower overall support (75.6%). Positive assessments ranged from 66.7% among higher education institutions to 73.8% in NACE A-F, 80.0% among research institutes, and 100% in NACE G-U. These findings suggest that blocking patents are perceived more strongly as instruments of technological and competitive protection than as mechanisms for safeguarding market share. The results reflect reported perceptions rather than independently verified competitive effects.

Table 3. Competitive and protective functions of blocking patents

STATEMENT AND TYPE OF INSTITUTION	STRONGLY DISAGREE	DISAGREE	NEITHER AGREE NOR DISAGREE	AGREE	STRONGLY AGREE	*N*
The blocking patent helps maintain a competitive advantage over other firms						
All entities	3	6	24	230	97	*360*
Higher education institutions	0	0	0	56	28	*84*
Research institutes	0	0	6	17	37	*60*
Other entities: NACE A-F	3	3	18	127	32	*183*
Other entities: NACE G-U	0	3	0	30	0	*33*
The blocking patent helps protect the organization's technology from copying or imitation by competitors						
All entities	0	0	6	193	161	*360*
Higher education institutions	0	0	0	56	28	*84*
Research institutes	0	0	0	17	43	*60*
Other entities: NACE A-F	0	0	6	87	90	*183*
Other entities: NACE G-U	0	0	0	33	0	*33*
Holding the blocking patent reduces the risk of losing market share						
All entities	0	0	88	197	75	*360*
Higher education institutions	0	0	28	28	28	*84*
Research institutes	0	0	12	13	35	*60*
Other entities: NACE A-F	0	0	48	123	12	*183*
Other entities: NACE G-U	0	0	0	33	0	*33*

Note: N = 360. The table reports estimated numbers of patents. Percentages discussed in the text are calculated using the corresponding row totals.

Source: Authors' calculations based on data from the Patent Office of the Republic of Poland and the Statistical Office in Szczecin.

5.3. Perceived financial and reputational benefits

The findings presented in Table 4 indicate that blocking patents are less frequently associated with maintaining profit margins than with other strategic benefits. Overall, 37.8% of assessments were positive (*agree* or *strongly agree*), with the highest share among research institutes (80.0%), followed by higher education institutions (33.3%), entities in NACE A-F (27.9%), and NACE G-U (27.3%). Neutral responses accounted for 42.2%, suggesting limited consensus regarding this financial function.

Table 4. Financial and reputational benefits of blocking patents

STATEMENT AND TYPE OF INSTITUTION	STRONGLY DISAGREE	DISAGREE	NEITHER AGREE NOR DISAGREE	AGREE	STRONGLY AGREE	*N*
The blocking patent helps maintain profit margins on other products or services offered by the firm						
All entities	0	72	152	102	34	*360*
Higher education institutions	0	0	56	28	0	*84*
Research institutes	0	0	12	26	22	*60*
Other entities: NACE A-F	0	60	72	42	9	*183*
Other entities: NACE G-U	0	12	12	6	3	*33*
The blocking patent contributes to increased sales of other products or services offered by the firm						
All entities	6	51	162	87	54	*360*
Higher education institutions	0	0	56	0	28	*84*
Research institutes	0	0	25	24	11	*60*
Other entities: NACE A-F	6	45	78	42	12	*183*
Other entities: NACE G-U	0	6	3	21	3	*33*
The blocking patent enhances the firm's perceived value among investors or customers and strengthens its reputation						
All entities	0	6	71	173	110	*360*
Higher education institutions	0	0	28	28	28	*84*
Research institutes	0	0	0	19	41	*60*
Other entities: NACE A-F	0	6	37	99	41	*183*
Other entities: NACE G-U	0	0	6	27	0	*33*

Note: N = 360. The table reports estimated numbers of patents. Percentages discussed in the text are calculated using the corresponding row totals.

Source: Authors' calculations based on data from the Patent Office of the Republic of Poland and the Statistical Office in Szczecin.

A similar pattern emerged for the perceived contribution of blocking patents to increasing sales of other products or services, with 39.2% positive assessments overall. Agreement was highest among entities in NACE G-U (72.7%) and research institutes (58.3%), compared with 33.3% among higher education institutions and 29.5% in NACE A-F. Neutral responses represented 45.0% of the total, indicating that sales-related benefits were less consistently recognized.

In contrast, the perceived contribution of blocking patents to organizational value and reputation received considerably stronger support, with 78.6% positive assessments. Agreement was highest among research institutes (100%), followed by NACE G-U (81.8%), NACE A-F (76.5%), and higher education institutions (66.7%). Research institutes also recorded the highest share of *strongly agree* responses (68.3%). Overall, blocking patents were perceived as contributing more to organizational value and reputation than to maintaining margins or increasing sales, although these assessments do not establish actual economic effects.

5.4. Negotiating power and market strategy

The results presented in Table 5 indicate that blocking patents also serve as instruments in negotiations with other firms, particularly concerning licensing agreements and strategic alliances. Overall, 61.9% of assessments were positive (*agree* or *strongly agree*). Agreement was highest among higher education institutions (100%), followed by entities in NACE G-U (72.7%), research institutes (68.3%), and NACE A-F (40.4%). Research institutes recorded the highest share of *strongly agree* responses (58.3%), while neutral assessments were particularly frequent in NACE A-F (46.4%).

The perceived influence of blocking patents on market strategy and product offerings received slightly stronger support, with 64.4% positive assessments overall. Agreement was highest among research institutes (90.0%) and entities in NACE G-U (81.8%), compared with 66.7% among higher education institutions and 51.9% in NACE A-F. Research institutes also showed the strongest agreement intensity, with 58.3% selecting *strongly agree*. These findings suggest that blocking patents are perceived as tools supporting both negotiations and strategic decision-making, although their reported importance varies across institutional and sectoral categories.

Table 5. Negotiating and strategic functions of blocking patents

STATEMENT AND TYPE OF INSTITUTION	STRONGLY DISAGREE	DISAGREE	NEITHER AGREE NOR DISAGREE	AGREE	STRONGLY AGREE	*N*
The blocking patent is used in negotiations with other firms, e.g. concerning licensing agreements or strategic alliances						
All entities	0	30	107	134	89	*360*
Higher education institutions	0	0	0	56	28	*84*
Research institutes	0	0	19	6	35	*60*
Other entities: NACE A-F	0	24	85	48	26	*183*
Other entities: NACE G-U	0	6	3	24	0	*33*
The blocking patent influences how the firm develops its market strategy or product offering						
All entities	0	28	100	160	72	*360*
Higher education institutions	0	0	28	28	28	*84*
Research institutes	0	0	6	19	35	*60*
Other entities: NACE A-F	0	28	60	86	9	*183*
Other entities: NACE G-U	0	0	6	27	0	*33*

Note: N = 360. The table reports estimated numbers of patents. Percentages discussed in the text are calculated using the corresponding row totals.

Source: Authors' calculations based on data from the Patent Office of the Republic of Poland and the Statistical Office in Szczecin.

5.5. Technological flexibility and investment decisions

As shown in Table 6, blocking patents are perceived as providing flexibility to develop or adapt technologies to changing market conditions, with 65.6% of assessments indicating *agree* or *strongly agree*. Positive responses were most frequent among research institutes (90.0%), followed by higher education institutions (66.7%), entities in NACE A-F (60.7%), and NACE G-U (45.5%). Research institutes also recorded the highest share of *strongly agree* responses (36.7%), while neutral assessments were relatively frequent in NACE G-U (36.4%) and NACE A-F (31.1%).

The perceived influence of blocking patents on investment and R&D decisions received similar overall support, with 66.1% positive assessments. Agreement was highest among research institutes (90.0%), followed by higher education institutions (66.7%), entities in NACE G-U (63.6%), and NACE A-F (58.5%). Research institutes again recorded the highest share of *strongly agree* responses (58.3%). These findings suggest that blocking patents may serve as instruments supporting technological flexibility and investment planning, although their perceived importance differs across institutional and sectoral categories. The results reflect reported assessments rather than independently verified effects on technological development or investment decisions.

Table 6. Technological flexibility and investment decisions related to blocking patents

STATEMENT AND TYPE OF INSTITUTION	STRONGLY DISAGREE	DISAGREE	NEITHER AGREE NOR DISAGREE	AGREE	STRONGLY AGREE	*N*
The blocking patent provides the firm with flexibility to develop or adapt its technology to changing market conditions						
All entities	0	21	103	205	31	*360*
Higher education institutions	0	0	28	56	0	*84*
Research institutes	0	0	6	32	22	*60*
Other entities: NACE A-F	0	15	57	102	9	*183*
Other entities: NACE G-U	0	6	12	15	0	*33*
The blocking patent influences decisions concerning investments or research and development projects						
All entities	0	34	88	166	72	*360*
Higher education institutions	0	0	28	28	28	*84*
Research institutes	0	0	6	19	35	*60*
Other entities: NACE A-F	0	34	42	98	9	*183*
Other entities: NACE G-U	0	0	12	21	0	*33*

Note: N = 360. The table reports estimated numbers of patents. Percentages discussed in the text are calculated using the corresponding row totals.

Source: Authors' calculations based on data from the Patent Office of the Republic of Poland and the Statistical Office in Szczecin.

5.6. Long-term strategic and sustainability objectives

The findings presented in Table 7 indicate that blocking patents are also perceived as elements of long-term strategy and future investment, with 65.3% of assessments indicating *agree* or *strongly agree*. Positive responses were most frequent among entities in NACE G-U (90.9%), followed by research institutes (78.3%), higher education institutions (66.7%), and NACE A-F (55.7%). Research institutes recorded the highest share of *strongly agree* responses (58.3%), while disagreement was particularly frequent in NACE A-F (29.5%).

Table 7. Long-term strategic and sustainability functions of blocking patents

STATEMENT AND TYPE OF INSTITUTION	STRONGLY DISAGREE	DISAGREE	NEITHER AGREE NOR DISAGREE	AGREE	STRONGLY AGREE	*N*
Holding this patent is part of the firm's long-term strategy and is regarded as a key investment for the future						
All entities	0	57	68	163	72	*360*
Higher education institutions	0	0	28	28	28	*84*
Research institutes	0	0	13	12	35	*60*
Other entities: NACE A-F	0	54	27	93	9	*183*
Other entities: NACE G-U	0	3	0	30	0	*33*
The blocking patent contributes to the firm's sustainability objectives: efficient use of resources/raw materials/energy						
All entities	13	30	132	140	45	*360*
Higher education institutions	0	0	56	28	0	*84*
Research Institutes	0	0	13	11	36	*60*
Other entities: NACE A-F	13	27	60	74	9	*183*
Other entities: NACE G-U	0	3	3	27	0	*33*

Note: N = 360. The table reports estimated numbers of patents. Percentages discussed in the text are calculated using the corresponding row totals.

Source: Authors' calculations based on data from the Patent Office of the Republic of Poland and the Statistical Office in Szczecin.

The perceived contribution of blocking patents to sustainability objectives, particularly efficient use of resources, raw materials, and energy, received weaker overall support (51.4%). Agreement was highest among entities in NACE G-U (81.8%) and research institutes (78.3%), compared with 45.4% in NACE A-F and 33.3% among higher education institutions. Neutral responses accounted for 36.7% overall, suggesting uncertainty regarding the sustainability-related functions of blocking patents. These findings indicate that blocking patents are more widely associated with long-term strategic positioning than with sustainability objectives, although their perceived importance varies across institutional and sectoral categories.

5.7. Comparative importance of blocking patent functions

As shown in Figure 6, the comparative assessment of blocking patent functions discussed in this chapter reveals considerable differences in their perceived importance. The strongest support was recorded for protection against copying or imitation (98.3%) and maintaining competitive advantage (90.8%), followed by organizational value and reputation (78.6%) and reducing the risk of losing market share (75.6%). These results highlight the predominance of competitive and protective functions.

Strategic and technological functions received moderate support, ranging from 61.9% for negotiations with other firms to 66.1% for investment and R&D decisions. Sustainability objectives received weaker support (51.4%), while increasing sales of other products or services (39.2%) and maintaining profit margins (37.8%) ranked lowest. Overall, the findings suggest that blocking patents are perceived primarily as instruments of technological protection and strategic positioning rather than sources of direct financial benefits.

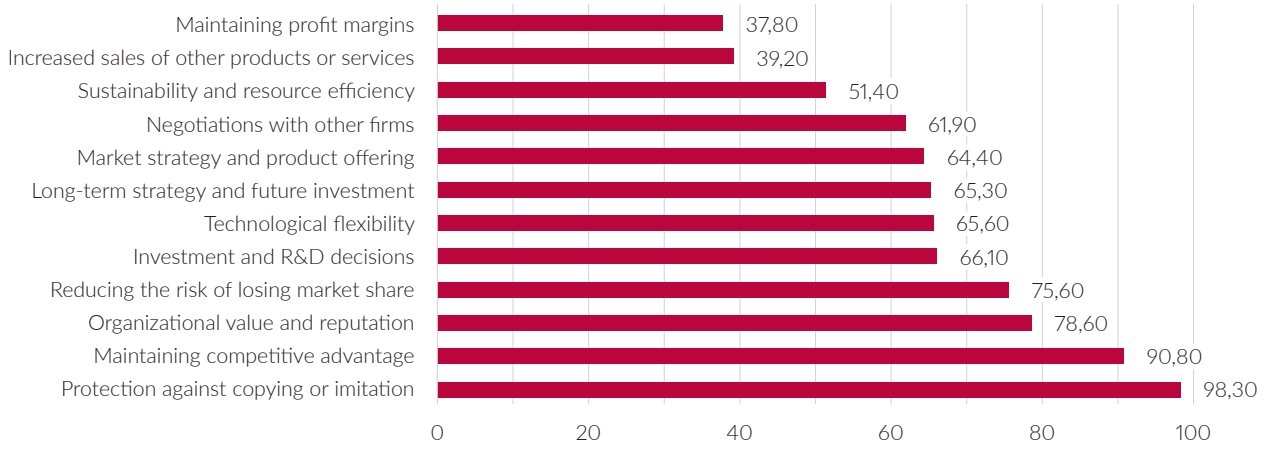


Figure 6. Perceived functions of blocking patents ranked by positive responses

Note: N = 360. Positive responses represent the combined share of *agree* and *strongly agree* assessments for each function. Percentages are calculated from estimated numbers of patents and ranked in descending order.

Source: Authors' calculations based on data from the Patent Office of the Republic of Poland and the Statistical Office in Szczecin.

5.8. Barriers to commercialization

While blocking patents represent a form of strategic non-commercialization, other patents remain outside commercialization processes due to market, financial, organizational, and technological barriers. This section examines barriers reported for patents that were not undergoing commercialization, were not classified as blocking patents, and had no plans for future commercialization.

As presented in Table 8, the most frequently reported barriers to commercialization among patents that were not undergoing commercialization, were not classified as blocking patents, and had no plans for future commercialization were lack of demand for the technology (4 678 patents; 62.7%) and insufficient investor interest (3 576 patents; 47.9%). Other important barriers included lack of financial resources (1 455 patents; 19.5%), insufficient human resources (1 197 patents; 16.0%), and lack of economic viability (957 patents; 12.8%). However, the relative importance of these barriers differed considerably across institutional categories.

Table 8. Barriers to commercialization of patents without future commercialization plans, excluding blocking patents

BARRIER	ALL ENTITIES	HIGHER EDUCATION INSTITUTIONS	RESEARCH INSTITUTES	OTHER ENTITIES: NACE A-F	OTHER ENTITIES: NACE G-U
Lack of financial resources	1 455	900	281	175	99
Lack of knowledge	136	43	45	39	9
Changes in external conditions	689	189	191	231	78
Lack of demand for the technology	4 678	3 818	354	368	138
Technological obsolescence	276	115	9	128	24
Legal issues	130	60	16	30	24
Insufficient human resources	1 197	1 011	123	36	27
Lack of economic viability	957	550	125	213	69
Regulatory uncertainty	97	18	19	42	18
Insufficient investor interest	3 576	2 842	423	201	110

BARRIER	ALL ENTITIES	HIGHER EDUCATION INSTITUTIONS	RESEARCH INSTITUTES	OTHER ENTITIES: NACE A-F	OTHER ENTITIES: NACE G-U
Technical difficulties	389	128	44	181	36
Market risk	354	134	64	135	21
Certification issues	182	155	0	15	12
Logistical constraints	106	69	19	18	0
Patent-related restrictions	21	0	9	9	3
Changes in business strategy	405	34	36	260	75
Data protection issues	6	0	0	3	3
Other	899	324	160	317	98
N	7 460	4 708	943	1 365	444
% of N					
Lack of financial resources	19.5	19.1	29.8	12.8	22.3
Lack of knowledge	1.8	0.9	4.8	2.9	2.0
Changes in external conditions	9.2	4.0	20.3	16.9	17.6
Lack of demand for the technology	62.7	81.1	37.5	27.0	31.1
Technological obsolescence	3.7	2.4	1.0	9.4	5.4
Legal issues	1.7	1.3	1.7	2.2	5.4
Insufficient human resources	16.0	21.5	13.0	2.6	6.1
Lack of economic viability	12.8	11.7	13.3	15.6	15.5
Regulatory uncertainty	1.3	0.4	2.0	3.1	4.1
Insufficient investor interest	47.9	60.4	44.9	14.7	24.8
Technical difficulties	5.2	2.7	4.7	13.3	8.1
Market risk	4.7	2.8	6.8	9.9	4.7
Certification issues	2.4	3.3	0.0	1.1	2.7
Logistical constraints	1.4	1.5	2.0	1.3	0.0
Patent-related restrictions	0.3	0.0	1.0	0.7	0.7
Changes in business strategy	5.4	0.7	3.8	19.0	16.9
Data protection issues	0.1	0.0	0.0	0.2	0.7
Other	12.1	6.9	17.0	23.2	22.1

Notes: The table presents estimated numbers and percentages of patents that were not undergoing commercialization, were not classified as blocking patents, and had no plans for future commercialization (N = 7 460). Multiple responses were allowed; therefore, percentages do not sum to 100%. Percentages are calculated relative to the total number of patents in each institutional category.

Source: Authors' calculations based on data from the Patent Office of the Republic of Poland and the Statistical Office in Szczecin.

Higher education institutions were particularly affected by demand- and investment-related barriers. Lack of demand for the technology was reported for 3 818 patents (81.1%), while insufficient investor interest affected 2 842 patents (60.4%). Insufficient human resources also represented a significant constraint, affecting 1 011 patents (21.5%). These findings suggest that commercialization barriers in higher education institutions were primarily associated with difficulties in identifying market demand, attracting investors, and mobilizing resources for commercialization.

Research institutes displayed a more diversified pattern of barriers. Insufficient investor interest was the most frequently reported constraint (423 patents; 44.9%), followed by lack of demand for the technology (354 patents; 37.5%) and lack of financial resources (281 patents; 29.8%). Changes in external conditions were also relatively important (20.3%), indicating that research institutes faced a broader combination of financial, market-related, and external constraints than higher education institutions.

Among other entities operating in NACE sections A-F and G-U, barriers were more diverse and relatively less concentrated on demand and investor interest. Lack of demand for the technology affected 27.0% and 31.1% of patents, respectively, substantially below the corresponding shares in higher education institutions. In contrast, changes in business strategy were more frequently reported in these entities (19.0% in NACE A-F and 16.9% in NACE G-U), compared with only 0.7% in higher education institutions and 3.8% in research institutes. Technical difficulties were also more prevalent among entities in NACE A-F (13.3%), while lack of financial resources was particularly relevant in NACE G-U (22.3%).

Overall, the results indicate distinct institutional patterns of barriers to patent commercialization. Higher education institutions were predominantly constrained by limited market demand and investor interest, research institutes faced a combination of market and financial barriers, while other entities reported a more diversified set of constraints, including changes in business strategy, technical difficulties, and economic viability. These differences suggest that the obstacles to commercialization vary according to the institutional and economic context in which patents are developed and potentially exploited.

6 Economic outcomes of patent commercialization

6.1. Costs and benefits of commercialized patent development

As shown in Table 9, assessments of commercialized patent development costs relative to the benefits of holding patents were relatively balanced. Overall, 34.9% of patents were associated with costs perceived as lower than the benefits, 32.4% with comparable costs and benefits, and 32.7% with costs exceeding the benefits. This distribution suggests considerable variation in the perceived economic value of patent development.

Institutional and sectoral differences were substantial. Higher education institutions reported the least favorable assessments, with costs exceeding benefits for 55.7% of patents, compared with only 9.6% for which costs were lower. In contrast, costs were perceived as lower than benefits for 54.4% of patents held by entities in NACE A-F, 52.6% in NACE G-U, and 47.5% in research institutes. The corresponding shares of patents with costs exceeding benefits were considerably lower, at 13.0%, 30.1%, and 19.1%, respectively. These findings indicate that the perceived cost-benefit balance of patent development differs markedly across institutional and sectoral categories, with more favorable assessments among entities outside higher education. However, the results reflect reported evaluations rather than independently verified financial returns.

Table 9. Commercialized patent development costs relative to benefits

STATEMENT AND TYPE OF INSTITUTION	SIGNIFICANTLY LOWER	MODERATELY LOWER	COMPARABLE	MODERATELY HIGHER	SIGNIFICANTLY HIGHER	*N*
Compared with the benefits derived from holding the patent, the costs of developing it are…						
All entities	564	436	929	541	398	*2 868*
Higher education institutions	75	42	421	433	244	*1 215*
Research institutes	74	13	61	6	29	*183*
Other entities: NACE A-F	341	345	411	66	98	*1 261*
Other entities: NACE G-U	74	36	36	36	27	*209*

Note: N = 2 868. The table reports estimated numbers of patents. Percentages discussed in the text are calculated using the corresponding row totals.

Source: Authors' calculations based on data from the Patent Office of the Republic of Poland and the Statistical Office in Szczecin.

6.2. Operational and financial benefits of commercialization

As shown in Table 10, operational benefits from patent commercialization were reported for 30.6% of patents, based on *agree* or *strongly agree* responses. Positive assessments were most frequent among entities in NACE A-F (54.6%) and NACE G-U (45.5%), compared with 28.4% among research institutes and only 3.5% among higher education institutions. Neutral responses accounted for 32.5% of the total, indicating considerable uncertainty regarding

operational effects. Moreover, 32.8% of responses were classified as *not applicable*, particularly among higher education institutions (53.9%) and research institutes (53.6%). These differences suggest that operational benefits from commercialization are more frequently recognized among entities operating in market-oriented sectors than among research-oriented institutions.

The contribution of commercialization to increased revenues from the sale of products and services received somewhat stronger support, with 36.2% positive assessments overall. Agreement was highest among entities in NACE G-U (58.4%) and NACE A-F (57.7%), followed by research institutes (32.2%) and higher education institutions (10.6%). Unlike operational benefits, sales-related effects were accompanied by a higher share of negative assessments (20.7%), while 18.1% of responses were neutral. Responses classified as *not applicable* accounted for 25.0% overall, with the highest share among higher education institutions (47.8%) and research institutes (40.4%). These findings indicate that increased sales are more frequently reported than operational benefits, particularly among entities in NACE A-F and G-U. However, the substantial differences across institutional categories highlight the varying relevance of commercialization outcomes, while the reported assessments do not independently establish their actual economic magnitude.

Table 10. Operational and financial benefits of patent commercialization

STATEMENT AND TYPE OF INSTITUTION	STRONGLY DISAGREE	DISAGREE	NEITHER AGREE NOR DISAGREE	AGREE	STRONGLY AGREE	NOT APPLICABLE	*N*
Commercialization generated operational benefits							
All entities	24	92	933	697	180	942	*2 868*
Higher education institutions	0	0	518	42	0	655	*1 215*
Research institutes	0	0	33	33	19	98	*183*
Other entities: NACE A-F	18	71	337	559	129	147	*1 261*
Other entities: NACE G-U	6	21	45	63	32	42	*209*
Commercialization resulted in increased revenues from the sale of products and services							
All entities	36	559	519	801	236	717	*2 868*
Higher education institutions	0	422	83	72	57	581	*1 215*
Research institutes	0	0	50	40	19	74	*183*
Other entities: NACE A-F	24	119	335	605	122	56	*1 261*
Other entities: NACE G-U	12	18	51	84	38	6	*209*

Note: N = 2 868. The table reports estimated numbers of patents undergoing commercialization. Percentages discussed in the text are calculated using the corresponding row totals, including responses classified as not applicable.

Source: Authors' calculations based on data from the Patent Office of the Republic of Poland and the Statistical Office in Szczecin.

6.3. Cost reductions and other benefits of commercialization

As shown in Table 11, cost reductions resulting from patent commercialization were reported for 15.9% of patents, based on *agree* or *strongly agree* responses. Positive assessments were most frequent among entities in NACE A-F (26.2%), followed by NACE G-U (24.4%) and research institutes (23.5%), while higher education institutions recorded a substantially lower share (2.6%). Overall, negative assessments accounted for 29.6%, while 30.9% of responses were

classified as *not applicable*. The latter category was particularly prevalent among higher education institutions (51.6%) and research institutes (55.7%), suggesting that cost-saving effects were not relevant to a substantial proportion of patents in these institutions.

Other benefits beyond operational improvements, increased sales, and cost reductions were reported for 25.3% of patents. Positive assessments were most frequent among entities in NACE G-U (47.4%) and research institutes (44.8%), followed by NACE A-F (33.6%) and higher education institutions (10.0%). However, neutral responses predominated, accounting for 66.9% of the total, particularly among higher education institutions (86.6%). These findings suggest that additional benefits from commercialization are more frequently recognized outside higher education, although their specific nature and economic significance cannot be established from these assessments.

Table 11. Cost reductions and other benefits of patent commercialization

STATEMENT AND TYPE OF INSTITUTION	STRONGLY DISAGREE	DISAGREE	NEITHER AGREE NOR DISAGREE	AGREE	STRONGLY AGREE	NOT APPLICABLE	*N*
Commercialization resulted in cost reductions							
All entities	54	796	676	379	76	887	*2 868*
Higher education institutions	0	406	151	31	0	627	*1 215*
Research institutes	0	0	38	30	13	102	*183*
Other entities: NACE A-F	42	340	424	285	45	125	*1 261*
Other entities: NACE G-U	12	50	63	33	18	33	*209*
Commercialization generated benefits other than operational improvements, increased sales, or cost reductions							
All entities	65	157	1 920	557	169	..	*2 868*
Higher education institutions	0	42	1 052	48	73	..	*1 215*
Research institutes	14	13	74	74	8	..	*183*
Other entities: NACE A-F	42	87	708	372	52	..	*1 261*
Other entities: NACE G-U	9	15	86	63	36	..	*209*

Note: N = 2 868. The table reports estimated numbers of patents undergoing commercialization. Percentages are calculated using the corresponding row totals. The not applicable response category was available for cost reductions but not for other benefits; the symbol ".." denotes a response category that was not included in the question.

Source: Authors' calculations based on data from the Patent Office of the Republic of Poland and the Statistical Office in Szczecin.

6.4. Commercialization revenues and future expectations

As presented in Table 12, revenue data were available or could be reliably estimated for 1 281 out of 2 868 patents undergoing commercialization (44.7%). Among these, 895 patents were associated with exact revenue figures and 386 with estimated values. For the remaining 1 587 patents, revenue data were unavailable or could not be reliably estimated. The availability of financial information differed across institutional categories. Higher education institutions recorded the largest number of patents with reportable revenues (617), followed by entities in NACE sections A-F (505). Notably, exact revenue figures predominated among higher education institutions, whereas estimated figures were more common among entities in NACE sections A-F and G-U.

Table 12. Number of patents granted in 2019–2023 subject to commercialization, by availability of revenue data

TYPE OF INSTITUTION	TOTAL	REVENUE DATA UNAVAILABLE OR CANNOT BE RELIABLY ESTIMATED	REVENUE DATA AVAILABLE FOR REPORTING – TOTAL	EXACT DATA	ESTIMATED DATA
All entities	2 868	1 587	1 281	895	386
Higher education institutions	1 215	598	617	588	29
Research institutes	183	117	66	33	33
Other entities: NACE A-F	1 261	756	505	244	261
Other entities: NACE G-U	209	116	93	30	63

Source: Authors' calculations based on data from the Patent Office of the Republic of Poland and the Statistical Office in Szczecin.

The financial outcomes presented in Table 13 reveal substantial differences in the scale and structure of reported commercialization revenues. Total revenues amounted to PLN 3 926.7 million, comprising PLN 2 793.6 million in direct revenues[1] and PLN 1 133.1 million in indirect revenues[2]. The overwhelming majority of reported revenues originated from entities in NACE sections A-F (PLN 3 695.0 million), followed by entities in NACE sections G-U (PLN 187.3 million). Research institutes and higher education institutions reported considerably lower amounts, at PLN 42.4 million and PLN 2.0 million, respectively. Direct revenues dominated in most institutional categories, while indirect revenues accounted for the larger share among higher education institutions. An important distinction also concerns the precision of reported values: estimated revenues amounted to PLN 2 197.0 million, exceeding exact revenues of PLN 1 729.8 million.

Table 13. Reported commercialization revenues: total, direct and indirect revenues (PLN thousands)

TYPE OF INSTITUTION	TOTAL REVENUES	DIRECT REVENUES	INDIRECT REVENUES
Sum of reported exact and estimated revenues			
All entities	3 926 711	2 793 603	1 133 108
Higher education institutions	2 045	645	1 400
Research institutes	42 430	40 468	1 962
Other entities: NACE A-F	3 694 985	2 652 659	1 042 326
Other entities: NACE G-U	187 251	99 831	87 420
Reported exact revenues			
All entities	1 729 760	1 230 329	499 431
Higher education institutions	2 016	616	1 400
Research institutes	1 010	568	442
Other entities: NACE A-F	1 702 767	1 205 178	497 589
Other entities: NACE G-U	23 967	23 967	0

[1] Direct revenue includes only revenue generated directly by the patent, i.e., revenue from the sale of products or services based on the patent, licensing, sublicensing, or the sale of the patent itself.

[2] Indirect revenues may include benefits derived from a patent as a result of organizational changes, process optimization, or improvements in operational efficiency.

TYPE OF INSTITUTION	TOTAL REVENUES	DIRECT REVENUES	INDIRECT REVENUES
Reported estimated revenues			
All entities	2 196 951	1 563 274	633 677
Higher education institutions	29	29	0
Research institutes	41 420	39 900	1 520
Other entities: NACE A-F	1 992 218	1 447 481	544 737
Other entities: NACE G-U	163 284	75 864	87 420

Source: Authors' calculations based on data from the Patent Office of the Republic of Poland and the Statistical Office in Szczecin.

A comparison of the two measures of reported commercialization revenues per patent presented in Table 14 reveals substantial differences depending on the denominator used. For the 1 281 patents with available or reliably estimable revenue data, average reported revenues amounted to PLN 3.07 million per patent, comprising PLN 2.18 million in direct revenues and PLN 0.88 million in indirect revenues. Dividing the same aggregate reported revenues by all 2 868 patents undergoing commercialization yields a broader revenue-per-patent ratio of PLN 1.37 million. The highest values were recorded among entities in NACE sections A-F, reaching PLN 7.32 million under the narrower measure and PLN 2.93 million under the broader measure. Entities in NACE sections G-U followed, with PLN 2.01 million and PLN 0.90 million, respectively.

The broader measure is retained to ensure comparability with previous reporting, while the narrower measure provides an average based on patents for which revenue information was available or could be reliably estimated. The difference between these measures results solely from the use of different denominators, as the underlying aggregate reported revenues remain unchanged. Importantly, the broader measure may underestimate actual average commercialization revenues per patent because reliable revenue data were unavailable for 1 587 patents undergoing commercialization.

Table 14. Reported patent commercialization revenues per patent (PLN per patent)

TYPE OF INSTITUTION	TOTAL REVENUES	DIRECT REVENUES	INDIRECT REVENUES
Reported patent commercialization revenues per patent with available or reliably estimable revenue data (N = 1 281)			
All entities	3 065 348	2 180 799	884 550
Higher education institutions	3 314	1 045	2 269
Research institutes	642 879	613 152	29 727
Other entities: NACE A-F	7 316 802	5 252 790	2 064 012
Other entities: NACE G-U	2 013 452	1 073 452	940 000
Reported patent commercialization revenues per patent undergoing commercialization (N = 2 868)			
All entities	1 369 146	974 060	395 086
Higher education institutions	1 683	531	1 152
Research institutes	231 858	221 137	10 721
Other entities: NACE A-F	2 930 202	2 103 615	826 587
Other entities: NACE G-U	895 938	477 660	418 278

Note: The two panels correspond to the patent populations presented in Table 12. The first reports commercialization revenues per patent with available or reliably estimable revenue data (N = 1 281). The second relates the same reported revenues to all patents undergoing commercialization (N = 2 868). All values are expressed in PLN per patent.

Source: Authors' calculations based on data from the Patent Office of the Republic of Poland and the Statistical Office in Szczecin.

The expected trends in future commercialization revenues, presented in Table 15, suggest that respondents generally anticipated stable or positive financial outcomes. Revenues were expected to remain stable for 710 patents, increase for 416, and decrease for 155. Stable revenues were particularly common among higher education institutions (379 patents), while entities in NACE sections A-F accounted for the largest number of expected revenue declines (90 patents). Research institutes reported no expected declines, and revenue increases were anticipated for 28 of their 66 patents with reportable revenue data. These findings suggest that respondents generally anticipated maintaining or improving commercialization revenues in the coming years, although expectations varied across institutional categories.

Table 15. Expected commercialization revenue trends in the coming years for patents with available or reliably estimable revenue data

TYPE OF INSTITUTION	EXPECTED TO INCREASE	EXPECTED TO REMAIN STABLE	EXPECTED TO DECREASE	*N*
All entities	416	710	155	*1 281*
Higher education institutions	182	379	56	*617*
Research institutes	28	38	0	*66*
Other entities: NACE A-F	164	251	90	*505*
Other entities: NACE G-U	42	42	9	*93*

Source: Authors' calculations based on data from the Patent Office of the Republic of Poland and the Statistical Office in Szczecin.

Overall, the results indicate that commercialization revenues are highly concentrated among entities operating in NACE sections A-F, while their composition and availability vary considerably across institutional categories. The substantial share of estimated revenues and the absence of reliable financial information for more than half of the patents undergoing commercialization highlight the need for caution when interpreting aggregate revenues and comparing financial outcomes across institutions.

7 Technological fields and patent commercialization

The analysis of patent commercialization across technological fields is based on the technology classification developed by Schmoch (2008) for the World Intellectual Property Organization. This classification links International Patent Classification codes to 35 technological fields grouped into five broad areas: electrical engineering, instruments, chemistry, mechanical engineering, and other fields. Originally developed to facilitate international comparisons of technological specialization, the classification provides a consistent framework for examining the technological structure of patent portfolios.

In the present study, this framework is used to analyze the distribution of patents granted in Poland in 2019–2023 and differences in their commercialization across technological fields and institutional categories. The analysis distinguishes between patenting activity, commercialization intensity, and technological specialization, allowing an assessment of whether fields with higher patenting activity also exhibit higher levels of commercialization. The results are presented at the level of five broad technological areas, while more detailed findings for individual technological fields are not reported due to statistical disclosure restrictions.

7.1. Patent activity and commercialization by technological field

The distribution of patents across technological fields reveals substantial differences in the concentration of patenting and commercialization activities (see Table 16). Chemistry accounted for the largest number of patents granted in 2019–2023 (4 907), followed by mechanical engineering (3 345) and instruments (1 562). Considerably fewer patents were recorded in other fields (1 026) and electrical engineering (686).

The distribution of patents undergoing commercialization followed a somewhat different pattern. Mechanical engineering accounted for the largest number of patents undergoing commercialization (1 000), followed by chemistry (860), other fields (413), instruments (373), and electrical engineering (222). Notably, although chemistry dominated overall patenting activity, mechanical engineering contributed the largest number of patents undergoing commercialization.

Table 16. Patents granted in 2019–2023 and patents undergoing commercialization, by technological field

TECHNOLOGICAL FIELD	TOTAL PATENTS	PATENTS UNDERGOING COMMERCIALIZATION	COMMERCIALIZATION INTENSITY (%)
Electrical engineering	686	222	32.4
Instruments	1 562	373	23.9
Chemistry	4 907	860	17.5
Mechanical engineering	3 345	1 000	29.9
Other fields	1 026	413	40.3

Note: Commercialization intensity is defined as the percentage of patents undergoing commercialization within a given technological field, calculated as the number of patents undergoing commercialization divided by the total number of patents in that field, multiplied by 100. The table presents estimated numbers of patents classified according to the WIPO technology classification developed by Schmoch (2008).

Source: Authors' calculations based on patent data from the Patent Office of the Republic of Poland and survey data from the Statistical Office in Szczecin.

Differences were also evident in commercialization intensity, measured as the proportion of patents undergoing commercialization within each technological field. As shown in Table 16, the highest commercialization intensity was recorded in other fields (40.3%), followed by electrical engineering (32.4%) and mechanical engineering (29.9%), all exceeding the overall average of 24.9%. Instruments recorded a slightly lower intensity (23.9%), while chemistry exhibited the lowest rate (17.5%), despite accounting for the largest number of granted patents.

These findings highlight a divergence between the concentration of patenting activity and commercialization intensity. In particular, the relatively low commercialization intensity in chemistry contrasts with the higher commercialization performance observed in mechanical and electrical engineering. This suggests that technological fields with the largest patent portfolios are not necessarily those in which patents are most frequently undergoing commercialization.

7.2. Technological specialization and commercialization across institutional categories

The analysis of technological specialization and commercialization across institutional categories reveals substantial differences in both the technological profiles and commercialization patterns of higher education institutions, research institutes, and other entities (see Table 17). The Technological Specialization Index (TSI) identifies technological areas that are relatively overrepresented or underrepresented in the patent portfolios of individual institutional categories compared with the overall patent portfolio. Combining this measure with commercialization intensity makes it possible to examine whether relative technological specialization is accompanied by a higher proportion of patents undergoing commercialization.

Table 17. Technological specialization and commercialization by institutional category

	ELECTRICAL ENGINEERING	INSTRUMENTS	CHEMISTRY	MECHANICAL ENGINEERING	OTHER FIELDS
Technological Specialization Index (TSI)					
Higher education institutions	0.98	1.25	1.10	0.88	0.54
Research institutes	1.17	1.06	1.29	0.75	0.22
Other entities: NACE A-F	0.90	0.48	0.75	1.28	2.16
Other entities: NACE G-U	1.28	0.78	0.57	1.41	1.91
Commercialization intensity					
Higher education institutions	26.4	22.7	11.4	22.6	44.6
Research institutes	34.4	14.6	10.9	13.7	11.5
Other entities: NACE A-F	53.8	32.8	40.8	46.4	42.0
Other entities: NACE G-U	10.3	41.3	27.9	26.8	27.9

Note: The Technological Specialization Index (TSI), adapted from the Revealed Technological Advantage (RTA) approach described by OECD (2009), measures the relative concentration of patents in a given technological field within an institutional category compared with the corresponding share in the overall patent portfolio. A TSI value above 1 indicates relative specialization, while a value below 1 indicates relative underrepresentation. Commercialization intensity was defined in note to Table 16.

Source: Authors' calculations based on patent data from the Patent Office of the Republic of Poland and survey data from the Statistical Office in Szczecin, using a methodology adapted from OECD (2009).

The results indicate distinct patterns of technological specialization across institutional categories. Higher education institutions exhibited relative specialization in instruments (TSI = 1.25) and chemistry (1.10), while electrical engineering was represented approximately in line with the overall patent structure (0.98). Mechanical engineering (0.88) and other fields (0.54) were relatively underrepresented. Research institutes demonstrated their strongest specialization in chemistry (1.29), followed by electrical engineering (1.17) and instruments (1.06). In contrast, mechanical engineering (0.75) and other fields (0.22) were underrepresented in their patent portfolios.

A different technological profile characterized other entities operating in NACE sections A-F, which predominantly comprise enterprises. Their strongest relative specialization was observed in other fields (TSI = 2.16), followed by mechanical engineering (1.28). Electrical engineering (0.90), chemistry (0.75), and particularly instruments (0.48) were relatively underrepresented. Entities operating in NACE sections G-U exhibited a similar specialization in other fields (1.91) and mechanical engineering (1.41), while also demonstrating relative specialization in electrical engineering (1.28). Instruments (0.78) and chemistry (0.57) were less strongly represented in their patent portfolios. These findings reveal a clear distinction between the technological profiles of research-oriented institutions, which are relatively specialized in chemistry and instruments, and those of enterprise-dominated categories, which exhibit stronger specialization in mechanical engineering and other fields.

The comparison of commercialization intensity reveals additional institutional differences. Other entities operating in NACE sections A-F recorded the highest commercialization intensity in three of the five technological areas. Their commercialization rates reached 53.8% in electrical engineering, 46.4% in mechanical engineering, and 40.8% in chemistry. They also recorded relatively high commercialization intensity in other fields (42.0%), although this was slightly below the rate observed in higher education institutions (44.6%). In instruments, commercialization intensity amounted to 32.8%, exceeding the corresponding rates for higher education institutions and research institutes, but remaining below that recorded for entities in NACE sections G-U (41.3%). These results indicate that enterprises operating in agriculture, industry, and construction exhibit relatively high commercialization intensity across technological areas, including those in which their patent portfolios do not demonstrate relative specialization.

Higher education institutions displayed a more differentiated relationship between technological specialization and commercialization intensity. Their highest commercialization intensity was recorded in other fields (44.6%), despite the relatively low TSI value of 0.54. Electrical engineering exhibited a commercialization intensity of 26.4%, followed by instruments (22.7%) and mechanical engineering (22.6%). Chemistry, despite being one of the areas of relative technological specialization (TSI = 1.10), recorded the lowest commercialization intensity (11.4%).

Research institutes exhibited a similar divergence. Although chemistry represented their strongest area of technological specialization (TSI = 1.29), its commercialization intensity was only 10.9%. Relatively low commercialization rates were also recorded in other fields (11.5%), mechanical engineering (13.7%), and instruments (14.6%). Electrical engineering was a notable exception, combining relative technological specialization (TSI = 1.17) with a commercialization intensity of 34.4%, exceeding the corresponding rate among higher education institutions (26.4%). Nevertheless, the overall pattern indicates that technological specialization among research institutes is not consistently accompanied by intensive commercialization.

Entities operating in NACE sections G-U demonstrated a distinct relationship between specialization and commercialization. Their highest commercialization intensity was observed in instruments (41.3%), despite the relative underrepresentation of this area in their patent portfolios (TSI = 0.78). Chemistry and other fields both recorded commercialization intensity of 27.9%, followed by mechanical engineering (26.8%). Electrical engineering, despite exhibiting relative technological specialization (TSI = 1.28), recorded the lowest commercialization intensity (10.3%).

A cross-institutional comparison further demonstrates that technological specialization and commercialization intensity do not necessarily coincide. Chemistry provides a particularly clear example: despite the relative specialization of higher education institutions and research institutes in this area, their commercialization intensities remained substantially below that recorded among entities in NACE sections A-F, which were relatively underrepresented in chemistry. A similar divergence was observed in electrical engineering, where entities in NACE sections A-F achieved the highest commercialization intensity despite the absence of relative specialization, while entities in NACE sections G-U combined relative specialization with the lowest commercialization intensity. Mechanical engineering presented a somewhat different pattern, as both enterprise-dominated categories exhibited relative specialization and commercialization intensities above the overall average of 24.9%, although their commercialization rates differed considerably. Overall, these findings indicate that technological specialization alone does not explain differences in patent commercialization across institutional categories.

8 Discussion and conclusions

8.1. Discussion

The findings of this study contribute to the literature on patent commercialization by demonstrating that patenting activity, involvement in commercialization processes, and realized economic outcomes represent distinct dimensions of technological innovation. Of the 11 526 patents examined, only 24.9% were undergoing commercialization, while most of the remaining patents were not planned for future exploitation. These findings are consistent with Giuri et al. (2007), who demonstrate the diversity of patent utilization pathways, and reinforce the distinction between patent protection and economic value emphasized by Gambardella et al. (2008). Importantly, the broad definition adopted in this study includes commercialization activities preceding market implementation or revenue generation. Consequently, commercialization intensity should not be equated with commercial success. This distinction is consistent with Feller and Feldman (2010), who emphasize the complex processes connecting academic patents and licensing activities to commercially viable innovations.

A central finding concerns the predominance of independent commercialization, particularly among enterprises operating in NACE sections A-F. This pattern can be interpreted through the resource-based view (Barney, 1991; Penrose, 1959; Wernerfelt, 1984) and Teece's (1986) framework of complementary assets. Enterprises possessing production capabilities, distribution networks, and market knowledge may be better positioned to exploit patented technologies internally. Research institutes, by contrast, exhibited relatively greater reliance on external partners and patent sales. These differences are consistent with the markets-for-technology perspective developed by Arora et al. (2001), although the study does not directly establish the organizational determinants of commercialization pathways.

The results reveal a pronounced asymmetry between the research sector and enterprises. Higher education institutions and research institutes accounted for approximately 68.1% of the patents examined, whereas enterprises exhibited higher commercialization intensity and generated the overwhelming majority of reported commercialization revenues. This pattern is consistent with the argument that technological knowledge alone is insufficient to ensure economic exploitation without access to complementary resources and organizational capabilities (Hamilton & Philbin, 2020; Teece, 1986). However, the lower revenues reported by research institutions should not be interpreted as evidence of lower economic value of their inventions. Research organizations may contribute to earlier stages of technological development, while subsequent commercial benefits may be realized by enterprises exploiting their technologies (Feller & Feldman, 2010).

The analysis of non-commercialization further demonstrates the importance of distinguishing strategic patent uses from barriers to exploitation. Blocking patents represented only 3.1% of the investigated population and were primarily perceived as instruments of protection against imitation and maintenance of competitive advantage. This strategic use of patents is also documented by Giuri et al. (2007), who distinguish blocking patents from commercially exploited and otherwise unused patents. For patents outside commercialization processes, the most frequently reported barriers were insufficient demand for the technology and limited investor interest. These constraints were particularly pronounced among higher education institutions, whereas enterprises reported a more diversified combination of market, technical, financial, and strategic barriers. The results suggest that commercialization challenges differ across institutional environments and cannot be addressed through uniform support instruments.

The economic outcomes of commercialization provide further evidence of the distinction between patent utilization and realized value. Reported revenues were strongly concentrated among enterprises operating in NACE sections A-F, consistent with the heterogeneity of patent values documented by Gambardella et al. (2008). Nevertheless, financial information was available or could be reliably estimated for fewer than half of the patents undergoing commercialization, and estimated values accounted for a substantial proportion of reported revenues. Moreover, commercialization revenues may reflect different mechanisms of value appropriation in research institutions and enterprises. These limitations highlight the difficulties of

measuring patent commercialization through financial indicators alone (Svensson, 2022; Wagner & Wakeman, 2016).

An important additional contribution concerns technological differences in patent commercialization. The analysis based on the classification developed by Schmoch (2008) shows that technological fields with the largest patent portfolios do not necessarily exhibit the highest commercialization intensity. Chemistry accounted for the largest number of granted patents but recorded relatively low commercialization intensity, whereas mechanical engineering contributed the largest number of patents undergoing commercialization.

The analysis of technological specialization provides additional insights into these differences. Higher education institutions and research institutes exhibited relative specialization primarily in chemistry and instruments, whereas enterprises were more strongly specialized in mechanical engineering and other fields. However, relative technological specialization was not consistently accompanied by higher commercialization intensity. For example, higher education institutions and research institutes demonstrated relative specialization in chemistry, with TSI values of 1.10 and 1.29, respectively, but recorded commercialization intensities of only 11.4% and 10.9%. Conversely, enterprises operating in NACE sections A-F exhibited relative underrepresentation in chemistry (TSI = 0.75), while achieving commercialization intensity of 40.8%. These findings suggest that technological specialization alone is insufficient to account for differences in commercial exploitation. They are compatible with the resource-based view and the complementary-assets framework, which emphasize the importance of organizational resources and market capabilities alongside technological knowledge.

Taken together, the findings support a multidimensional interpretation of patent commercialization in which technological characteristics, institutional context, commercialization pathways, and market conditions are considered jointly. From a policy perspective, they suggest that improving the economic utilization of patented inventions requires more than increasing patenting activity. Particular attention should be paid to market validation, cooperation between research institutions and enterprises, access to investors and financing, and the development of commercialization capabilities. Support instruments should also reflect differences across institutional categories and technological fields.

The results should nevertheless be interpreted within the limitations of the study. The analysis covers national patents granted between 2019 and 2023, relies on survey-based estimates, and adopts a broad definition of commercialization that includes activities preceding market implementation. Commercialization status was assessed at a single reference date, while financial information was incomplete for a substantial proportion of patents. Furthermore, the descriptive research design does not establish causal relationships between technological specialization, institutional characteristics, and commercialization outcomes. Future research could examine these relationships longitudinally and assess the role of organizational capabilities and complementary assets in greater detail.

8.2. Conclusions

This study demonstrates that patenting activity, commercialization, and realized economic outcomes represent distinct dimensions of technological innovation. Of the 11 526 national patents granted in Poland between 2019 and 2023, only 24.9% were undergoing commercialization. Independent commercialization was the dominant pathway, while cooperation with external partners and patent sales were considerably less frequent. Most patents outside commercialization processes were not planned for future exploitation, and strategic blocking accounted for a relatively small proportion of the patent population.

The findings reveal substantial differences between the research sector and enterprises. Higher education institutions and research institutes accounted for the majority of granted patents, whereas enterprises exhibited higher commercialization intensity and generated the overwhelming majority of reported commercialization revenues. Barriers to commercialization also differed across institutional categories. Research-oriented institutions were particularly affected by insufficient market demand and investor interest, while enterprises faced a more diversified combination of market, financial, technical, and strategic constraints.

The technological analysis provides an additional important finding: relative technological specialization does not necessarily correspond to higher commercialization intensity. Research institutions exhibited relative specialization in chemistry and instruments, while enterprises were more strongly specialized in mechanical engineering and other fields. Nevertheless, enterprises generally recorded higher commercialization intensity, including in technological areas in which they were relatively less specialized. This highlights the importance of distinguishing technological capabilities from their commercial utilization.

The study contributes to the literature by combining administrative patent records with patent-level survey evidence and integrating institutional, technological, and economic perspectives on commercialization. Its findings suggest that innovation policy should extend beyond stimulating patenting activity to strengthening market validation, technology transfer, cooperation between research institutions and enterprises, and access to complementary resources. Support instruments should reflect differences in institutional capabilities and technological requirements.

Several limitations should be acknowledged. The analysis covers national patents granted during a defined period, relies on survey-based estimates, and uses a broad definition of commercialization that includes activities preceding market implementation. Financial information was incomplete for a substantial proportion of patents, and the descriptive research design does not establish causal relationships. Future research could examine commercialization trajectories longitudinally and investigate how technological specialization, organizational capabilities, and market conditions jointly influence commercialization outcomes.

Overall, the findings indicate that the economic significance of patenting depends not only on the creation and protection of technological knowledge but also on the ability to transform that knowledge into commercially relevant applications. Assessing innovation performance therefore requires attention to both the generation of patented inventions and their subsequent economic utilization.

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