

R&D tax allowance and voluntary information disclosures

Ulga podatkowa na działalność badawczo-rozwojową a dobrowolne ujawnianie informacji

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Abstract

Purpose: This paper examines whether the R&D tax allowance in force in Poland since 2016 has increased the voluntary disclosure of information on innovation, R&D, and strategic plans in the management commentary of companies listed on the Warsaw Stock Exchange (WSE).


Methodology/approach: First, the Tobit model was used to examine the determinants of recognising development works in a sample of 29,288 observations from 3,406 firms. Second, it uses logit and generalised least squares (GLS) methods to analyse 556 management commentaries from 97 public companies that benefited from the R&D tax allowance between 2016 and 2021.


Findings: We show that tax relief increases the probability of recognising development work and disclosing information about patents to signal innovativeness and engagement in R&D. Indebted companies disclose more R&D information and strategic plans. IFRS and advanced management increase disclosures, as opposed to tax planning that uses tax havens or that is supported by more advisors. Companies audited by the Big 4 provide fewer details on R&D outcomes and strategic plans.


Research limitations/implications: Extending the sample requires collecting disclosure data based on the wording in management commentaries using text-mining tools.

Originality/value: The paper contributes to the literature by identifying that R&D tax allowance influences voluntary R&D information disclosure in management commentaries, especially by smaller companies in debt with larger intangible assets.

Keywords: R&D, disclosure, innovation, tax allowance, patent applications.

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Streszczenie

Cel: Celem artykułu jest zbadanie, czy wprowadzona w Polsce ulga podatkowa na B+R w 2016 roku zwiększyła dobrowolne ujawnianie informacji na temat innowacji, działalności B+R i planów strategicznych w sprawozdaniach z działalności spółek notowanych na Giełdzie Papierów Wartościowych w Warszawie (GPW).

Metodyka/podejście badawcze: Po pierwsze, zbadano za pomocą modelu tobitowego na próbie 29 288 obserwacji 3406 firm determinanty rozpoznania prac rozwojowych w bilansie. Po drugie, wykorzystano logit i uogólnioną metodę najmniejszych kwadratów (GLS) do zbadania 556 sprawozdań z działalności 97 spółek publicznych, korzystających z ulgi na B+R w latach 2016–2021.

Wyniki: Wykazano, że ulga zwiększa prawdopodobieństwo rozpoznania prac rozwojowych i ujawnienia informacji o patentach, aby zasygnalizować innowacyjność i zaangażowanie w B+R. Zadłużeni ujawniają więcej informacji o B+R oraz planach strategicznych. MSSF i zaawansowane zarządzanie zwiększają ujawniania, w przeciwieństwie do planowania podatkowego z wykorzystaniem rajów podatkowych lub wspieranych przez więcej doradców. Badani przez wielką czwórkę ujawniają mniej szczegółów o wynikach prac B+R i planach strategicznych.

Ograniczenia/implikacje badawcze: Rozszerzenie próby wymaga zebrania danych dotyczących ujawnień opartych na sformułowaniach w komentarzach zarządu przy użyciu narzędzi do eksploracji tekstu.

Originalność/wartość: Artykuł wnosi wkład do literatury poprzez zidentyfikowanie, że ulga na B+R wpływa na dobrowolne ujawnianie informacji o B+R w sprawozdaniach z działalności, zwłaszcza przez mniejsze firmy zadłużone, posiadające większe wartości niematerialne.

Słowa kluczowe: B+R; ujawnianie informacji, innowacje, ulga podatkowa, wnioski patentowe.

Introduction

This paper investigates how the R&D tax allowance in Poland, which has been in force since 2016, influences the voluntary disclosure of information on innovation, R&D, and strategic plans in the management commentary of companies listed on the Warsaw Stock Exchange (WSE). First, we examine determinants of recognising private and public firms' development works. Second, we analyse voluntary disclosure in the management commentaries of public companies that benefited from the R&D tax allowance at least once between 2016 and 2021. This paper contributes to the discussions in the literature on the relationship between voluntary R&D information disclosures (RDIDs) and innovation in the economy.

Breuer et al. (2020) investigated how mandatory management commentary in financial statements affects corporate innovation. They focused on regulations in Europe, particularly Germany, that require companies to prepare complete financial statements, contrasting this with the exemption for small businesses in the European Union (EU). This exemption, outlined in Directive 2013/34/EU, allows micro and small enterprises to skip the management commentary requirement. Using Community Innovation Survey (CIS) data from 2000– to 2014, they found that forcing companies to publicly disclose financial statements (including a management commentary revealing company strategy, risks, and R&D activities) discourages companies from innovating.

At the industry level, positive spillovers to competitors, suppliers and customers are insufficient to compensate for the negative direct impact on innovation. Indeed, spillovers seem to concentrate innovation within a few large firms in an industry. Breuer et al. (2020) showed that reporting regulations impact firms' innovation by imposing administrative burdens, reducing their incentive to innovate. In addition, companies often argue that disclosure and reporting rules, such as the EU Accounting Directive, require them to disclose proprietary information, discouraging innovation.

Breuer et al. (2020) showed that financial reporting regulations have significant aggregate and distributional effects on corporate innovation, reducing the number of firms that generate product and process innovations, both new to companies and those that are new to the market. Because reporting regulations typically aim to improve the functioning of capital markets and protect investors and other stakeholders, these results raise the question of whether it remains the same in the case of voluntary disclosures.

A critical area of analysis is the spillover effect of voluntary disclosure on R&D outcomes incentivized by tax relief, particularly across different regulatory environments. This is especially relevant in the context of Directive 2013/34/EU, which exempts micro and small enterprises from preparing management commentary. Similarly, in Poland, a high annual revenue threshold (under two million euros for partnerships) exempts a significant portion (87%) of businesses from bookkeeping requirements, including financial statements and management commentary. This threshold, the highest in the EU, likely contributes to the low innovativeness in the Polish economy due to the limited spillover effect.

While mandatory disclosure offers proven benefits for capital markets (Healy & Palepu, 2001), companies often resist such regulations. They argue that disclosure requirements force them to reveal proprietary information to competitors, customers, and suppliers. In particular, RDID could make it difficult for firms to profit from innovation and, in turn, damage their incentives to innovate (Ali, Tang, 2023; Arrow, 1962). Moreover, disclosures can foster competitors and limit innovative activities of companies that disclose more information (Kim, Valentine, 2020).

The true extent of companies' concerns about disclosure remains unclear. Firstly, companies may cite costs to mask deeper motives against transparency (Berger, Hann, 2007). Additionally, even if the law forces companies to disclose proprietary information, other companies benefit from this kind of information proliferation (Zingales, 2009). Such redistribution can be beneficial overall, such as faster adoption of new processes and products. It can also stimulate further innovation as companies build upon each other's work, potentially reducing unnecessary duplication of R&D expenditure. Therefore, the net impact of disclosure regulations on business innovation remains unclear. While companies may incur costs from disclosing proprietary information, the benefits from R&D tax allowances can at least partially offset these costs.

This debate is particularly relevant in light of Europe's slowing productivity growth over the past two decades compared to the US, where a much smaller proportion of companies voluntarily disclose financial information to the public (Minis, 2011).

Our research contributes to the literature in two ways. First, we analyse 29,288 observations from 3,406 firms searching for determinants of development works recognition using the Tobit model. Second, we analyse in-depth 556 management commentaries from 97 public companies that benefited from the R&D tax allowance at least once between 2016 and 2021. We employ using logit and generalised least squares methods in this analysis.

Our findings indicate that:

- Beneficiaries of R&D tax relief are more likely to recognise development work and signal their intent to apply for a patent in their management commentary.
- Those companies disclose voluntary R&D information to signal their innovativeness and engagement in R&D.
- Larger companies carry out less diversified R&D and have fewer R&D strategic plans.
- Profitable businesses reveal less R&D information in their management commentary.
- Companies with higher levels of intangibility have a broader range of R&D and achieve more visible effects. However, they rarely disclose details about innovations created and implemented in their management commentary.
- Indebted companies disclose more voluntary R&D information and strategic plans, building trust and justifying funding needs. Thus, they can use R&D and strategic plan voluntary disclosures in management commentary to support loan applications or attract creditors' attention to negotiate better loan conditions.

The originality of our research lies in identifying the influence of R&D tax allowance on voluntary RDID in management commentaries, particularly for smaller companies that are more indebted and have higher intangibility. Thus, R&D information voluntary disclosure is motivated not only by a desire to reduce information asymmetry but also by a need to signal high-quality operations and compliance with tax law.

The remainder of the paper is structured as follows. Section 1 provides a literature review. Section 2 presents the research design, followed by a description of the data. Section 4 provides the results, and the paper concludes with a discussion of the results.

1. Literature review and hypothesis development

Voluntary disclosures can be explained by stakeholder theory, agency theory, legitimisation and signalling theories (An et al., 2011; Kamath, 2017; Parshakov, Shakina, 2020), and information asymmetry theory (Myers, Majluf, 1984). Information asymmetry between external investors and internal staff (management board) requires the firm to pay a premium for external resources, increasing external financing costs compared to internal financing, especially in imperfect capital markets (Myers, Majluf, 1984). Agency theory suggests that higher information asymmetry may exacerbate the free cash flow problem, making it more difficult for external

investors to monitor and interpret managerial activities, increasing agency costs (Jensen, 1986; Szymanek, Bialek-Jaworska, 2023).

R&D significantly contributes to information asymmetry and insider gains, raising issues about management compensation, incentives, and disclosure policies. First, many R&D projects, such as radically new drugs under development or software programs, are unique to the developing firm. Consequently, investors have limited information about the productivity and value of a firm's R&D from observing the R&D performance of other firms. Second, there are no organised markets for R&D and, hence, no asset prices from which to derive information. Third, accounting measurement and reporting rules treat R&D differently from other investments and immediately expense it if it does not meet the definition of development work capitalised in the balance sheet. Thus, no information on the value and productivity changes of R&D is reported to investors, confirming the relative scarcity of public data about firms' R&D. Still, these activities are crucial to measuring the profit potential of technology and science-based companies. Thus, R&D contributes to information asymmetry between corporate insiders and outside investors, and the former can exploit this asymmetry to gain from insider trading (Aboody, Lev, 2001).

Arora et al. (2021) argued that private returns to corporate research depend on the balance between two opposing forces: the benefits of using science in their inventions and the costs of spillovers to rivals. Changes in the equilibrium between internal use and spillovers may be related to the declining share of research in corporate R&D. The relationship between a company's value and its stock of scientific output is positive and stronger when the company's patents use the science produced by its scientists. Conversely, the corporate stock of scientific work is less valuable to inventors when a company's rivals use its science.

Barth et al. (2001) demonstrated that analysts devote tremendous effort to following firms with intangible assets. Their coverage is significantly greater for firms with more considerable R&D and advertising expenses than their industry and R&D-intensive industries. R&D disclosures help investors evaluate a company's investment opportunities, reducing information asymmetry and enhancing corporate transparency. R&D disclosures also increase investment efficiency for firms with high R&D intensity, institutional ownership, and analyst coverage. This effect is more substantial for companies with better corporate governance and those located in provinces with better market development.

Mazzi et al. (2022) examined the relevance of accounting information on R&D activities and the capitalisation of development costs for equity investors. The results indicate that investors pay attention to R&D disclosure when evaluating a company. This implies that increased R&D disclosures are accompanied by greater investor interest and, thus, a more advantageous position for the company. Therefore, disclosure of intangible assets and R&D reduces the information asymmetry between an entity's managers and its shareholders and stakeholders (Bialek-Jaworska, Krawczyk, 2019; Bialek-Jaworska, 2017), helping improve the allocation of capital in the economy and increasing overall well-being.

Balakrishnan et al. (2014) provide evidence that voluntary disclosure is primarily aimed at reducing information asymmetries between retail and institutional investors. This is consistent with asset pricing models, which stress the importance of information asymmetries for investor demands and asset prices. In addition, it decreases the cost of equity (Mazzi et al., 2017; Balakrishnan et al., 2014), improves stock liquidity (Labidi, Gajewski, 2019; Balakrishnan et al., 2014) and boosts a company's value (Gomes et al., 2019; Balakrishnan et al., 2014).

Donnelly and Mulcahy (2008) show that voluntary disclosures increase with the number of non-executive directors on the board, as independent boards reduce information asymmetry between owners and managers. However, they found no evidence that ownership structure is related to voluntary disclosure. While the former supports the predictions of agency theory, the absence of proof that ownership structure influences voluntary disclosure does not. Thus, sociological and organisational factors (e.g., informal networking) matter.

The costs and benefits of exposure vary across firms. Regardless of agency considerations and regulatory guidelines, firms will ultimately formulate their disclosure policy concerning overall marginal costs and marginal benefits (Donnelly, Mulcahy, 2008). Companies disclose the information if the benefits outweigh the costs of exposure (Schipper, 2007), and corporate disclosures are driven by factors shaping the demand for and supply of information. R&D-related disclosures are costly for a firm if the disclosure is related to proprietary information that would benefit a competitor, such as developing new technology. Higher proprietary costs are associated with less R&D information exposure.

Kim and Valentine (2020) examined the impact of increased patent disclosures on enterprise innovation after the introduction of the American Inventors Protection Act (AIPA). They showed that disclosures inhibit innovation among firms that reveal more information and stimulate their competitors. Meanwhile, the costs of proprietary information were discussed by Zhou (2020). She indicated that the mandatory disclosure of information on disaggregated segment data caused by Statement of Financial Accounting Standards (SFAS) no. 131 contributed to competitive harm for disclosing companies.

Still, a lower book-to-market ratio forces firms to disclose more detailed information about R&D. This is because basic financial reports are less informative about a company's market value. Development-stage R&D disclosures reduce analyst uncertainty about how development-stage R&D translates into short-term sales. More R&D projects in progress and development-stage R&D disclosure are associated with less error in analysts' one-year-ahead earnings forecasts. Forward-looking exposures are negatively associated with analysts' one-year-ahead earnings forecast error (Jones, 2007).

García-Meca and Martínez (2005), Goebel (2019), Kumar (2013), and Oliveira et al. (2006) found a positive relationship between firm size and the level of disclosure of intangible assets. It is reasoned that larger companies are characterised by higher agency costs, higher user demand for information, and lower price of information creation, thus making better disclosures. By contrast, when analysing the

determinants affecting the capitalisation of development costs in the private company sector, Brasch et al. (2022) indicated that the small and medium-sized enterprise (SME) sector is more likely to capitalise development costs. This is because lower-sized companies are more risk-averse. The desire to obtain additional funding from investors prompts SMEs to report potential financial rewards. Any information on a company's potential growth impacts the investor market and the acquisition of debt financing. Therefore, increased reporting on R&D activities and development costs is extremely valuable for small companies with a non-established market position. Cazavan-Jeny and Jeanjean (2006) examined the impact of the method of reporting R&D costs (capitalisation or amortisation) on the value of a company listed on the French stock exchange. The analysis points out that the capitalisation of R&D costs negatively affects stock return value. Moreover, the choice of this method for R&D costs is more common for smaller companies with a high indebtedness and higher risk propensity.

Based on interviews that we conducted with business valuers in 2024, investors and analysts are searching for information on R&D in the balance sheet or P&L statement. However, the Polish Accounting Act, mainly used by private firms (2,600 in our research sample), significantly differs from international financial reporting standards (IFRS). IFRS permits the capitalisation of expenditures for development work in progress and completed development work as an element of intangible assets. In contrast, the Polish Accounting Act only allows for the capitalisation of expenditure on positively completed development costs in the balance sheet. Costs of completed development work carried out by a company for its purposes, incurred before the commencement of production or the application of technology, are recognised as intangible assets (Art. 3(1)(14) of the Accounting Act) when the following conditions are met (Art. 33(2) of the Accounting Act):

- 1) the product or manufacturing technology is firmly established, and the development costs relating to it are reliably determined,
- 2) the technical suitability of the product or technology has been ascertained and adequately documented—on this basis, the entity has decided to manufacture these products or use the technology,
- 3) development costs are expected to be covered by the sale revenue of those products or applications of the technology.

Therefore, development costs will not always be included in intangible assets. Still, they must have been incurred before the production or application of technology and be covered in the future, as expected, by sales' revenue from products or application of technology.

According to Article 33(3) of the Polish Accounting Act, development costs cannot be written off for more than five years. IFRS allows for no amortisation in the case of indefinite useful life.

However, the Polish Accounting Act does not indicate where to recognise the development costs incurred during the period the development work is carried out until it is completed. Based on Article 10(3) of the Accounting Act, Polish companies may apply national accounting standards when adopting accounting principles

(policies) in matters not regulated by the Act. And without such standards, they may use solutions such as International Accounting Standards (IAS).

IAS 38 'Intangible Assets' can be applied to development work. IAS 38 defines development as "the practical application of research discoveries or achievements of other knowledge in planning or designing the production of new or substantially improved materials, equipment, products, technological processes, systems or services". All those mentioned above should occur before starting mass production or application (paragraph 8 of IAS 38).

In addition, paragraph 59 of IAS 38 indicates that

[...] examples of development activities are:

- (a) the design, construction and testing of pre-production or pre-use prototypes and models;
- (b) the design of tools, jigs, moulds and dies involving new technology;
- (c) the design, construction and operation of a pilot plant that is not of a scale economically feasible for commercial production and
- (d) the design, construction and testing of a chosen alternative for new or improved materials, devices, products, processes, systems or services.

In terms of the 'Development phase', paragraph 57 of IAS 38 states:

An intangible asset arising from development (or from the development phase of an internal project) shall be recognised if, and only if, an entity can demonstrate all of the following:

- (a) the technical feasibility of completing the intangible asset so that it will be available for use or sale;
- (b) its intention to complete the intangible asset and use or sell it;
- (c) its ability to use or sell the intangible asset;
- (d) how the intangible asset will generate probable future economic benefits. Among other things, the entity can demonstrate the existence of a market for the output of the intangible asset or the intangible asset itself or, if it is to be used internally, the usefulness of the intangible asset;
- (e) the availability of adequate technical, financial and other resources to complete the development and to use or sell the intangible asset;
- (f) its ability to measure reliably the expenditure attributable to the intangible asset during its development.

Under the regulations of IAS 38, goodwill, journal titles, publishing titles, customer lists, and items of similar substance generated internally by an entity are not recognised as an intangible asset, as the expenditure incurred cannot be reliably separated from the development costs of the business as a whole. Considering the above-described conditions for recognition of development works as intangibles in assets, we hypothesise that:

H1: R&D tax allowance increases the probability of recognising development works.

Ballester et al. (2003) demonstrated that the share of R&D assets in the market value of equity is negatively related to firm size and profitability. Furthermore, R&D expenditure's negative impact on the growth rate is also apparent. They suggest that companies in an early stage of market activity are more likely to invest

in R&D activities because they have not yet accumulated R&D assets, in contrast to larger companies with an established market position and capitalised R&D assets from which they gain profits. Profitability and indebtedness motivate managers to make better disclosures to explain high performance, enhancing investors' confidence in the company and meeting lenders' information expectations (García-Meca, Martínez, 2005).

O'Connell et al. (2022) examined the relationship between R&D investment, financial leverage, and the success of a firm's R&D activities. They indicated a negative relationship between R&D investment (in the run-up period) and changes in leverage (in the current period). They also revealed a positive effect on the success of the company's R&D project. These findings suggest that higher-indebted companies are more likely to disclose information about R&D success, as it influences lenders' favourable assessment of the company.

Audits by the Big Four also matter (Oliveira et al., 2006; Whiting, Woodcock, 2011). Companies with diverse ownership structures are also expected to incur higher agency costs due to conflicts of interest between multiple owners. Therefore, lower ownership concentration is associated with higher levels of disclosure (Kumar, 2013). Higher levels of R&D exposure in sectors classified as intangible resource intensive have also been confirmed (Kumar, 2013; Oliveira et al., 2006; Whiting, Woodcock, 2011).

Guellec et al. (2003) studied trade-offs between subsidies and tax credits. They found that while both subsidies and tax credits have a positive effect on private R&D spending individually, they are substitutes that diminish the impact of the other. Haufler and Schindler (2020) further analysed a similar issue. They argue that the simultaneous introduction of separate policy instruments to promote innovation may affect how firms and governments utilise such tools, i.e., a profit-shifting attracting tool rather than an inducing one. On the other hand, it may introduce errors in measuring the effectiveness of innovation policy.

Poland has been encouraging and subsidising research cooperation among its business owners as a part of EU Framework Programmes. The goal has been to stimulate the economy and pull Poland out of the middle-income trap by increasing R&D expenditures and developing new indicators to track the level of innovation in Poland (Ministerstwo Nauki i Szkolnictwa Wyższego, 2016). The methods to achieve this have improved over recent years. They include direct government funding for R&D activities to introduce new tax incentives, e.g., expense-based R&D relief in 2016 and income-based Innovation Box (IP Box) preferential tax rate (5%) in 2019 (Białek-Jaworska et al., 2023; Teterycz et al., 2022). Although such solutions are relatively new in Poland, measuring their output and improving the legal environment is crucial based on the results. It may also be important from the perspective of planned incentive programs to robotise Polish production firms.

Tax credits are considered a relatively simple and cheap type of incentive, especially regarding the administrative procedures necessary to benefit from them. Moreover, their design ensures unrestricted access to the application of this type of support, allowing companies rather than governments to decide on the kind and

scope of R&D activities. However, this instrument is susceptible to market volatility. Thus, the company's financial performance determines the amount of support from the R&D tax incentive (Wasiluk, Białek-Jaworska, 2020; Dimos, Pugh, 2016).

According to Article 49 of the Polish Accounting Act, a company's management commentary should include relevant information on its expected development and major achievements in R&D, its assessment of the results, an indication of risk factors, and a description of threats. The report on the activities of issuers whose securities are admitted to trading on a regulated market must be formatted according to Commission Regulation (EU) 2019/815. The report on the activities of non-issuers of securities admitted to trading on a regulated market preparing financial statements under IAS must be formatted according to Commission Regulation (EU) 2019/815 or another searchable format. Based on the aforementioned determinants of voluntary RDIDs in management commentary and R&D tax allowance incentives' characteristics, we hypothesise that:

H2: R&D tax allowance incentives encourage beneficiaries to disclose more information about their R&D activities. This includes the total R&D spending, a breakdown between innovation creation and implementation, the types of R&D undertaken, their effects (including patent applications), and their strategic plans.

Based on disclosures on R&D and patents or patent applications in the management commentary, business valuers often reformulate balance sheets and income statements to prepare projections and calculate free cash flows, which are used in the discounted cash flow (DCF) method for calculating enterprise value (findings of interviews conducted in 2024). Intellectual property protection is most important in the high-tech industry, as adequate intellectual property protection allows for more extensive technology transfer under patent law (Manap et al., 2016). Moreover, reliable patent protection increases private R&D expenditures (Brawn, Martinsson, Pearson, 2017). Wasiluk and Białek-Jaworska (2020) show a positive correlation between the number of patents and corporate R&D spending in Germany and France. Therefore, we hypothesise that:

H3: R&D tax allowance encourages beneficiaries (increases the probability) to reveal patent applications in management commentary.

2. Research design

The study uses a Tobit panel model to test the H1 hypothesis that tax incentives influence the recognition of development works in assets (capitalisation of R&D expenditures). The sample encompasses a broader sample, including private and public firms that benefited at least once from the R&D tax allowance introduced in Poland in 2016. The paper investigates 3,406 firms, including 2,700 private and public beneficiaries of the R&D tax allowance between 2016 and 2020 (identified based on tax data on CIT/BR forms), along with companies listed on the Warsaw Stock Exchange (WSE), both on the regulated and alternative markets (NewConnect).

The study then analyses RDIDs in management commentaries applying the Generalised Least Squares Method (cross-sectional time-series FGLS regression) and a logit model on a sample of 556 observations of 97 companies listed on the WSE between 2016 and 2021 using STATA software.

The data were collected manually from financial statements from the EMIS database (development works capitalised in the assets and main explanatory variables), management commentaries from the archives of the National Court Register, and the websites of public companies that benefitted from the R&D relief between 2016 and 2020. By examining the wording used in these commentaries between 2016 and 2021, we were able to determine whether the R&D tax allowance in force in Poland since 2016 has increased the disclosure of information on innovation, R&D activities, and strategic plans in the management commentary of companies listed on the WSE.

To assess the information disclosed by companies, we constructed an R&D disclosure index. This index was developed based on a review of the relevant literature, the structure of management commentaries, and information capacity, as pointed out by accounting standards, corporate law, and experts interviewed in June/July 2022. Categorisation based on professional insight produced four main categories: innovation, types of R&D, R&D outcomes, and strategic plans related to R&D.

Each type of R&D disclosure index distinguishes subcategories that were the backbone of the coded information. If wording related to the four categories above was mentioned in the text of management commentaries, the voluntary disclosure category was assigned a score of “1”. Based on the analysis of wordings of the content of the management commentary, three experts coded the individual components of the disclosure indicator for 97 public companies that benefitted from R&D tax allowance at least once between 2016 and 2021. These three experts consulted on concerns and agreed on the coding to maintain consistency and comparability of the disclosures included in the coding.

Following the coding process, an R&D disclosure index was calculated. Next, a database of information on innovations invented and implemented, types and outcomes of R&D activities carried out, and strategic R&D plans were prepared, with a total of 556 observations. Total and component disclosure indicators were determined based on the collected and coded text data.

Table 1 presents a breakdown of the RDID index, highlighting its four components: (1) Innovations developed or implemented, (2) Type of R&D, (3) Outcomes of R&D, and (4) Strategic R&D plans and their outcomes.

Next, the dataset of dependent variables (the RDID index) was expanded to include characteristics of these 97 public companies for the period 2016–2021. These characteristics were used as explanatory variables. The definitions of these variables are provided in Table 2.

Before analysing the RDIDs, we assessed whether R&D expenditures were recognised in assets when treated as development works or disclosed in the management commentary or the integrated report (if the latter combined the commentary and was unavailable separately).

Table 1. Structure of the R&D information disclosure (RDID) index

Component	Scope of information
1. Innovation	Innovations developed or implemented
product_innovation	Product innovations
process_innovation	Process, service, technological innovations
organisation_innovation	Organisational innovations (related to corporate governance, new management methodologies, e.g. projects)
marketing_innovation	Marketing innovations (related to new communication strategies, distribution model)
2. R&D_types	Type of R&D
basic_R&D	Fundamental research
industrial_R&D	Industrial/application research (e.g. clinical trials)
development_works	Development work
3. R&D_effects	Outcomes of R&D
concept_material_prototype	Conceptual, development, prototype, pre-implementation work on own products – tangible product.
concept_digital_prototype	Conceptual, development, prototype, pre-implementation work on own products – digital product.
technology_search	Conceptual, development, research, prototype, and pre-implementation work on technology (including a targeted search for new technology).
digital_IP	Development work – development of original intangible asset (e.g. programme, system, code, engine, software)
patent_application	Information on the filing of a patent application, protection rights for a utility model, the right to register an industrial design, the right to register a topography of an integrated circuit, additional protection rights for a patent for a medicinal product or plant protection product,
prototype	Development and construction of a prototype
product_development	Improvement, development of existing products
new_product_placement	Introduction of new products
robotisation	Robotisation, automation of processes
PPE_R&D	Investments in R&D apparatus and infrastructure/equipment, laboratory and their development
R&D_Centre	Development of own R&D centre/department, R&D department
4. Strategic_plans	Strategic plans related to R&D and its outcomes
R&D_plans	Plans concern research and development activities
innovation_plans	Plans concern innovative activities
new_products_plans	Plans concern the introduction of new products
product_development_plans	Plans concerning the development of existing products
patenting_plans	Information on plans to apply for patents and other intellectual property rights

Source: authors' own elaboration.

Table 2. Definitions of variables

Variable	Definition
R&D_expenditure	R&D expenditures, both either capitalised in the assets or expensed in the P&L statement
development works	The amount of development works recognised in the intangible assets when R&D expenditures are capitalised and shown as an element of intangible assets (e.g. costs of positively completed development work under the Polish Accounting Act or development works, even in progress, in line with IAS 38) We control the source of information on innovation and R&D activities: Management Commentary and Integrated reports.
R&D_tax relief	The logarithm of tax-deducted R&D expenditures under Polish tax law, based on CIT/BR forms (source: Ministry of Finance)
dummy_R&D_tax_relief	a dummy variable indicating that a firm benefits from the R&D tax allowance, based on CIT/BR forms (source: Ministry of Finance)
size_sale	The logarithm of sales revenue as a proxy of firm size
debtwithcosts_ta	Debt with interest costs to total assets ratio
cf_ta	Cash flow from operations to total assets ratio
cf_ta_positive	The cash flow from operations to total assets ratio when positive, 0 otherwise
tangibility	Share of tangible assets in total assets ratio
ln_subsidises	The logarithm of subsidises
WSE	A dummy variable indicating a company when it is listed on the Warsaw Stock Exchange
roe_ebitda	A rate of return on equity, calculated as EBITDA (earnings before interests, tax, depreciation and amortisation) divided by equity (shareholders' funds)
intangible	A share of intangible assets in total assets ratio
soe	A binary variable indicating a state-owned enterprise
debt_ratio	Total liabilities to total assets ratio
directors_managers	The logarithm of the number of directors and managers
IFRS_accounting_practice	A dummy variable indicating accounting practice based on IFRS
advisors	The logarithm of the number of advisors
foreign_shareholder_2_	A dummy variable indicating a company with at least two foreign shareholders
big4	A dummy variable indicating when the auditor of a given company is a Big Four company (EY, KPMG, PwC, Deloitte)
tax_haven	A dummy variable indicating a company with at least one foreign shareholder set in a tax haven

Source: authors' own elaboration.

3. Data

Table 3 and Figure 1 present the number of beneficiaries of the R&D tax relief between 2016 and 2020 listed on the WSE, including those that disclosed R&D expenditures in the management commentary and capitalised development costs on the balance sheet. Following the introduction of the R&D tax allowance, the number of beneficiaries of this relief listed on the WSE increased, including those that disclosed R&D expenditure, and development costs increased between 2016 and 2020. Over 45% conducted scientific research or development works, only 8% were involved in industrial works, and 6.5% had applied for patents. In addition, almost 37% of observations considered deducting eligible R&D costs, and 8.4% considered carrying forward deductions for future periods when a company gains profits (Table 3).

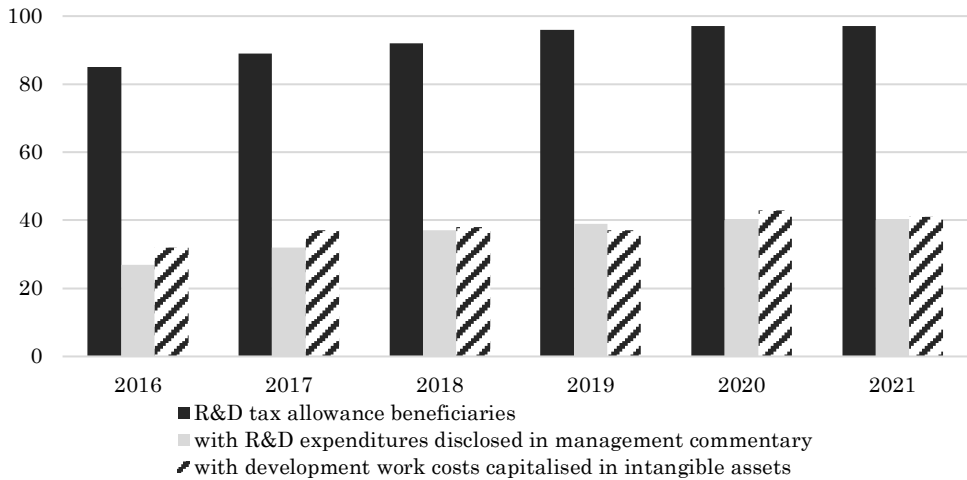
Table 3. Characteristics of R&D tax relief beneficiaries listed on the Warsaw Stock Exchange

Number of firms with the following characteristics	2016	2017	2018	2019	2020	2021
R&D tax allowance beneficiaries in a given year	85	89	92	96	97	97
with R&D expenditures disclosed in management commentary	27	32	37	39	40	40
with development works' costs capitalised in intangible assets	32	37	38	37	43	41
Variable	Observations (2016–2021)		Mean (PLN)		Share (%) in item (1)	
(1) eligible costs to be deducted	550		2.5 mln			
(a) total eligible costs	190		5.5 mln		37.5	
(b) eligible costs deducted	187		4.6 mln		36.9	
(c) carry-forward deductions	44		6.6 mln		8.4	
(d) carry back deductions	32		1.2 mln		6.0	
R&D type	Share (%) in total observations					
scientific research	45.6					
development works	45.6					
industrial works	8.0					
applicable works	5.1					
applied research	1.6					
fundamental research	1.8					
patent costs	6.5					
micro firms & SMEs	12.5					

Note: The sum of the shares is not 100%, as the features are not disjoint sets, and there are overlaps between some of them.

Source: authors' own elaboration based on tax data from CIT/BR (Ministry of Finance) and data retrieved from financial statements (from EMIS database) and management commentary (from National Court Register archive).

Figure 1. Characteristics of R&D tax relief beneficiaries listed on the Warsaw Stock Exchange (number of firms)



Source: authors' own elaboration based on data retrieved from financial statements and management commentaries.

The disclosure ratio in the listed companies' management commentaries is the ratio of the number of disclosures in each category to the total number of types. Table 4 presents the descriptive statistics for the entire RDID index and its four components. The first quartile and mean values show an upward trend with minor fluctuations over the period studied. The median initially shows an increase but experiences a significant drop in 2021, approaching the mean. The 3rd quartile of the indicator increased in 2018, i.e. two years after the R&D tax allowance was introduced in Poland.

Descriptive statistics of the disclosure index for innovation between 2016 and 2021 show that the median equals the value of the 3rd quartile. The median is higher than the mean, suggesting a left-skewed distribution of the innovation implementation indicator. After the R&D tax relief was introduced in 2016, the mean increased until 2020 but decreased in the next period, possibly due to the COVID-19 pandemic.

The median value of the disclosure indicator for R&D activities is equal to the 3rd quartile and higher than the mean, suggesting a left-skewed distribution of indicator values. The mean disclosure indicator for conducted R&D activities fluctuates, showing an increasing trend. Between 2017 (i.e. one year after the introduction of the R&D relief) and 2020, the mean of the R&D performance indicator is higher than the median, suggesting a rightward skewness of the indicator distribution. The third quartile reaches higher values than the mean and median during the period under review. The first quartile also increased between 2016 and 2018. The median of the strategic plan disclosure indicator is equal to the 3rd quartile between 2016 and 2021.

Table 4. Descriptive statistics of R&D information disclosure index of public companies

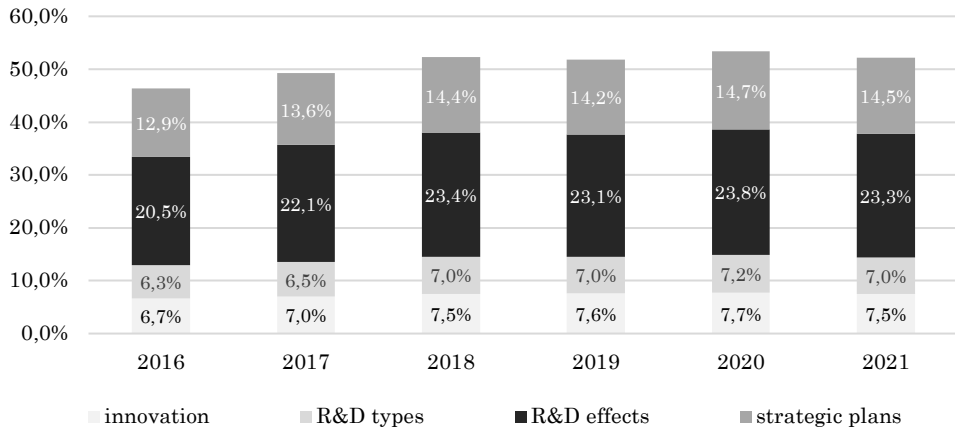
RDID	2016	2017	2018	2019	2020	2021	Total	Innovation	R&D type	R&D effects	Strategic plans
Q1	0.3043	0.3478	0.4348	0.4130	0.4348	0.4348	0.39	0.25	0.33	0.36	0.6
median	0.5217	0.5217	0.5435	0.5652	0.5652	0.5217	0.52	0.5	0.67	0.45	0.8
Q3	0.6522	0.6522	0.6956	0.6956	0.6956	0.6956	0.70	0.5	0.67	0.64	0.8
mean	0.4639	0.4924	0.5232	0.5235	0.5320	0.5204	0.51	0.42	0.52	0.48	0.65
skewness	-0.399	-0.666	-0.739	-0.704	-0.7398	-0.693	-0.673	-0.166	-0.725	-0.034	-1.096
innovation RDID			2016	2017	2018	2019	2020	2021			
Q1			0.25	0.25	0.25	0.25	0.25	0.25			
median			0.5	0.5	0.5	0.5	0.5	0.5			
Q3			0.5	0.5	0.5	0.5	0.5	0.5			
mean			0.3853	0.4017	0.4321	0.4401	0.4433	0.4304			
R&D_types RDID			2016	2017	2018	2019	2020	2021			
Q1			0.3333	0.3333	0.3333	0.3333	0.3333	0.3333			
median			0.6667	0.6667	0.6667	0.6667	0.6667	0.6667			
Q3			0.6667	0.6667	0.6667	0.6667	0.6667	0.6667			
mean			0.4823	0.5019	0.5398	0.5382	0.5464	0.5292			
R&D_effects RDID			2016	2017	2018	2019	2020	2021			
Q1			0.1818	0.2727	0.3636	0.3636	0.3636	0.3636			
median			0.4545	0.4545	0.4545	0.4545	0.4545	0.4545			
Q3			0.6364	0.6364	0.6364	0.6818	0.6364	0.7273			
mean			0.4278	0.4627	0.4891	0.4886	0.4958	0.4855			
strategic plans RDID			2016	2017	2018	2019	2020	2021			
Q1			0.4	0.4	0.6	0.6	0.6	0.6			
median			0.8	0.8	0.8	0.8	0.8	0.8			
Q3			0.8	0.8	0.8	0.8	0.8	0.8			
mean			0.5953	0.6247	0.6609	0.6583	0.6742	0.6639			

Source: authors' own elaboration.

The distribution of the indicator exhibits left skewness. However, the mean shows an upward trend accompanied by slight fluctuations. An apparent increase in the value of the first quartile of the indices in 2017/2018 is evident. Figure 2 summarises the time trend of RDID indices broken down into their four subcomponents: (1) Innovations developed or implemented, (2) Type of R&D, (3) Outcomes of R&D, and (4) Strategic plans related to R&D and its outcomes. Disclosure information on R&D effects and strategic plan components dynamically increased from 2016 until

2019. This trend suggests a learning effect, where companies gradually improved their understanding of what and how to disclose in their management commentaries. However, a significant drop was in 2019, followed by a sharp increase in 2020 and a slight decrease in 2021.

Figure 2. The learning effect – an increase in voluntary R&D information disclosures in Management Commentary between 2016 and 2021



Source: authors' own elaboration.

4. Results

Table 5 presents the results of Tobit panel model estimations on a broader sample. These results support our initial hypothesis (**H1**) that the R&D tax allowance positively influences the probability of companies recognising development work in the balance sheet. Additionally, larger companies with higher debt burdens are more likely to recognise R&D in their assets. However, unlike subsidies and R&D tax allowances, the recognition of development work is not sensitive to cash flow from operations. The higher coefficients for donations suggest that nonrefundable grants may be more influential in this decision compared to tax allowances.

The third column of the table shows the findings of the model with interactions between the WSE dummy variable and the explanatory variables. This analysis shows that larger public companies, those with higher debt and interest burdens, and those benefiting from R&D tax allowance are less likely to recognise development works in the balance sheet. However, the R&D tax allowance since 2015 has not discouraged public companies from recognising development works (and increasing profitability).

Table 5. Results of Tobit panel model of probability to recognise development works in assets

Variable	(1)	(2)	(3)	(4) since 2015
R&D_tax_relief	0.0025*** (0.0002)	0.0025*** (0.0002)	0.0026*** (0.0002)	0.0015*** (0.0002)
size_sale	0.0015*** (0.0003)	0.0015*** (0.0003)	0.0021*** (0.0003)	0.0026*** (0.0004)
debtwithcosts_ta	0.0324*** (0.0072)	0.0311*** (0.0067)	0.0396*** (0.0074)	0.0147 (0.0097)
cf_ta	0.0018*** (0.0044)			
cf_ta_positive		-0.0049 (0.0075)	-0.0095 (0.0079)	0.0007 (0.0101)
tangibility	0.0087 (0.0070)	0.0107 (0.0066)	0.0091 (0.0070)	-0.0377*** (0.0107)
ln_subsidises	0.0048*** (0.0003)	0.0046*** (0.0002)	0.0044*** (0.0003)	0.0052*** (0.0004)
WSE#size_sale			-0.0017*** (0.0004)	
WSE#debtwithcosts_ta			-0.0381** (0.0168)	
WSE#cf_ta_positive			0.0116 (0.0261)	
WSE#tangibility			-0.0106 (0.0205)	
WSE#R&D_tax_relief			-0.0031*** (0.0008)	-0.0014 (0.0010)
_cons	-0.0034 (0.0055)	-0.0029 (0.0053)	-0.0074 (0.0053)	0.0032 (0.0069)
Number of observations	29,288	29,288	29,288	14,224
Number of groups	3,406	3,406	3,406	3,365
LR test	8863.23***	10000***	10000***	364.93***
Wald test	646.55***	720.99***	790.35***	6160.22***
Log-likelihood	11338.19	13479.39	13512.32	6237.81

Note: Standard errors are given in brackets under the coefficient estimates. Significant at * 0.1, ** 0.05, *** 0.01. The LR test formally compares the pooled estimator (Tobit) with the panel estimator. In this case, we reject the null hypothesis that there are no panel-level effects. Based on the p-value of the Wald test, we reject the null hypothesis that the independent variables are jointly insignificant.

Source: authors' own elaboration.

Table 6 presents the results on the determinants of RDID. The model estimations confirm that R&D tax relief acts as a positive stimulus for corporations to disclose more information about R&D. This includes details on the types of innovation created, the types of R&D conducted and its effects, and strategic R&D plans and outcomes, which aligns with hypothesis **H2**. In addition, our findings confirm the efficiency of R&D tax allowances, pointing out the positive influence of tax relief on companies' R&D. More R&D expenditures deducted from the tax base enhance R&D and incentivise RDID to signal innovativeness and engagement in R&D. Larger companies disclose more information in terms of their innovative activity. However, they carry out less diversified R&D.

Additionally, they have fewer plans connected with R&D works for the future. Profitable businesses reveal less R&D information in their management commentary, possibly because they do not need it to attract investors' attention or signal their innovativeness, as their profitability is already a strong signal for investors.

Table 6. GLS results on determinants of voluntary R&D information disclosures in management commentaries in total and four components

Variable	RDID index in total	RDID index components			
		innovation	R&D types	R&D effects	strategic plans
l.R&D_tax relief	0.0041*** (0.0013)	0.0053*** (0.0013)	0.0038*** (0.0015)	0.0041*** (0.0015)	0.0034* (0.0018)
l.size_sale	-0.0035 (0.0038)	0.0071* (0.0038)	-0.0144*** (0.0042)	-0.0004 (0.0044)	-0.0125** (0.0052)
l.roe_ebitda	-0.1342*** (0.0356)	-0.0599* (0.0358)	-0.0746* (0.0392)	-0.1726*** (0.0410)	-0.1449*** (0.0482)
l.intangible	0.0034* (0.0018)	-0.0044** (0.0018)	0.0093*** (0.0020)	0.0045** (0.0021)	0.0036 (0.0024)
soe	-0.0066* (0.0035)	-0.0035 (0.0035)	0.0018 (0.0039)	-0.0055 (0.0041)	-0.0165*** (0.0048)
l.debt_ratio	0.1018* (0.0616)	0.0785 (0.0619)	0.1634** (0.0678)	0.0196 (0.0709)	0.2641*** (0.0834)
_cons	0.5183*** (0.0713)	0.3184*** (0.0716)	0.6311*** (0.0785)	0.4282*** (0.0820)	0.8087*** (0.0965)
No. of observations	541	541	541	541	541
Number of groups	96	96	96	96	96
Wald test	32.96***	30.27***	48.52***	28.81***	44.17***
Log-likelihood	65.5337	63.0941	13.3904	-10.4595	-98.3804

Note: Standard errors are given in brackets under the coefficient estimates. Significant at * 0.1, ** 0.05, *** 0.01. Based on the p-value of the Wald test, we reject the null hypothesis, indicating that the independent variables are jointly insignificant, so we statistically improve the estimates of these models.

Source: authors' own elaboration.

Companies with a higher share of intangible assets in total assets have a wider range of R&D and, consequently, more visible outcomes. However, they are less likely to mention their innovations in management commentaries.

Table 7. The impact of IFRS and tax havens on voluntary R&D information disclosures in management commentaries

Item	RDID index	RDID index	innovation	innovation	R&D types	R&D effects	strategic plans
l.R&D_tax relief	0.0048*** (0.0013)	0.0049*** (0.0013)	0.0059*** (0.0013)	0.0058*** (0.0013)	0.0037*** (0.0014)	0.0048*** (0.0015)	0.0041** (0.0018)
l.size_sale	-0.0076 (0.0052)	-0.0099*** (0.0050)	-0.0087* (0.0051)	-0.0086* (0.0050)	-0.0125** (0.0057)	-0.0045 (0.0058)	-0.0173** (0.0070)
l.roe_ebitda	-0.0932** (0.0362)	-0.0933*** (0.0355)	-0.0034 (0.0359)	-0.0033 (0.0359)	-0.0686* (0.0397)	-0.1334*** (0.0408)	-0.0904* (0.0488)
l.intangible	0.0038** (0.0018)	0.0043** (0.0018)	-0.0035* (0.0018)	-0.0035* (0.0018)	0.0096*** (0.0020)	0.0054*** (0.0021)	0.0048* (0.0025)
soe	-0.0044 (0.0035)		0.0009 (0.0035)		0.0010 (0.0038)	-0.0034 (0.0040)	-0.0150*** (0.0047)
l.debt_ratio	0.1128* (0.0601)	0.0956 (0.0591)	0.1115* (0.0597)	0.1116* (0.0596)	0.1295** (0.0660)	0.0086 (0.0678)	0.2555*** (0.0812)
directors_managers	0.0815*** (0.0238)	0.0925*** (0.0235)	0.0984*** (0.0237)	0.0982*** (0.0237)	0.0148 (0.0262)	0.0925*** (0.0270)	0.1292*** (0.0323)
IFRS_accounting_practice	0.0716*** (0.0249)	0.0944*** (0.0243)	0.1055*** (0.0249)	0.1044*** (0.0246)	0.0354 (0.0276)	0.1042*** (0.0284)	0.0739** (0.0339)
advisors	-0.0494* (0.0271)	-0.0675** (0.0266)	-0.0889*** (0.0270)	-0.0880*** (0.0268)	-0.0166 (0.0299)	-0.0749** (0.0307)	-0.0467 (0.0368)
foreign_shareholder_2	-0.0212*** (0.0062)	-0.0165*** (0.0062)	-0.0001 (0.0062)		-0.0365*** (0.0069)	-0.0141** (0.0071)	-0.0246*** (0.0085)
big4	-0.0571** (0.0239)	-0.0436* (0.0236)	0.0010 (0.0238)	0.0009 (0.0237)	0.0188 (0.0263)	-0.0629** (0.0271)	-0.0764** (0.0324)
tax_haven		-0.0954*** (0.0202)	-0.0586*** (0.0204)	-0.0587*** (0.0202)	-0.0686*** (0.0226)	-0.1250*** (0.0232)	-0.0773*** (0.0278)
_cons	0.4133*** (0.0983)	0.4627*** (0.0962)	0.4159*** (0.0978)	0.4132*** (0.0970)	0.5953*** (0.1081)	0.3586*** (0.1111)	0.5874*** (0.1330)
No. observations	541	541	541	541	541	541	541
No. of groups	96	96	96	96	96	96	96
Wald test	73.66***	97.14***	86.76***	86.67***	96.23***	95.2***	90.24***
Log-likelihood	84.0655	94.2056	88.5973	88.5606	34.4449	19.3518	-77.8819

Note: Standard errors are given in brackets under the coefficient estimates. Significant at * 0.1, ** 0.05, *** 0.01. Based on the p-value of the Wald test, we reject the null hypothesis that the independent variables are jointly insignificant, so we statistically improve the estimates of these models.

Source: authors' own elaboration.

Table 8. Determinants of voluntary R&D information disclosures in management commentary on patent applications submitted and patenting plans

Variable	Pooled patent_ application	RE patent_ application	FGLS patent_ application	FGLS patenting_ plans
l.dummy_R&D_tax_relief l.R&D_tax relief (FGLS)	0.4848** (0.2489)	0.9005* (0.5261)	0.0044** (0.0022)	0.0040** (0.0020)
l.size_sale	-0.1771*** (0.0532)	-0.4722*** (0.0517)	-0.0264*** (0.0086)	-0.0355*** (0.0079)
l.roe_ebitda	-0.8093* (0.4810)	2.2391* (1.2604)	-0.0601 (0.0602)	-0.0056 (0.0553)
l.intangible	0.0468* (0.0270)		0.0039 (0.0031)	0.0066** (0.0028)
soe	0.0078 (0.0506)		0.0038 (0.0058)	-0.0030 (0.0054)
l.debt_ratio	-1.8000* (1.0581)		-0.1538 (0.1001)	-0.0522 (0.0920)
directors_managers			0.0630 (0.0398)	0.0699* (0.0366)
IFRS_accounting_practice			0.0865** (0.0418)	0.0248 (0.0385)
advisors			-0.0098 (0.0453)	-0.0157 (0.0417)
foreign_shareholder_2_			0.0022 (0.0105)	0.0074 (0.0096)
big4			-0.1433*** (0.0400)	0.0189 (0.0367)
tax_haven			0.1096*** (0.0342)	0.0647** (0.0315)
_cons	1.0185 (0.9162)		0.3838** (0.1640)	0.4466*** (0.1507)
Number of observations	541	541	541	541
Number of groups		96	96	96
LR test	22.66***	203.85***		
Wald test		110.42***	50.95***	36.99***
Log-likelihood	-220.54	-122.25	-191.17	-145.49
Pseudo R2	0.0489			

Note: Standard errors are given in brackets under the coefficient estimates. Significant at * 0.1, ** 0.05, *** 0.01. The LR test formally compares the pooled estimator (Tobit) with the panel estimator. In this case, we reject the null hypothesis that there are no panel-level effects. Based on the p-value of the Wald test, we reject the null hypothesis, indicating that the independent variables are jointly insignificant, so statistically improve the estimates of these models.

Source: authors' own elaboration.

State-owned enterprises engage in less R&D and have fewer plans to extend innovations and R&D activities. This can be attributed to their political relationships and collaborations with the government rather than to leading innovation in this country. Companies with high levels of debt disclose more information on their operations on multiple levels of R&D activities and have many strategic plans for innovation creation and R&D operations for the future. This builds trust and justifies their need for borrowing and urgent funding. Thus, they can use R&D and strategic plan disclosures in management commentaries to support their loan applications or attract creditors' attention to negotiate better conditions.

Table 7 shows that companies with more directors and managers disclose more information, except for the types of R&D that are conducted. Using IFRS as an accounting practice supports more RDID. On the other hand, having a shareholder that is registered in a tax haven discourages companies from disclosing R&D information. Similarly, those with more advisors disclose less R&D information except for the types of R&D and strategic plans. Companies audited by a Big 4 auditor (i.e., Deloitte, EY, KPMG, or PwC) have a lower RDID index and provide fewer details on R&D outcomes and strategic objectives. However, the results related to innovation disclosure in companies with at least two foreign shareholders are not significant.

Table 8 provides the estimations of the logit models regarding the probability of patenting of R&D effects by listed companies and signalling this news to the market in management commentary. Finally, we test whether the R&D tax allowance encourages companies to do it. We provide evidence to confirm this positive relationship, which aligns with hypothesis **H3**. However, larger and indebted companies are less likely to disclose information on patenting their R&D outcomes. Conversely, firms with a higher share of intangibles in total assets are more likely to disclose information on patenting their inventions and future patent application plans. Accounting practice based on IFRS supports patenting R&D effects by listed companies, while audits by the Big 4 limit patenting activity. Finally, companies owned by shareholders in tax havens more often apply for patents and disclose such patenting plans.

Conclusions

This research investigated the relationship between R&D tax allowance and voluntary disclosures on R&D and innovation. It builds on previous work that examined the impact of disclosure requirements' effects on corporate innovation. This work offers a novel contribution to the literature on the effectiveness of R&D tax relief by introducing a new measure of innovation based on the wordings of RDID in management commentaries. The development of such a measure of innovation is crucial for assessing the effects of public policy, including fiscal instruments in countries like Poland, where the statistical confidentiality rule restricts access to

CIS (Community Innovation Survey) even for policymakers, including the Ministry of Finance. Because only anonymous statistical data on innovation are available, it is not possible to link tax expenditures on R&D to the outcomes of R&D spending by taxpayers-beneficiaries of the R&D tax allowance.

The specifics of the Polish market force us to create alternative measures of innovations in the business sector based on R&D and innovation information disclosure in management commentary. Although we start by analysing the wording used by public companies to disclose R&D outcomes and innovation, the proposed methodology to construct the RDID index can be adapted to measure innovation in private firms.

Our findings shed light on the spillover effects among public companies incentivised by the R&D tax allowance. These companies signal patent applications in their management commentaries and recognise development works in the intangibles. Therefore, this research underscores the importance of voluntary disclosure and its impact on related stakeholders, i.e., investors, creditors, competitors, and industries. Our findings contradict the idea that rules about sharing information can slow down new ideas but highlight how we need to think about many different aspects when we look at how rules affect companies' performance. This adds a wider perspective to academic discussions and real-world talks about companies sharing new ideas and information.

Concluding discussion

This paper investigates the impact of voluntary disclosure on corporate innovation. We build on the findings of Breuer et al. (2020), who studied how mandatory financial statements in Germany influenced commentary practices before Directive 2013/34/EU on corporate innovation was introduced. To analyse this impact in the context of voluntary disclosure, we examine Polish companies that received R&D tax allowances since 2016. We focus specifically on the information these companies disclose about their innovation activities, including details on the types and effects of their R&D efforts, as well as their strategic plans for future R&D endeavours'. Our research takes a unique approach to measuring corporate innovation. We analyse the intensity with which companies write about innovation development or implementation, R&D types and outcomes, and strategic plans related to the effects of R&D and innovations. This approach holds particular value as our study is based on management commentary wordings of companies that deducted R&D expenditures from the tax base. Therefore, our research sample is less biased due to the knowledge that they confirm R&D spending and engagement in R&D for tax purposes.

Furthermore, we exploit the unique setting of the Polish market, where over 87% of enterprises are exempt from mandatory disclosures. This is because partnerships are not obligated to conduct accounts or prepare financial statements until their annual revenues reach two million EUR. Thus, Poland offers the highest

exemption from bookkeeping in the EU: no disclosure is required. This is in contrast to the simplified, yet still mandatory, reports in Germany.

First, we identified the determinants of recognising development work in 3,406 private and public companies. The benefits from the R&D tax allowance are significant enough to increase the probability of recognising development works and signal the company's innovativeness, engagement in R&D, and plans for applying for a patent in their management commentary. As a result, there is no basis to reject H1, which states that the R&D tax allowance increases the probability of recognising development works in assets.

Second, an in-depth analysis of 556 management commentaries of 97 public companies in 2016–2021 supports hypothesis H2. This hypothesis states that the R&D tax allowance encourages beneficiaries to voluntarily disclose more information about creating or implementing innovation, the types of R&D, R&D outcomes (including patent applications), and strategic R&D plans.

Third, the findings indicate that R&D tax relief stimulates patenting activity disclosed in management commentary. This is consistent with hypothesis H3.

This study's findings regarding the relationship between company size and R&D disclosure differ from recent research (e.g., García-Meca, Martínez, 2005; Goebel, 2019; Kumar, 2013; Oliveira et al., 2006). Our analysis suggests that larger companies have lower disclosure ratios, carry out less diversified R&D, and have fewer R&D strategic plans. Profitable businesses reveal less R&D information, which is consistent with Ballester et al. (2003).

On the other hand, companies with higher intangibility have a wider range of R&D and more visible effects. However, they rarely disclose details about their innovations. Indebted companies disclose more R&D information and strategic plans, building trust and justifying their funding needs. Thus, they can use R&D and strategic plan disclosures in management commentary to support loan applications or attract creditors' attention to negotiate better loan conditions, which aligns with García-Meca and Martínez (2005).

The originality of the paper comes from identifying that the R&D tax allowance influences voluntary RDID in management commentaries. This effect is particularly pronounced for smaller, more indebted companies that have higher intangibility. Thus, R&D information voluntary disclosure is motivated not only by reducing information asymmetry but also by signalling high quality and compliance with tax law. This manuscript contributes to discussions in the literature on the relationship between RDIDs and innovation in the economy.

Instead of forcing companies to publicly disclose their strategy, risks, and R&D activities in a management commentary, the Polish settings allow firms to avoid disclosure at the expense of assuming higher (unlimited) responsibility for their assets. Consequently, this choice incentivises companies to innovate and engage in R&D. Smaller, indebted companies drive spillovers to competitors, suppliers, and customers at the industry level. The lower cost of capital seems sufficient to compensate for any potential negative externalities caused by access to information on R&D, innovations and strategic plans. The R&D fiscal incentives directly impact innovation spillover.

In contrast to Germany before Directive 2013/34/EU, as studied by Breuer et al. (2020), R&D information disclosures that are fundamental for innovation spillovers seem to concentrate innovation within smaller firms in R&D-intensive industries. They decide whether to disclose proprietary information. Therefore, it does not hinder innovation; instead, it potentially accelerates the adoption of new processes and products or generates important innovations that other companies continue, reducing unnecessary duplication of R&D expenditure. Therefore, allowing voluntary disclosure seems more beneficial than imposing reporting obligations on private limited liability companies (before Directive 2013/34/EU). This aligns with Breuer et al.'s (2020) observation that the latter harms business innovation. To sum up, the benefits gained from the R&D tax allowance at least partially compensate for the costs associated with disclosing proprietary information.

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Legislation and standards

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