

Evaluation of Business Finland's R&D Funding for the European Commission

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Foreword

This evaluation report assessing the impacts of Business Finland's R&D funding is based on the evaluation plan, as requested by the European Commission. The aid scheme is for research and development projects. The R&D scheme is targeted at projects that shall contribute to the improvement of capabilities (behavioural additionality), renewal of the beneficiary (output additionality), national or international networking of undertakings (behavioural additionality), or an increase in the employment, turnover, or exports of the beneficiary (output additionality). According to the European Commission, "State aid evaluation can explain whether and to what extent the original objectives of an aid scheme have been fulfilled (i.e. assessing the positive effects) and determine the impact of the scheme on markets and competition (i.e. possible negative effects)." According to the Government Decree (Art. 3), funding for

R&D projects in the R&D scheme is either in the form of grants or loans. The choice of funding instrument depends on the stage of the project. Grants are mainly used for more challenging R&D (industrial research and experimental development with a longer time to market) and loans for closer-to-market experimental development (such as pilots and demonstrations).

This report evaluates the input, output, and behavioural additionalities of Business Finland's R&D funding. Input additionality is estimated by examining how funding has affected the share of firms deciding to invest in R&D and create R&D jobs, as well as the number of jobs created and innovation expenditure as a percentage of turnover. Output additionality is estimated using the number of patents and the share of firms filing new patent applications, making new process innovations, and making new product innovations. Impacts on

economic performance are estimated using tangible and intangible assets, employment, turnover, and value added. Behavioural additionalities are estimated as the share of firms collaborating with competitors, customers, and research organizations. Furthermore, the report investigates the indirect impacts of R&D funding by examining the potential positive spillover effects and indirect additionality among non-supported firms, as well as whether the funding has affected competition.

The evaluation study was carried out by Antti Norkio and Henna Busk from Pellervon taloustutkimus PTT. Business Finland wishes to thank the evaluators for their thorough and systematic approach. Business Finland expresses its gratitude to the steering group and all others who have contributed to the study.

Helsinki, October 2026 Business Finland

Executive summary

The study evaluates the impacts of Business Finland's R&D funding on firm performance in terms of input additionality, output additionality, behavioural additionality, and indirect effects. In addition, the proportionality and appropriateness of the aid are assessed by comparing the impacts of different funding instruments. The evaluation is based on the European Commission's Evaluation Plan, and methodologically relies on a combined propensity score matching and difference-in-differences (PSM-DID) approach. Indirect effects are examined primarily through descriptive and exploratory analysis.

The study employs a linked firm-level dataset covering the period 2013–2024. Business Finland's funding application data are combined with Statistics Finland's business register and financial statement data. The dataset is further complemented with Finnish Customs data on firms' international trade in goods, patent application and registration data from the Finnish Patent and Registration Office (PRH) and from the European Patent Office's



PATSTAT database, Statistics Finland's data on public business subsidies, the Community Innovation Survey (CIS), and the Business Enterprise Research and Development Survey covering firms' R&D expenditure and R&D personnel.

The evaluation provides evidence that Business Finland's R&D funding increases firms' R&D-related employment and supports subsequent firm growth. However, the evidence for the effects on innovation outputs, productivity and collaboration is considerably weaker. The results indicate that the funding primarily strengthens firms' innovation capacity and resource base, while the extent to which these additional inputs translate into measurable innovation outcomes and wider innovation-system effects remains less evident within the observed time horizon. This pattern is broadly consistent with the international research literature, which typically finds stronger effects on innovation inputs than on innovation outputs or productivity. The analysis of indirect effects provides no indication that R&D funding adversely affects non-supported firms, although the descriptive nature of the analysis limits causal interpretation. Furthermore, no systematic differences are found between grants and loans in terms of their contribution to the objectives of the funding scheme.

The findings support continued targeting of R&D funding towards projects where public funding is most likely to generate additional private R&D

activity and broader societal benefits. From an economic perspective, the rationale for public intervention is particularly strong where firms face financing constraints or innovation projects generate substantial knowledge spillovers. The findings also highlight the importance of monitoring supported firms over longer time horizons, as effects on innovation outputs and productivity may materialise only several years after project completion.

Despite comprehensive register-based data, identifying causal effects using observational data remains challenging. A central source of uncertainty is the potential role of unobservable firm characteristics, which may affect both selection into subsidy and subsequent firm outcomes. Although there are some important limitations in identifying causal effects, we consider this method – propensity score matching combined with difference-in-differences – to be the best feasible approach given the available data.

Future evaluations could strengthen causal identification by using more comparable groups of accepted and rejected applicants and by exploiting application scoring information, funding thresholds or variation across evaluators. However, such approaches may be constrained by the limited number of rejected applications and the availability of detailed evaluation data.

1. Introduction

The macroeconomic rationale for public R&D support is based on well-established market failures associated with innovation activities. R&D investments are characterised by high uncertainty, long payback periods, information asymmetries and positive externalities that firms are often unable to appropriate fully. As a result, private firms may invest less in R&D than would be socially optimal. Public R&D funding aims to address these market failures by reducing financing constraints, encouraging risk-taking and promoting projects with potentially high social returns.

The objective of this study is to evaluate the direct impacts of Business Finland R&D funding on firm performance as well as indirect impacts. The evaluation is based on the European Commission's evaluation framework and aims to assess the effectiveness of the support in achieving its objectives, as well as to examine its indirect effects on

markets and competition. The R&D funding under study covers the aid scheme based on Art. 25 of the General Block Exemption Regulation as well as innovation aid to SMEs (Art. 28 of the GBER).¹ Thus, the evaluation does not cover all R&D instruments used in Finland. The details of the scheme are presented in Appendix 1.

The macroeconomic policy environment during the evaluation period has been affected by several exceptional shocks and structural changes, including the COVID-19 pandemic, disruptions in global value chains, increased geopolitical uncertainty and rising interest rates. These developments have affected firms' investment conditions, financing environment and innovation incentives. At the same time, Finland has adopted an ambitious national objective of increasing total R&D expenditure to 4 % of GDP by 2030, supported by substantial increases in public R&D funding allocations. Business Finland's R&D funding forms a central component of this broader national innovation policy framework.

Previous ex-post evaluations of Business Finland and its predecessor Tekes provide extensive evidence on the impacts of the scheme and closely

related programmes. More than one hundred evaluation reports concerning Business Finland and Tekes R&D funding activities have been produced since the early 2000s. The existing literature generally finds strong evidence of input additionality, while evidence on productivity and broader market impacts is more mixed, with such impacts typically materializing only over longer time horizons.

One of the most relevant evaluations is Fornaro et al. (2020), which analysed the impacts of Tekes R&D subsidies on firm performance using a combined matching and difference-in-differences methodology. The results showed that R&D subsidies significantly increased firms' R&D employment and R&D intensity, indicating positive input additionality and limited evidence of crowding out of private R&D investment. The study also found evidence that subsidised firms collaborated more frequently with competitors, customers and research institutions. However, the analysis did not identify statistically significant short-term productivity effects. The study further suggested that spillover effects are difficult to measure empirically and that R&D subsidies may increase the survival probability of relatively inefficient firms.

Another central evaluation is Viljamaa et al. (2014), which examined the impacts of Tekes funding on productivity and economic renewal. Using combined matching and difference-in-differences methods, the study found no statistically significant productivity differences between supported and non-supported firms in the short term. Nevertheless, the authors interpreted the findings as broadly positive because supported firms often face stronger financing constraints and operate in riskier innovation environments than average firms. The study also highlighted the importance of strategically targeted R&D funding, particularly for SMEs and young innovative firms.

Valovirta et al. (2014) examined the broader societal impacts of Tekes R&D funding. Using propensity score matching and treatment-effect models, the study found positive effects on firms' innovation intensity, innovation outputs and growth. The results highlighted the importance of networking and collaboration effects, suggesting that public R&D support can generate wider societal benefits through knowledge diffusion and cooperation between firms and other actors. The study also

¹The instruments under study in Finnish are: Laivanrakennuksen innovaatiotuki, SHOK, Tuki innovaatiotoimintaan, Tutkimus ja kehitys.

compared grants and loans and concluded that grants contribute more strongly to the creation of new technological inventions, whereas loans appear to have a more direct impact on firms' market performance.

More recent Finnish evidence includes Martikainen et al. (2023), which evaluated the impacts of Business Finland's RDI funding during 2003–2019. The study utilised combined matching and difference-in-differences methods. The results showed that public R&D support increased firms' R&D activities and growth without crowding out private R&D investment. The evaluation also reported particularly strong effects for collaborative R&D projects. However, the authors noted that subsidies may weaken market selection by supporting low-productivity firms that would otherwise exit the market.

Complementing the evaluation literature, Einiö et al. (2022) analysed innovation policy and economic growth using Finnish firm-level data and a structural framework based on Acemoglu et al. (2018). The study concluded that R&D support can generate substantial welfare gains when it is allocated efficiently toward firms with high innovation

capacity and productivity potential. The analysis also emphasised the importance of resource reallocation and targeting in innovation policy.

Furthermore, van der Have and Deschryvere (2026) studied how RDI grants affect the probability of commercialising innovations in Finnish firms. They found significant and positive, although modest, effects, which increased over a period of five to eight years.

Taken together, the Finnish evaluation evidence points to strong input additionality and positive effects on innovation activity, while evidence on productivity, market performance and wider spillovers is more mixed and typically emerges only over longer time horizons.

The Finnish evidence is broadly consistent with the international empirical literature on R&D support and innovation policy.² International studies and meta-analyses conclude that public R&D support increases private R&D investment rather than fully crowding it out (e.g., Zúñiga-Vicente et al. 2014; Dimos and Pugh 2016; Dimos et al. 2022). The evidence further suggests that support is particularly effective when targeted towards projects

characterised by high technological uncertainty, financing constraints and strong spillover potential. The literature further suggests that positive effects are often stronger for SMEs and young innovative firms than for mature firms with easier access to external finance. At the same time, previous studies also highlight potential risks related to inefficient resource allocation, distortions in competition and the possibility of supporting relatively low-productivity firms. Moreover, productivity and growth effects often materialise only gradually over long time horizons, making the evaluation of innovation policies inherently challenging.

Despite the extensive research literature on R&D support, identifying its causal effects using observational data remains challenging. A central source of uncertainty is the potential role of unobservable firm characteristics, which may affect both selection into subsidy and subsequent firm outcomes. Moreover, because R&D projects often have long time horizons, the effects of subsidies may materialise only with substantial lags.

² More comprehensive reviews of the Finnish and international literature are provided, for example, by Ylhäinen et al. (2016), Fornaro et al. (2020) and Martikainen et al. (2023).

2. Data

The evaluation is based on linked firm-level micro-data combining Business Finland's administrative funding data with several national statistical and administrative registers maintained by Statistics Finland and other Finnish public authorities. The data cover the years 2013–2024 and allow longitudinal analysis of firms before and after the receipt of R&D support. In all the analyses, the data are restricted to private firms with the corporate form of a limited company. The data are described in more detail in Appendix 2.

Data sources for the analysis of direct effects

For the analysis of direct effects, the main data sources are Business Finland's application and funding databases, Statistics Finland's business register and financial statement data, the Business Enterprise Research and Development Survey (RDINNO), and the Community Innovation Survey (CIS). These datasets provide detailed information on firms' characteristics, turnover, value added, employment, productivity, R&D expenditure, R&D personnel, innovation activities, and collaboration networks. The evaluation also utilises patent application and registration data from the Finnish

Patent and Registration Office (PRH) and from the European Patent Office's PATSTAT database to analyse innovation outputs and technological development. In addition, Finnish Customs data on firms' international trade in goods and Statistics Finland's data on public business subsidies are utilised. The datasets are linked using unique firm-level identifiers.

Business Finland's administrative databases include project-level information on applications, funding decisions, and aid instruments. The financial statement data and business register maintained by Statistics Finland provide annual firm-level information on turnover, employment, assets, industry, location, age and other structural characteristics of firms. The Business Enterprise Research and Development Survey contains information on firms' R&D expenditure, R&D personnel and other innovation inputs, while the Community Innovation Survey provides complementary information on product and process innovation as well as innovation collaboration with other firms, customers, universities and research organisations. With respect to international trade, it should be noted that the data do not include exports of

services, as comprehensive firm-level data on service exports were not available during the implementation of the study. Future evaluations may benefit from newly available firm-level service export data based on administrative records from the Finnish Tax Administration.

The main outcome variables³ used in the analysis of direct effects include:

- R&D expenditure,
- R&D employment,
- patent applications,
- innovation outputs,
- turnover,
- employment⁴,
- value added⁵,
- tangible and intangible assets, and
- collaboration activities.

Data sources for the analysis of indirect effects

For the analysis of indirect effects, the evaluation uses the same linked micro-data together with industry-level information. The analysis examines whether non-supported firms operating in

³ All variables denominated in euros are deflated to 2025 prices.

⁴ The number of employees outcome variable is analysed both as the log of employment and as the Birch index, which is calculated by multiplying absolute change by relative change (see Birch 1987).

⁵ In the analysis, value added is divided by person-years of labour to make it more comparable across firms.

sectors or technological fields with high levels of R&D support differ in terms of innovation activity, productivity, or market performance from firms operating in sectors with lower exposure to the funding. Industry classifications are used to identify firms operating in similar product markets and technological fields. The original plan was also to exploit technological information from patent data, but this approach was not pursued because the resulting sample size would have been too small.

Data sources for the analysis of proportionality and appropriateness

For the assessment of proportionality and appropriateness of the aid, the evaluation relies primarily on Business Finland's funding data distinguishing between grants and loans. The evaluation uses the same linked microdata used in the estimations of direct effects.

The analysis compares firms receiving different aid instruments and examines differences in innovation activity, firm growth, and economic performance between recipients of grants and loans.

Data limitations

First, the latest waves of the Community Innovation Survey (CIS) and some R&D survey variables become available with a delay of approximately one to two years.⁶ As a result, the assessment of the most recent projects funded under the current scheme period remains partly preliminary, especially regarding long-term productivity, innovation, and market impacts. Since the economic and commercial impacts of R&D projects typically materialise several years after project completion, the observation period for the newest projects remains relatively short. To address this issue, the evaluation uses a longer observation window including projects funded under Business Finland and previous Tekes R&D schemes.

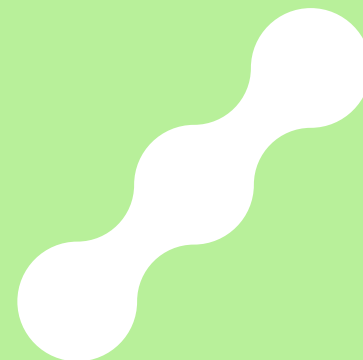
Second, some of the statistical surveys used in the evaluation are based partly on voluntary responses, particularly among smaller firms. This may lead to incomplete coverage for certain variables and years. This limitation is most pronounced for measures of innovation outputs and networking activities, which are derived from the biennial CIS.

Third, comparisons between accepted and rejected R&D funding applicants were not feasible due to an insufficient number of rejected applicants. This limitation was particularly important because the rejected applicants included in the control group were also required not to have received R&D support in the three years before or the three years after the matching year. Consequently, the evaluation relies primarily on matched non-supported firms drawn from firms that had applied for R&D support by the matching year but were not accepted either in the matching year or in the three years before or after matching.

Moreover, between 2021 and 2025, Business Finland administered and awarded funding under the European Union's Recovery and Resilience Facility (RRF), which forms part of the EU recovery package. Approximately half of the projects funded under the RRF were completed after the latest year available in the register data (i.e., completed in 2025 or later). Hence, these projects could not be adequately assessed and were therefore excluded from the analysis.

⁶ The Community Innovation Survey (CIS) is conducted biennially, and the available survey waves cover the years 2016, 2018, 2020, and 2022. The Business Enterprise Research and Development Survey is conducted annually, with available waves covering the years 2014–2024.

3. Evaluation questions and methods



The evaluation examines the effectiveness, indirect impacts and appropriateness of Business Finland's R&D funding scheme in accordance with the Evaluation Plan approved by the European Commission. The analysis focuses on three broad categories of evaluation questions: (i) direct effects of the aid on beneficiary firms, (ii) indirect effects of the aid on non-supported firms, markets and the wider economy, and (iii) the proportionality and appropriateness of the aid instruments.

The evaluation combines econometric methods with descriptive statistical analysis. The methodological framework is designed to assess the causal impacts of R&D support while addressing the main empirical challenges related to innovation policy evaluation, including selection bias, firm heterogeneity, and time lags in the materialisation of R&D impacts.

Direct effects

The first set of evaluation questions concerns the direct effects of the aid on beneficiary firms. The analysis focuses on input additionality, output additionality, and behavioural additionality, that is, the extent to which public funding affects private



R&D investments, firm-level outcomes, and collaboration and networking activities. The main evaluation questions are:

- Q1. Do supported firms increase R&D inputs as a result of public support? To what extent R&D inputs are increased?
- Q2. Do supported firms produce more innovative output as a result of public support? To what extent innovative output is increased?
- Q3. Do supported firms improve their economic performance as a result of public support? To what extent performance is increased?
- Q4. Do supported firms increase networking in technological development projects with other businesses and research organisations?

The analysis of direct effects is based primarily on econometric methods combining propensity score matching (PSM) and difference-in-differences (DID) estimation. The matching procedure is used to construct a control group of non-supported firms that are comparable to supported

firms in terms of observable characteristics in period t when the R&D support was granted to the firms in the treatment group.⁷ As a robustness check, we also implemented the matching in period $t-1$, the year before the R&D support was granted, since the information about receiving the subsidy could affect firms' decisions already in period t . However, this did not affect the interpretation of the results.

Matching variables include the number of employees ($t-1$ and t), turnover ($t-1$ and t), number of R&D employees, debt to total assets, return on total assets, EBITDA, total assets, value added per employee, age, industry, geographical location, export activity, employees' average years of schooling, patenting activity, and subsidies received other than R&D support. In both the treatment and control groups, only firms that are observed in the data throughout the period from $t-2$ to $t+2$ are included.⁸ A common-support restriction is used in the matching, hence, observations of supported firms with propensity scores higher than the maximum or lower than the minimum propensity score among non-supported firms are dropped. The matching is conducted using kernel matching with

an Epanechnikov function.⁹ The balance of covariates between the supported and non-supported groups is tested by evaluating standardized biases of all matching covariates. The balance is considered sufficient when the standardized biases of all individual covariates are under 10 per cent, and the mean standardized bias of all covariates is below 5 per cent (see Rosenbaum and Rubin 1985).

Table 1 presents the covariate balance for the estimations of RDI and innovation expenditure outcomes. The mean standardized biases of all covariates are below the 5 per cent threshold in the estimations of the share of firms deciding to invest in RDI and of RDI jobs. However, in the former estimation, there are individual variables for which the bias exceeds the 10 per cent threshold. One possible explanation is that the number of observations is smaller when estimating the share of firms deciding to invest in RDI than when estimating RDI jobs. The largest individual biases are still within a reasonable range and we therefore consider the balance to be acceptable. By contrast, the covariate balance is very poor when estimating innovation expenditures, which is likely due to the very small sample size in the CIS data.

⁷ In most estimations, we require control firms to have applied for R&D support either in the matching year or earlier (but not to have been granted support between periods $t-3$ and $t+3$). The outcome variables derived from the CIS data are the only exception. Due to the limited number of observations in the CIS data, we do not require that a control firm has applied for R&D support when estimating outcomes based on the CIS. When estimating outcome variables using either the CIS or the Business Enterprise Research and Development Survey data, we require both treatment and control firms to be included in the respective dataset.

⁸ We did not require firms to have observations for all variables in every period. Hence, the number of observations varies somewhat across estimation periods and variables.

⁹ Matching was also performed using Coarsened Exact Matching (CEM). However, the quality of the resulting matches was lower than that achieved using Propensity Score Matching (PSM), at least partly because the sample size was insufficient for CEM.

	Share of firms deciding to invest in RDI			RDI jobs estimations			Innovation expenditures as a percentage of turnover		
	Treated	Control	Bias	Treated	Control	Bias	Treated	Control	Bias
$\ln(\text{turnover}_{i,t})$	15.18	15.07	2.94	14.93	15.06	-3.64	18.95	18.25	38.29
$\ln(\text{turnover}_{i,t-1})$	14.97	14.87	2.58	14.71	14.88	-4.54	18.92	18.23	36.56
$\ln(\text{employment}_{i,t})$	3.74	3.45	16.05	3.45	3.46	-0.28	6.18	5.13	77.54
$\ln(\text{employment}_{i,t-1})$	3.63	3.34	15.82	3.34	3.35	-0.68	6.15	5.14	74.65
$\ln(\text{RDIemployment}_{i,t})$	2.06	1.86	14.92	1.79	1.73	4.60	3.23	2.29	60.29
$\text{debt ratio}_{i,t}$	0.27	0.30	-10.11	0.28	0.29	-3.34	0.13	0.11	8.52
$\text{ROA}_{i,t}$	-0.07	-0.05	-6.95	-0.08	-0.06	-7.91	0.08	0.06	7.87
$\ln(\text{EBITDA}_{i,t})$	8.27	8.18	1.27	7.87	8.14	-3.90	14.30	13.21	18.83
$\ln(\text{total assets}_{i,t})$	16.05	15.73	14.28	15.68	15.76	-3.46	18.74	17.86	45.16
$\ln(\text{value added}_{i,t} / \text{employment}_{i,t})$	7.21	8.03	-10.88	7.22	7.70	-6.46	10.93	10.49	13.54
$\ln(\text{exports}_{i,t})$	8.61	8.29	4.40	7.59	8.06	-6.49	14.68	13.91	11.20
$\ln(\text{age}_{i,t})$	2.57	2.54	3.56	2.52	2.56	-4.46	3.07	3.06	1.79
number of patents applied ($t-4 - t$) $_{i,t}$	2.86	1.33	1.05	2.19	1.93	0.21	21.23	4.98	42.95
number of subsidies received other than R&D ($t-4 - t$) $_{i,t}$	1.16	1.09	5.31	1.24	1.13	8.53	0.92	1.16	-19.26
average schooling years of employment $_{i,t}$	15.21	15.12	5.38	15.16	15.09	4.31	14.31	13.97	26.33

Table 1. Covariate balance after matching for estimations of RDI and innovation expenditure outcomes.

Table 2 presents the covariate balance for the patent estimations and the process and product innovation estimations. In the patent estimations, the mean standardized bias of all covariates is well below the 5 per cent threshold. The biases of some individual variables exceed the 10 per cent threshold but remain below 12.5 per cent, so we consider the balance to be acceptable. However, the covariate balance is very poor when estimating process and product innovations, which is likely due to the very small sample size in the CIS data.

Table 3 presents the covariate balance for the firm performance estimations, namely employment, turnover, value added, and tangible and intangible assets. The mean standardized biases of all covariates are below the 5 per cent threshold. In addition, the biases of individual variables are below the 10 per cent threshold, except for total assets and exports, for which the biases remain below 13 per cent. Hence, we consider the balance to be acceptable.

	Patent estimations			Process and product innovation estimations		
	Treated	Control	Bias	Treated	Control	Bias
$\ln(\text{turnover}_{i,t})$	14.71	15.17	-11.88	18.46	18.07	19.09
$\ln(\text{turnover}_{i,t-1})$	14.49	14.97	-12.04	18.44	18.02	20.88
$\ln(\text{employment}_{i,t})$	3.39	3.47	-3.83	5.84	5.43	29.80
$\ln(\text{employment}_{i,t-1})$	3.26	3.36	-5.20	5.81	5.41	28.59
$\ln(\text{RD}I\text{employment}_{i,t})$	1.65	1.56	6.63	2.98	2.89	5.31
$\text{debratio}_{i,t}$	0.29	0.26	6.86	0.13	0.12	5.20
$\text{ROA}_{i,t}$	-0.11	-0.07	-11.15	0.05	0.06	-2.39
$\ln(\text{EBITDA}_{i,t})$	7.55	8.05	-7.11	12.84	13.55	-11.49
$\ln(\text{total assets}_{i,t})$	15.68	15.85	-7.41	18.35	17.93	21.35
$\ln(\text{value added}_{i,t} / \text{employment}_{i,t})$	6.57	7.61	-12.48	10.36	9.91	10.38
$\ln(\text{exports}_{i,t})$	7.77	8.43	-9.09	13.38	13.87	-6.96
$\ln(\text{age}_{i,t})$	2.48	2.54	-8.04	3.09	2.63	62.41
number of patents applied ($t-4 - t$) $_{i,t}$	2.87	2.04	0.67	49.07	5.60	23.83
number of subsidies received other than R&D ($t-4 - t$) $_{i,t}$	1.24	1.10	11.33	0.91	1.27	-28.99
average schooling years of employment $_{i,t}$	15.19	15.06	7.53	14.70	14.51	13.39

Table 2. Covariate balance after matching for estimations of patent outcomes and process and product innovation outcomes.

	Employment (birch index)			Employment (log)			Turnover (log)			Value added (log)			Tangible and intangible assets (log)		
	Treated	Control	Bias	Treated	Control	Bias	Treated	Control	Bias	Treated	Control	Bias	Treated	Control	Bias
$\ln(\text{turnover}_{i,t})$	14.61	14.89	-8.26	14.60	14.88	-8.11	14.60	14.88	-8.11	14.61	14.89	-8.26	14.60	14.87	-7.95
$\ln(\text{turnover}_{i,t-1})$	14.36	14.68	-9.23	14.35	14.66	-8.65	14.35	14.66	-8.65	14.36	14.68	-9.23	14.35	14.65	-8.51
$\ln(\text{employment}_{i,t})$	3.20	3.33	-7.17	3.20	3.32	-6.87	3.20	3.32	-6.87	3.20	3.33	-7.17	3.20	3.32	-6.82
$\ln(\text{employment}_{i,t-1})$	3.06	3.22	-8.77	3.05	3.21	-8.42	3.05	3.21	-8.42	3.06	3.22	-8.77	3.05	3.20	-8.36
$\ln(\text{RDIemployment}_{i,t})$	1.11	1.10	1.26	1.11	1.10	1.21	1.11	1.10	1.21	1.11	1.10	1.26	1.11	1.10	1.18
$\text{debratio}_{i,t}$	0.29	0.28	3.94	0.29	0.28	3.37	0.29	0.28	3.37	0.29	0.28	3.94	0.29	0.28	3.14
$\text{ROA}_{i,t}$	-0.11	-0.10	-5.00	-0.11	-0.10	-4.99	-0.11	-0.10	-4.99	-0.11	-0.10	-5.00	-0.11	-0.10	-4.97
$\ln(\text{EBITDA}_{i,t})$	7.24	7.45	-3.06	7.23	7.44	-3.05	7.23	7.44	-3.05	7.24	7.45	-3.06	7.23	7.45	-3.17
$\ln(\text{total assets}_{i,t})$	15.37	15.66	-12.65	15.37	15.65	-12.33	15.37	15.65	-12.33	15.37	15.66	-12.65	15.37	15.64	-12.26
$\ln(\text{value added}_{i,t} / \text{employment}_{i,t})$	6.70	6.92	-2.83	6.68	6.89	-2.64	6.68	6.89	-2.64	6.70	6.92	-2.83	6.68	6.90	-2.82
$\ln(\text{exports}_{i,t})$	6.50	7.37	-12.94	6.50	7.35	-12.69	6.50	7.35	-12.69	6.50	7.37	-12.94	6.50	7.35	-12.73
$\ln(\text{age}_{i,t})$	2.43	2.49	-7.77	2.43	2.49	-7.63	2.43	2.49	-7.63	2.43	2.49	-7.77	2.43	2.49	-7.55
number of patents applied ($t-4 - t$) $_{i,t}$	1.99	1.78	0.20	1.98	1.77	0.21	1.98	1.77	0.21	1.99	1.78	0.20	1.98	1.78	0.20
number of subsidies received other than R&D ($t-4 - t$) $_{i,t}$	1.27	1.24	2.66	1.27	1.23	2.66	1.27	1.23	2.66	1.27	1.24	2.66	1.27	1.24	2.40
average schooling years of employment $_{i,t}$	15.04	14.95	4.43	15.04	14.95	4.38	15.04	14.95	4.38	15.04	14.95	4.43	15.04	14.95	4.46

Table 3. Covariate balance after matching for estimations of firm performance outcomes.

	Collaboration estimations		
	Treated	Control	Bias
$\ln(\text{turnover}_{i,t})$	18.46	18.07	19.09
$\ln(\text{turnover}_{i,t-1})$	18.44	18.02	20.88
$\ln(\text{employment}_{i,t})$	5.84	5.43	29.80
$\ln(\text{employment}_{i,t-1})$	5.81	5.41	28.59
$\ln(\text{RDIemployment}_{i,t})$	2.98	2.89	5.31
$\text{debratio}_{i,t}$	0.13	0.12	5.20
$\text{ROA}_{i,t}$	0.05	0.06	-2.39
$\ln(\text{EBITDA}_{i,t})$	12.84	13.55	-11.49
$\ln(\text{total assets}_{i,t})$	18.35	17.93	21.35
$\ln(\text{value added}_{i,t} / \text{employment}_{i,t})$	10.36	9.91	10.38
$\ln(\text{exports}_{i,t})$	13.38	13.87	-6.96
$\ln(\text{age}_{i,t})$	3.09	2.63	62.41
number of patents applied (t-4 - t) _{i,t}	49.07	5.60	23.83
number of subsidies received other than R&D (t-4 - t) _{i,t}	0.91	1.27	-28.99
average schooling years of employment _{i,t}	14.70	14.51	13.39

Table 4 presents the covariate balance for estimations of collaboration outcomes, namely collaboration with competitors, customers, and universities. In these estimations, the mean standardized bias across all covariates exceeds 12 per cent, and the biases of many individual variables exceed 20 per cent. Hence, the covariate balance is very poor when estimating collaboration outcomes, which is likely due to the very small sample size in the CIS data.

After matching, the DID approach is used to compare the development of supported and non-supported firms for several years before and after the receipt of aid. This approach controls for unobserved time-invariant differences between firms and common macroeconomic trends affecting both groups. In DID estimation, we estimate the following equation (see Heckman et al. 1997):

$$(1) E(y_{i,t+s}^1 - y_{i,t+s}^0 | \text{support}_i = 1, x_{i,t}) = E(y_{i,t+s}^1 | \text{support}_i = 1, x_{i,t}) - E(y_{i,t+s}^0 | \text{support}_i = 0, x_{i,t}),$$

where y is the outcome variable and support is the treatment variable, the superscript indicates whether a firm received R&D support (1) or not (0), and x represents the covariates used for matching. Since we cannot observe how the supported firms would have developed had they not received the subsidy, we compare them with

Table 4. Covariate balance after matching for estimations of collaboration outcomes.

similar non-supported firms that have the same probability of receiving support based on observable covariates. In the estimations, we use influence-function based standard errors which are robust (Jann 2019).

The possible heterogeneous effects were estimated by analysing high- and low-R&D industries separately in manufacturing and services.¹⁰ Furthermore, separate estimations were also conducted for firms with high and low indebtedness and for firms of different sizes.

The evaluation period also overlaps with the COVID-19 pandemic, during which Business Finland granted a substantial volume of business support. However, these support measures were largely aimed at general business development and firms' adaptation to the exceptional circumstances, and are therefore mostly outside the scope of the R&D support scheme examined in this study. Furthermore, the pandemic is unlikely to affect the validity of the evaluation results, unless the effects of R&D funding differed systematically during the pandemic period. However, the long-term nature of R&D projects and the three-year observation period mitigate this concern. Other public subsidies received by firms are controlled for in the matching procedure.

Indirect effects

The second set of evaluation questions concerns indirect effects of the aid scheme on non-sup-

ported firms, product markets and the wider economy. The main evaluation questions are:

- Q5. Does public support induce input, output or behavioural additionality among non-supported firms?
- Q6. What are the potential indirect negative effects of the scheme on the rivals of the supported firms?

Indirect effects are analysed primarily using descriptive and exploratory econometric methods. The analysis examines whether non-supported firms operating in sectors with high levels of R&D support differ systematically from non-supported firms operating in sectors with lower exposure to support. The estimations are conducted separately for manufacturing and service firms, and for the subsets of manufacturing and service firms with a patenting history.

To further examine potential spillover and competition effects, non-supported applicant firms are compared with non-supported non-applicant firms within manufacturing and services. This comparison provides evidence on how firms which applied for R&D funding but did not receive support developed relative to other firms operating in the same market segments. Additional analyses are conducted for the subsample of firms with a prior patenting history.

Given the descriptive nature of the indirect analysis and the limited sample sizes available for

some subsamples, particularly among firms with a patenting history, the analysis focuses on differences in outcome means, rather than on difference-in-differences estimates, while controlling for other public subsidies received by firms, the number of patent applications filed during the four years up to and including the matching year, year effects and two-digit industry classifications.

Identifying indirect effects and knowledge spillovers is considerably more challenging than identifying direct effects, as exposure to support is difficult to measure and causal channels are often indirect. Consequently, the results should be interpreted with caution and regarded as indicative evidence rather than definitive causal estimates.

Proportionality and appropriateness of the aid

The third set of evaluation questions concerns the proportionality and appropriateness of the aid scheme and its instruments. The main evaluation question is:

- Q7: Could the same effects have been obtained with a different structure of aid instruments?

This part of the evaluation focuses particularly on differences between grants and repayable advances (loans). Separate treatment groups are constructed for firms receiving grants and firms receiving loans. Comparisons are conducted between supported and non-supported firms, and between firms receiving different aid instruments.

¹⁰ When analysing services, we include knowledge-intensive services, which are more closely associated with RDI activities than are some basic services (as used, e.g., in Norkio 2024). The included industry classifications are 50, 51, 58, 59, 60, 61, 62, 63, 69, 70, 71, 72, 73, 74, 75, 78, 80, O, P, Q, and R.



These analyses examine the same outcomes as the analyses of direct effects. However, some innovative outcomes could not be analysed due to the small sample size.

The assessment is limited to grants and loans because, in Finland, other forms of R&D support, such as R&D tax incentives, have been used infrequently. Therefore, the data do not allow us to form a sufficiently large group of firms receiving alternative forms of support beyond grants or loans.

Methodological limitations in identifying causal effects

Although this paper uses comprehensive register-based data and applies a methodology commonly used in impact evaluations, questions remain about whether the analysis can identify a clear causal effect.

Perhaps the most important source of uncertainty arises from unobservable firm characteristics. A naïve interpretation would be that, if supported firms perform better than non-supported firms, the difference can be attributed to the subsidy. However, because the analysis relies on observational data, several unobservable firm characteristics may affect the outcomes. Although we control for factors such as patenting activity and the number of R&D employees, supported firms may nevertheless have higher-quality ideas or greater capacity to execute R&D projects. They may also be more growth-oriented.

In addition to unobservable characteristics, potential lags in the outcomes of R&D projects must also be considered. On the one hand, such effects may take several years to materialise. On the other hand, the longer the estimation period, the greater the uncertainty in attributing the observed impact to a specific subsidy received several years earlier. Furthermore, the distribution of impacts may be highly skewed: only a minority of supported firms may experience large positive effects, while the majority may not experience any statistically significant impact.

In addition to R&D support, firms may apply for other types of subsidies. Some of the observed effects in the analysis could therefore reflect subsidies other than R&D support. In estimating the causal effects, other types of subsidies are accounted for by including them as covariates in the matching procedure.

Although there are some important limitations in identifying causal effects, we consider this method — propensity score matching combined with difference-in-differences — to be the best feasible approach given the available data.

4. Results

4.1 Allocation of R&D funding

This subsection examines the allocation of Business Finland's R&D funding in terms of the amount of funding granted and the characteristics of recipient firms, particularly by industry and firm size. We also examine the number of funding applications and their approval rate. Funded firms are defined as firms with an approved funding decision, with the observation year determined by the date of the decision.

The analysis combines Business Finland's funding application data with Statistics Finland's business register, which provides background information on firms.

R&D funding applications

The annual number of funding applications under the R&D aid scheme varied between 600 and 1,600 over the period 2013–2024 (Figure 1). Application volumes were highest at the beginning of the observation period, exceeding 1,500 applications in 2013. After that, the number of applications remained relatively stable at around 1,000–1,150 applications per year until 2021.

A more pronounced decline was observed in 2022–2023, when the number of applications fell to around 650–700 per year, followed by a modest recovery in 2024.

The annual acceptance rate ranged between 50 % and 72 %, reaching its highest level in 2018 and its lowest level in 2022 (Figure 1). Following the decline in applications, the acceptance rate increased again and reached 67 % in 2024. Approximately 2 % of applications were cancelled each year.

The number of approved applications varied between approximately 400 and 1,000 per year (Figure 2). The annual number of grants ranged between 200 and 700, while the number of loans varied between 140 and 400 over 2013–2024.¹¹ In 2024, approximately 490 applications were approved, of which 62 % were direct grants and 38 % loans.

During 2015–2016, the volume of R&D grants declined temporarily to an exceptionally low level

compared with other years. The decline can be attributed to significant cuts in funding authorisations implemented by the Sipilä government. Moreover, in 2013 and 2014 the data include a small number of firms that received both grants and loans within the same year, which is atypical for the

rest of the observation period. This reflects the use of so-called “combo funding” schemes during those years, whereby funding was provided as a 50–50 combination of loans and grants. The use of these instruments was discontinued at the beginning of 2015.

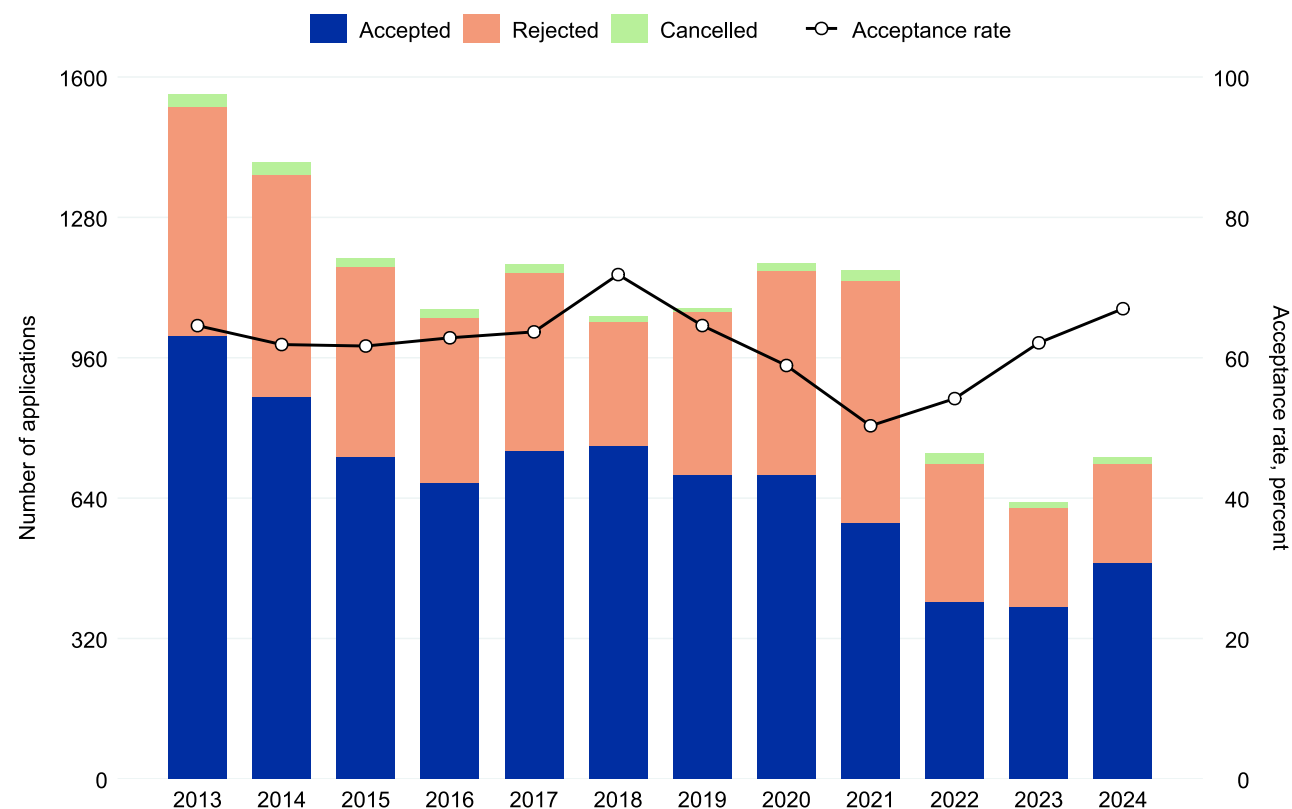


Figure 1. R&D funding applications by the funding decision and acceptance rate (%), 2013–2024.

¹¹ It should be noted that a single firm may have received funding multiple times and in multiple forms within the same observation year. During the period 2013–2024, approximately 92 per cent of the funded firms received R&D funding once within a year, 7 per cent twice, and 1.5 per cent three or more times.

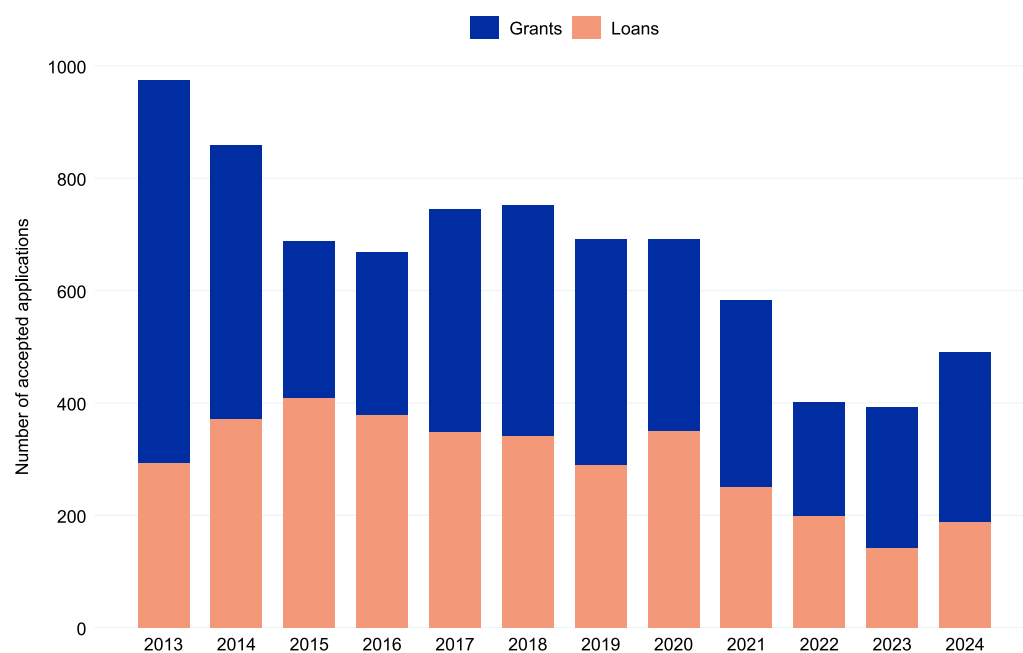


Figure 2. Annual number of accepted R&D applications by funding type (grants and loans), 2013–2024.

Annual R&D funding

Between 2013 and 2024, the total annual amount of funding awarded under the R&D aid scheme ranged from EUR 290 million to EUR 563 million (Figure 3). Grant funding exhibited somewhat greater year-to-year variation than loan funding. Total R&D funding awarded to firms declined between 2013 and 2016 and increased moderately thereafter. The year 2020 represents an exception, with a pronounced peak in funding associated with the COVID-19 pandemic. In 2024, the total amount of R&D funding awarded was EUR 338 million, of which direct grants accounted for EUR 202 million and loans for EUR 136 million.

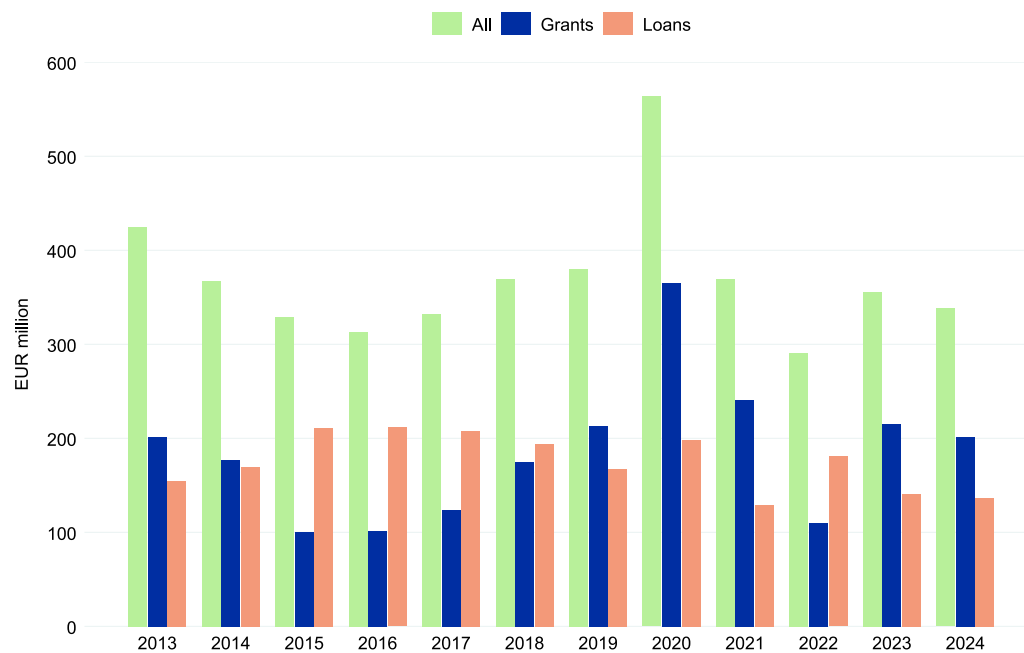


Figure 3. Total R&D funding (million Euros) granted to firms by funding type (all, grants and loans), 2013–2024.

Average and median R&D funding

Over 2013–2024, the average amount of R&D funding awarded was approximately EUR 558,000, while the median amount was EUR 275,000 (Figure 4). The average grant amounted to approximately EUR 510,000, and the average loan to EUR 591,000. Loans tended to be somewhat larger than grants, as reflected also in the median amounts: EUR 330,000 for loans compared with EUR 218,000 for grants.

A small number of exceptionally large projects temporarily increased the average grant amount in 2020. In 2024, the average funding amount awarded was approximately EUR 688,000, while the median amount was EUR 305,000.

Both the mean and median amounts of R&D funding awarded increased over the observation period. However, at the same time, the number of recipients decreased between 2021 and 2023 (see Figure 2). This pattern suggests a shift in the allocation of R&D funding towards larger funding amounts per project during 2021–2023. However, this trend moderated in 2024.

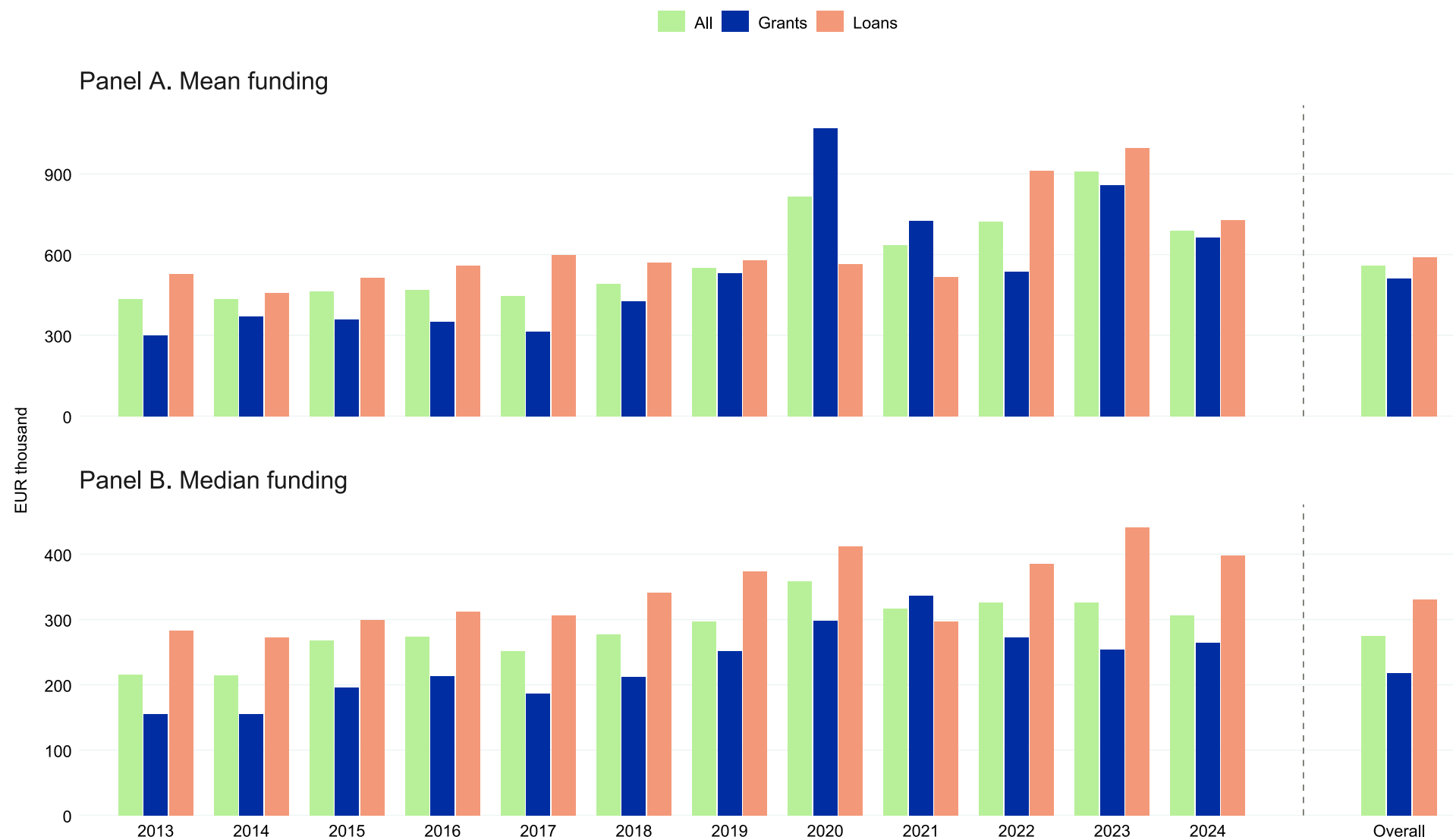


Figure 4. Average (Panel A) and median (Panel B) R&D funding granted to firms by funding type, 2013–2024. "Overall" refers to the average funding amount over the full period 2013–2024. Funding amounts below EUR 10,000 are excluded. All amounts are expressed in 2025 prices.

R&D funding by industry and firm size

Three main industries dominate the distribution of funding awards, namely manufacturing (36 %), information and communication (33 %) and professional, scientific and technical activities (19 %) (Appendix 3, Table 3.1). In manufacturing, the share of total funding (44 %) exceeds its share of awards (36 %), which indicates that manufacturing firms accumulated more funding than firms in other industries over 2013–2024. The median funding amount was also the second highest in manufacturing (EUR 308,098) and the highest in agriculture, forestry and fishing (EUR 310,298).

In contrast, the highest average funding amounts were observed in mining and quarrying (EUR 927,377) and in energy and water supply (EUR 779,015). The lowest funding levels, below EUR 400,000, were recorded in financial and insurance activities, other service activities, accommodation and food service activities, transportation and storage, real estate activities, and education.

Looking at firm size, micro firms account for approximately 40 % of R&D awards (Appendix 3, Table 3.2). The corresponding shares are 24 % for small firms, 14 % for medium-sized firms, and 22 % for large firms. However, when total funding volumes are considered, large firms accumulated the largest share of funding over 2013–2024. Their share of total funding amounts to 36 %, and they

also exhibit the highest average funding amounts (EUR 914,014). Medium-sized firms have the lowest share both in terms of the number of awards and the total amount of funding received.

The average R&D funding amount increases clearly with firm size. However, the relatively similar median funding amounts across size categories suggest that the typical funding is broadly comparable between firm size groups, and that the differences in means are driven by a limited number of large individual grants.

Characteristics of R&D funded firms

Over the years 2013–2024, both the number and the share of micro firms among R&D funding recipients declined, whereas the shares of small, medium-sized, and large firms remained relatively stable (no figure). Across all size categories, the number of recipient firms declined between 2020 and 2023, reflecting the overall reduction in funding applications and approved projects. In 2024, however, the number of recipients increased in all size classes. The evaluation applies the EU definition of firm size.

In 2024, 38 % of funded firms were micro firms, 28 % small firms, 15 % medium-sized firms, and 20 % large firms (Figure 5). In absolute terms, this corresponds to 167 micro firms, 124 small firms, 67 medium-sized firms, and 87 large firms.

In terms of firm age, the recipient population includes both young and mature firms. In 2024,

25 % of recipient firms were aged 0–4 years, 24 % were aged 5–9 years, 19 % were aged 10–14 years, and 32 % were at least 15 years old. Over time, the share of firms younger than five years declined, while the shares of older firms increased. In recent years, firms aged 15 years or more have represented the largest recipient group.

Most recipient firms were domestically privately owned (92 %) and operated a single establishment (77 %). More than half of all recipient firms were located in the Helsinki-Uusimaa region. More precisely, 53 % of recipient firms were headquartered in the province of Uusimaa. The next largest shares of recipient firms were located in Pirkanmaa (11 %), North Ostrobothnia (8 %), and Southwest Finland (7 %). Firms located in Northern and Eastern Finland account for smaller shares of recipients.

Most of the R&D funding has been allocated to firms operating in services and manufacturing. Looking more closely, the most prominent industry among R&D recipients is Computer programming, consultancy and related activities (NACE Rev. 2: 62) (Figure 6). This industry accounted for 32 per cent of recipient firms in 2024 and 29 per cent over the period 2013–2024. Although the number of R&D recipients in this industry declined between 2021 and 2023, the decrease in its relative share was more modest. Also, in 2024 the number of funded firms in this industry started to increase again.

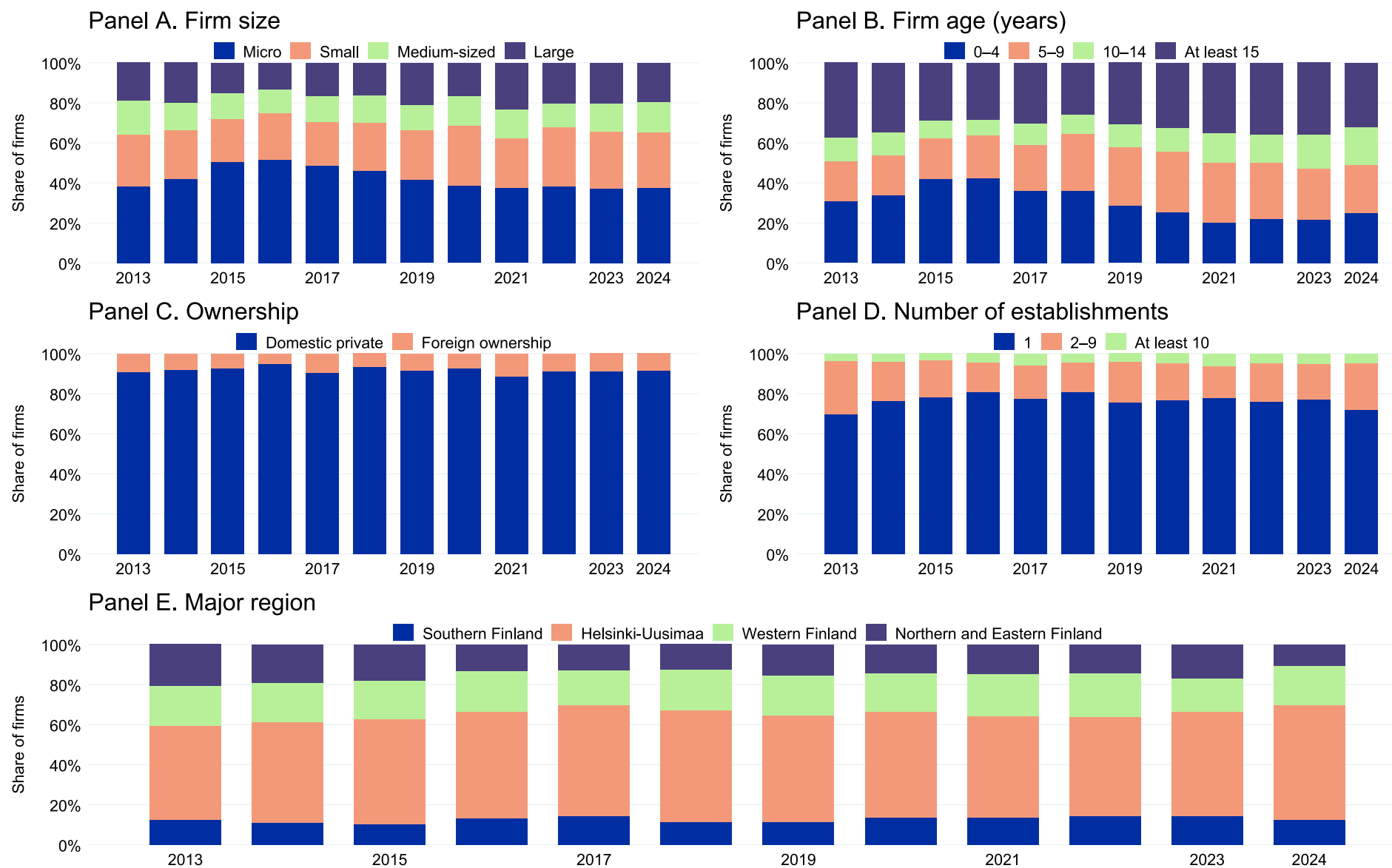


Figure 5. Distribution of recipient firms by firm size, firm age, ownership, number of establishments and major region, 2013–2024.

Overall, the Computer programming industry's share of recipient firms varied between 24 and 32 per cent over the years 2013–2024. At a more detailed five-digit industry level, funding is concentrated within the industry particularly in Computer programming activities (NACE 62010; 28 % in 2024) and, to a lesser extent, in Computer consultancy activities (NACE 62020; 2 % in 2024) and in Other information technology and computer service activities (NACE 62090; 2 % in 2024).

Other industries account for clearly smaller numbers and shares of R&D recipients than Computer programming, consultancy and related activities (Figure 6). The top five industries, both in 2024 and over the full observation period, also include Manufacture of machinery and equipment n.e.c. (NACE 28; 9 % in 2024), Manufacture of computer, electronic and optical products (NACE 26; 9 % in 2024), Scientific research and development (NACE 72; 8 % in 2024), and Architectural and engineering activities; technical testing and analysis (NACE 71; 6 % in 2024). Within these industries, funding is concentrated particularly in Manufacture of instruments and appliances for measuring, testing and navigation (NACE 26510; 3 % in 2024), Research and development on engineering and technology (NACE 72193; 3 % in 2024), Manufacture of other special-purpose machinery n.e.c. (NACE 28990; 2 % in 2024), and Mechanical and process engineering design (NACE 71127; 3 % in 2024).

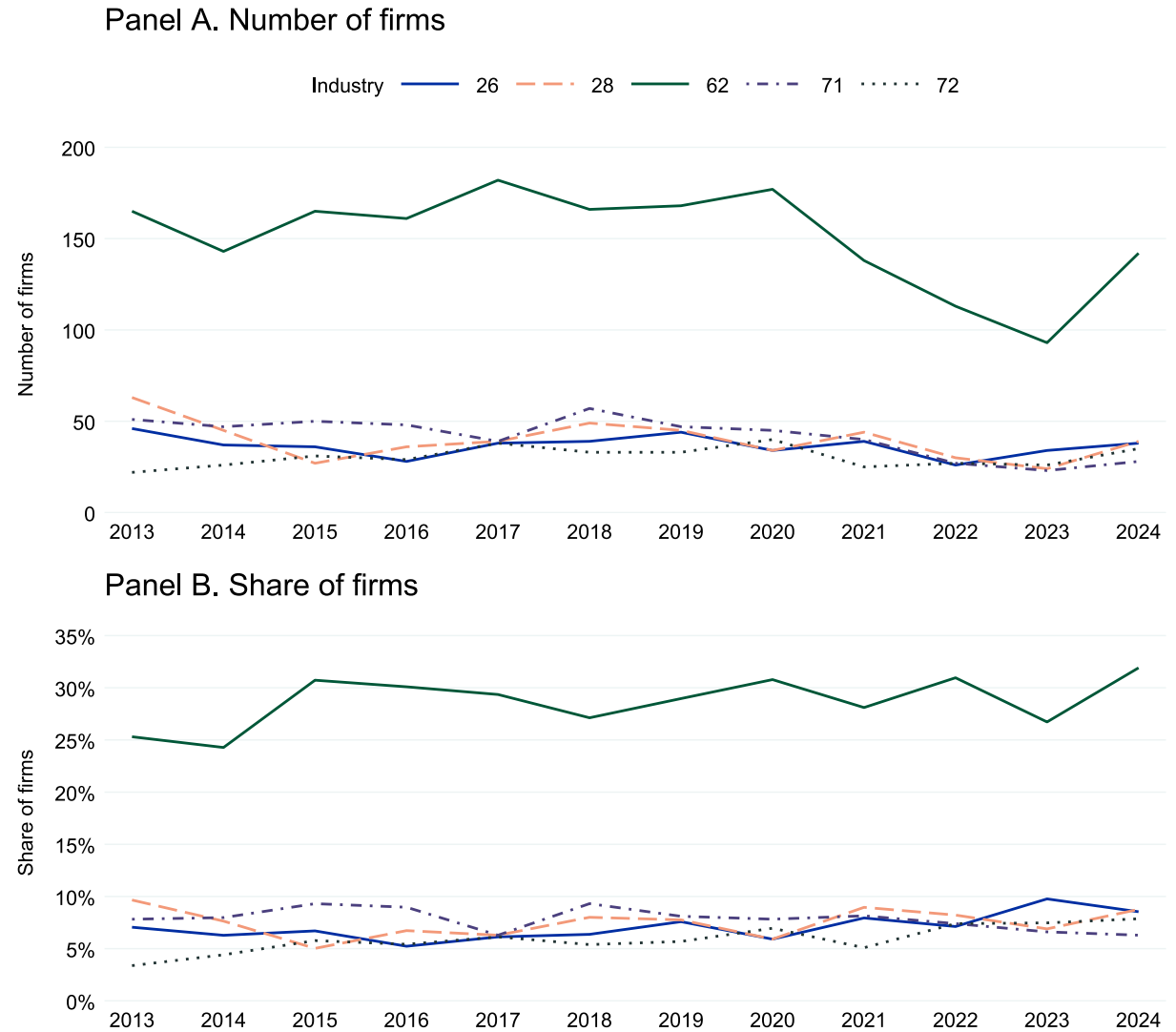


Figure 6. The number and share of TOP5 industries among R&D funded firms, 2013–2024. Notes: Industries by NACE Rev. 2: 26 = Manufacture of computer, electronic and optical products; 28 = Manufacture of machinery and equipment n.e.c.; 62 = Computer programming, consultancy and related activities; 71 = Architectural and engineering activities; technical testing and analysis; 72 = Scientific research and development.

Overall, the descriptive analysis shows that the beneficiary population consists primarily of domestically owned firms operating in knowledge-intensive sectors, although firms of all sizes and ages are represented among recipients. Appendix 4 examines whether certain types of firms are overrepresented among recipients. The distribution of R&D recipients differs markedly from that of the overall firm population in terms of firm size and location and, to a lesser extent, firm age. Moreover, Business Finland's R&D funding is strongly concentrated in a limited number of industries (NACE 26, 28, 62, 71 and 72), and these industries are generally overrepresented among funded firms relative to their shares in the overall firm population.

R&D intensity by industries

The R&D-support intensity, measured as the share of firms receiving R&D funding relative to the total number of firms in the industry, is particularly high in manufacturing and knowledge-intensive

service industries. During 2013–2024, the highest R&D-support intensity at the two-digit industry level was observed in NACE 21 Manufacture of basic pharmaceuticals products, where more than 10 % of firms received R&D funding (Figure 7). This was followed by NACE 26 Manufacture of computer, electronic and optical products, with almost 9 % of firms receiving support, and NACE 72 Scientific research and development, where approximately 5 % of firms received funding. The evolution of R&D-support intensity is presented in Figure 8. The ranking of the most R&D-intensive industries remained broadly stable over time when comparing periods 2013–2019 and 2020–2024. The share of firms receiving R&D funding declined across almost all industries during the latter period.

The results indicate that Business Finland's R&D funding is concentrated in industries where innovation activities, technological development, and formal R&D investments are typically most intensive.

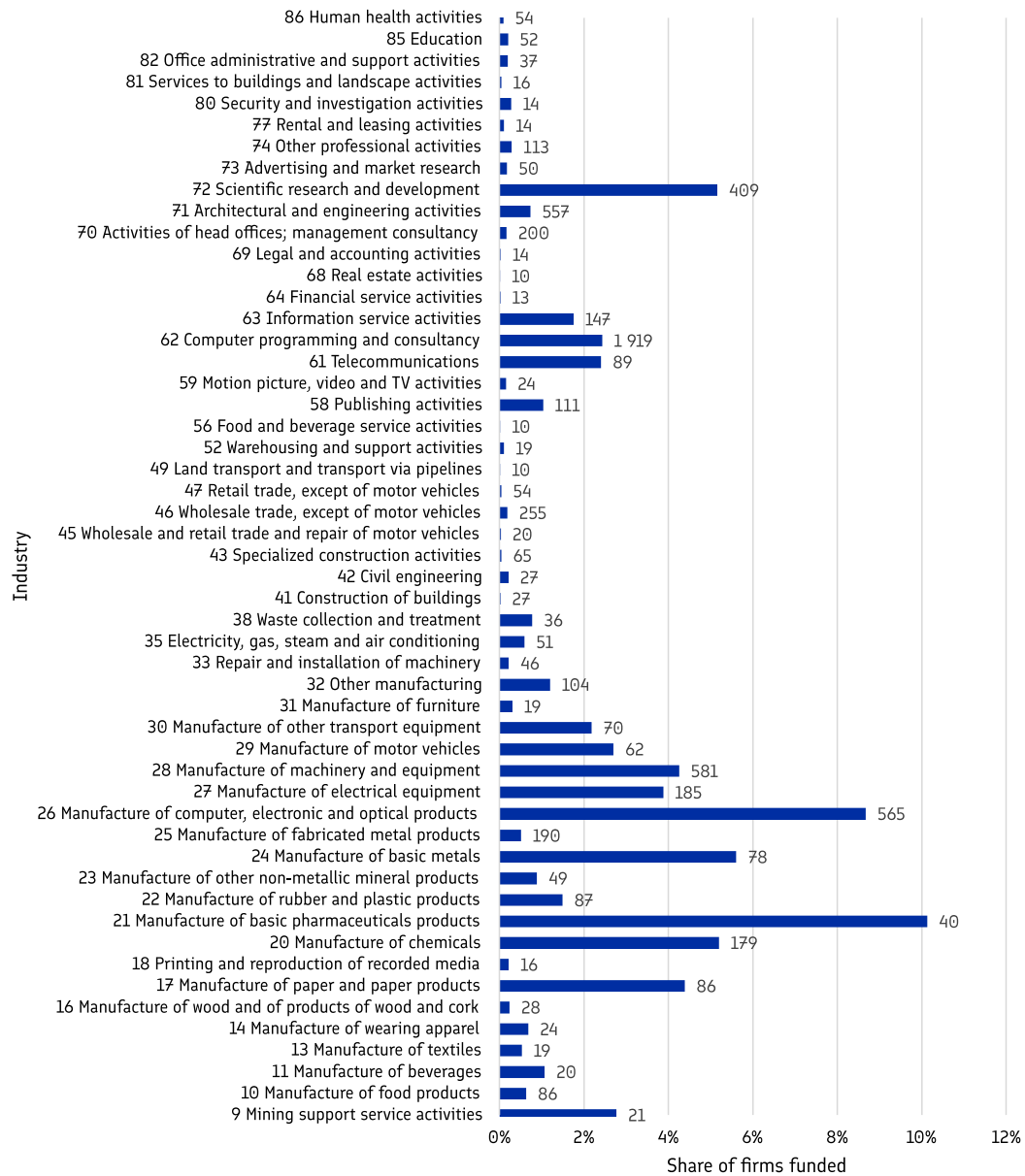


Figure 7. R&D-support intensity by industry (NACE rev2, two-digit-level), 2013–2024. Calculated for industries with at least 10 observations. Number of R&D funded firms is shown on the right-hand side.

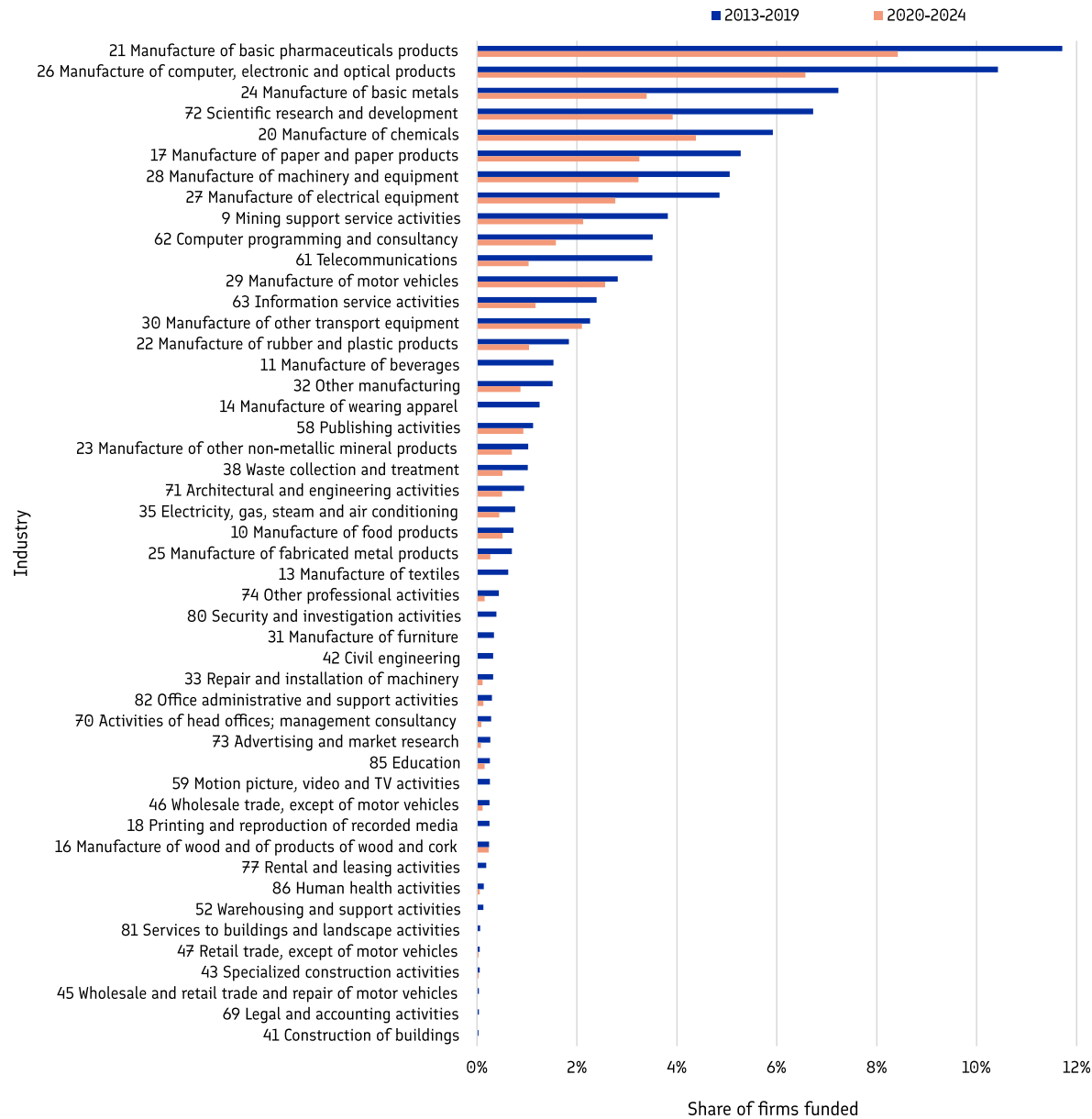


Figure 8. R&D-support intensity by industry (two-digit-level) and time period (2013–2019 vs 2020–2024). Calculated for industries with at least 10 observations.



4.2 Causal analysis

This section presents the results of the causal analysis of Business Finland's R&D funding scheme. The analysis is organised into three parts. First, the direct effects of R&D support on supported firms are examined. Second, the analysis considers indirect effects on non-supported firms, product markets and the wider economy. Third, the proportionality and appropriateness of the aid are assessed by comparing the impacts of different aid instruments. The analysis combines econometric methods with descriptive evidence and is based on the linked administrative microdata described in Section 2 and the methodological framework presented in Section 3.

The evaluation was also conducted separately for sectors with high and low R&D intensity within manufacturing and services in order to examine potential sector-specific effects. In addition, some of the analyses were performed separately by firm size and by financial position in order to assess potential heterogeneity in the effects of the R&D funding.

4.2.1 Direct effects

The analysis of direct effects examines whether R&D support affects the innovation activities and economic performance of beneficiary firms. The evaluation focuses on three dimensions: input additionality, output additionality and behavioural additionality. The econometric analysis is based on a combination of propensity score matching and difference-in-differences estimation. Supported firms are matched with observationally similar non-supported firms based on 'pre-treatment' characteristics, after which the development of the two groups is compared before and after the receipt of support. The analysis covers outcomes related to R&D investment, innovation outputs, economic performance, productivity, and collaboration activities.

The direct effects are examined through four evaluation questions covering R&D inputs, innovation outputs, firm performance and behavioural additionality.

Q1. Do supported firms increase R&D inputs as a result of public support?

The analysis shows a partly positive effect on R&D inputs. The positive effect is strongest for R&D employment and it is particularly pronounced in periods t and $t+1$. In addition, the estimates of the share of firms deciding to invest in RDI are mostly positive but statistically significant only in period $t+1$.

The results provide mixed but partly positive evidence of input additionality (Table 5).

No statistically significant effect is found for innovation expenditure as a percentage of turnover. This suggests that R&D support does not systematically increase the intensity of innovation expenditure relative to firm size, at least when measured by this outcome. However, the results indicate a small positive effect on the share of firms investing in RDI, although the effect is statistically significant only during the first year after receiving the support.

The clearest evidence of input additionality is observed for R&D employment. Supported firms increase their number of R&D jobs relative to comparable non-supported firms. This finding is consistent with the interpretation that public R&D funding enables firms to expand their R&D capacity and allocate additional personnel resources to research and development activities. In period t , the relative change in R&D employment is over 20 per cent higher in supported firms than in non-supported firms. Figure 9 shows that the positive effect on R&D jobs is particularly pronounced in period t when the R&D support is granted. This can also be seen in the share of firms creating R&D jobs in Table 5, where the result for period t is positive and statistically significant.

Overall, the results suggest that the scheme has a positive impact on R&D employment, while the evidence for broader increases in innovation expenditure is weaker.

It should be noted, however, that several outcome variables related to innovation outputs and networking activities are derived from biennial survey data, resulting in substantially smaller sample sizes than those in the register-based analyses. Consequently, these estimates have lower statistical power, making it more difficult to determine whether modest effects exist.

Q2. Do supported firms produce more innovative output as a result of public support?

The findings mostly suggest that Business Finland's R&D funding does not have a clear effect on firms' propensity to generate innovation outputs within the observed period. This may partly reflect the long time horizons often required for innovation outputs to materialise and the limited observation period available for some of the most recent projects.

The results suggest limited effects on innovation output indicators (Table 6).

The estimated effect on the number of patents is close to zero and statistically insignificant. Similarly, no statistically significant effect is found for the share of firms filing new patent applications. These findings indicate that support does not lead to a measurable increase in patenting activity within the observed time horizon. Indeed, the cumulative change in the number of patents over the full three-year period is negative and statistically significant.



Since not all innovation outputs are patented, product and process innovation indicators provide an important complementary measure of innovation performance. The results indicate that R&D support does not significantly increase the share of firms introducing product innovations. Although the estimated effects are positive, they are not statistically significant. However, the effect on the share of firms introducing process innovations is significantly positive for the first two-year period after receiving the subsidy.

Still, the findings mostly suggest that Business Finland's R&D funding does not have a clear effect on firms' propensity to generate innovation outputs within the observed period. This may partly reflect the long time horizons often required for innovation outputs to materialise and the limited observation period available for some of the most recent projects.

Figure 10 confirms these results, as no clear difference in the variable means can be seen between the treated and control firms.

Direct effects	Time period							
Question	Outcome, change	Δ t-2	Δ t-1	Δ t	Δ t+1	Δ t+2	Δ t+3	Δ (t, t+3)
Q1	Share of firms deciding to invest in RDI	0.025 (0.016)	-0.010 (0.017)	0.003 (0.015)	0.055*** (0.018)	0.033 (0.023)	0.016 (0.024)	
Q1	Share of firms which create RDI jobs	-0.037 (0.042)	0.036 (0.041)	0.153*** (0.043)	-0.044 (0.037)	-0.017 (0.033)	0.007 (0.034)	
Q1	Number of RDI jobs created (log)	0.033 (0.066)	0.012 (0.044)	0.136*** (0.036)	0.223*** (0.056)	0.130** (0.056)	0.049 (0.051)	0.366*** (0.079)
		2Δ t-2	2Δ t	2Δ t+2	2Δ t+4	Δ(t, t+4)		
Q1	Innovation expenditures as a percentage of turnover	0.011 (0.009)	0.002 (0.005)	-0.001 (0.002)	0.000 (0.001)	0.001 (0.002)		

Table 5. Estimation results of the PSM-DID models: impact of R&D support on R&D inputs.

Notes: The table presents the estimated average treatment effects of R&D support on treated firms. The estimates compare changes in outcomes between supported and matched non-supported firms three years before and after the receipt of the subsidy. Standard errors are robust and presented in parenthesis. Δ indicates change in the ratio from the previous year. Δ (t, t+3) examines the whole 3-year period (not estimated for dummy variables). Statistical significance levels are denoted as follows: *** $p < 0.01$, ** $p < 0.05$, * $p < 0.10$. Number of observations for different variables: Share of firms deciding to invest in RDI, treated 966–1,522, controls 527–1,041; Share of firms which create RDI jobs, treated 1,229–1,723, controls 999–1,285; Number of RDI jobs created (log), treated 1,514–1,723, control 999–1,285; Innovation expenditures as a percentage of turnover, treated 14–74, controls 34–241. The number of observations is smallest in periods t-2 (since the change is measured from period t-3) and t+3, or t+4 in innovation expenditure estimations.

Direct effects	Time period							
Question	Outcome, change	Δ t-2	Δ t-1	Δ t	Δ t+1	Δ t+2	Δ t+3	Δ (t, t+3)
Q2	Number of patents created (log)	0.032 (0.021)	0.017 (0.021)	0.012 (0.020)	-0.015 (0.024)	-0.014 (0.019)	-0.042 (0.027)	-0.071** (0.029)
Q2	Share of firms which filed new patent applications	0.001 (0.024)	0.004 (0.024)	0.035* (0.021)	-0.005 (0.024)	-0.020 (0.022)	-0.027 (0.025)	
		2Δ t-2	2Δ t	2Δ t+2	2Δ t+4			
Q2	Share of firms which made new product innovations	-0.105 (0.128)	0.062 (0.116)	0.119** (0.060)	0.130 (0.090)			
Q2	Share of firms which made new product innovations	-0.107 (0.120)	0.079 (0.067)	0.050 (0.040)	0.038 (0.056)			

Table 6. Estimation results of the PSM-DID models: impact of R&D support on innovative outputs.

Notes: The table presents the estimated average treatment effects of R&D support on treated firms. The estimates compare changes in outcomes between supported and matched non-supported firms three years before and after the receipt of the subsidy. Standard errors are robust and presented in parenthesis. Δ indicates change in the ratio from the previous year. $\Delta(t, t+3)$ examines the whole 3-year period (not estimated for dummy variables). Since data of process and product innovations are available only every other year, 2Δ indicates the change in the ratio compared to the value two years earlier. Statistical significance levels are denoted as follows: *** $p < 0.01$, ** $p < 0.05$, * $p < 0.10$. Number of observations for different variables: Number of patents created (log), treated 1,634–1,858, controls 1,038–1,380; Share of firms which filed new patent applications, treated 1,628–1,858, controls 1,039–1,380; Share of firms which made new process innovations, 78–159, controls 358–1,220; Share of firms which made new product innovations, treated 78–159, controls 358–1,220. The number of observations is smallest in periods t-2 (since the change is measured from period t-3) and t+3, or t+4 in innovation estimations.

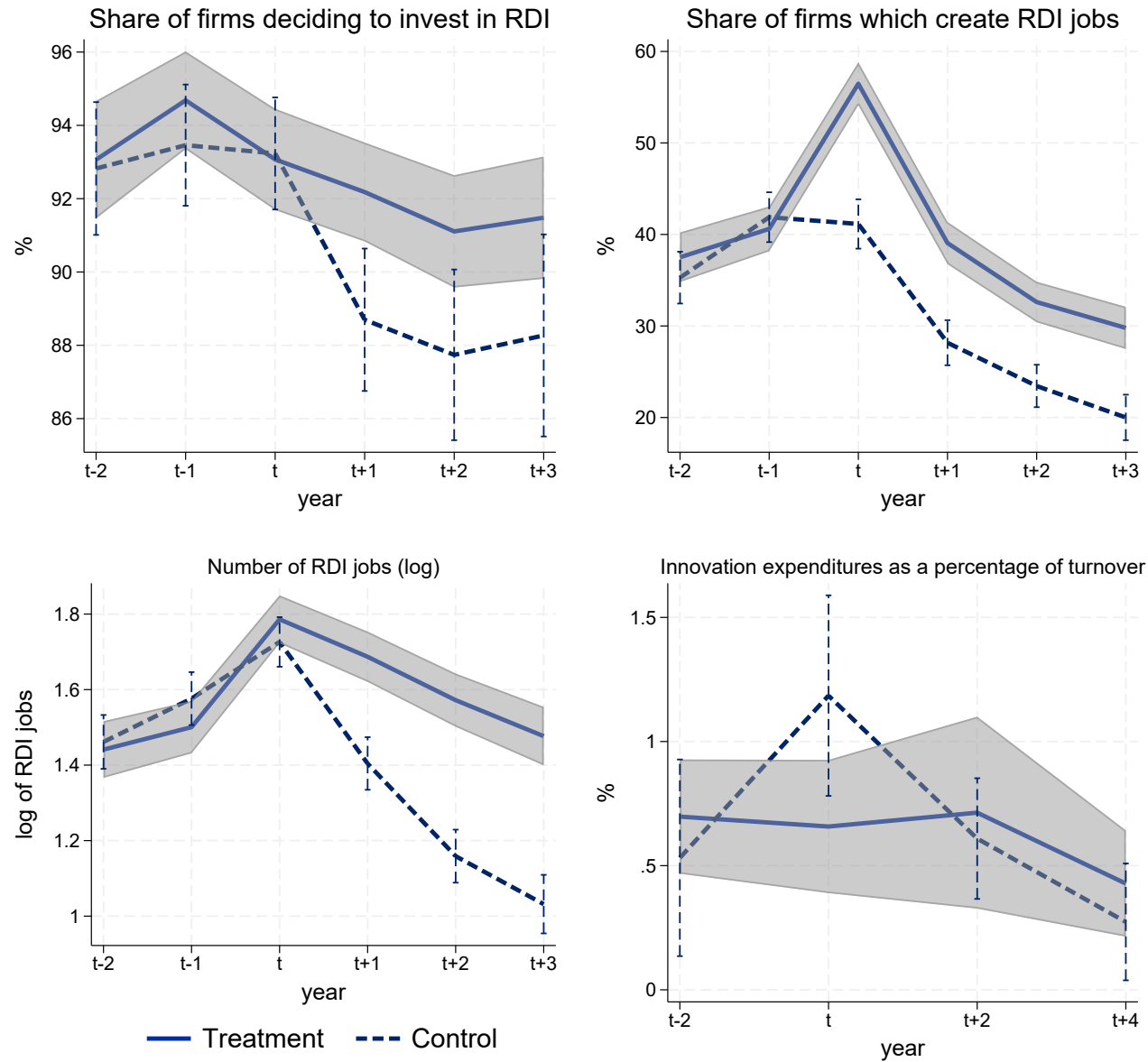


Figure 9. Estimated mean levels of RDI input indicators among supported and matched non-supported firms before and after the receipt of R&D funding.

Notes: The figure presents estimated mean levels of four RDI input indicators for firms receiving Business Finland R&D funding (treatment group) and matched non-supported firms (control group): the share of firms deciding to invest in RDI, the share of firms creating RDI jobs, the number of RDI jobs (log), and innovation expenditure as a percentage of turnover. Year t refers to the year in which R&D funding is received. The shaded areas and error bars indicate 95 percent confidence intervals.

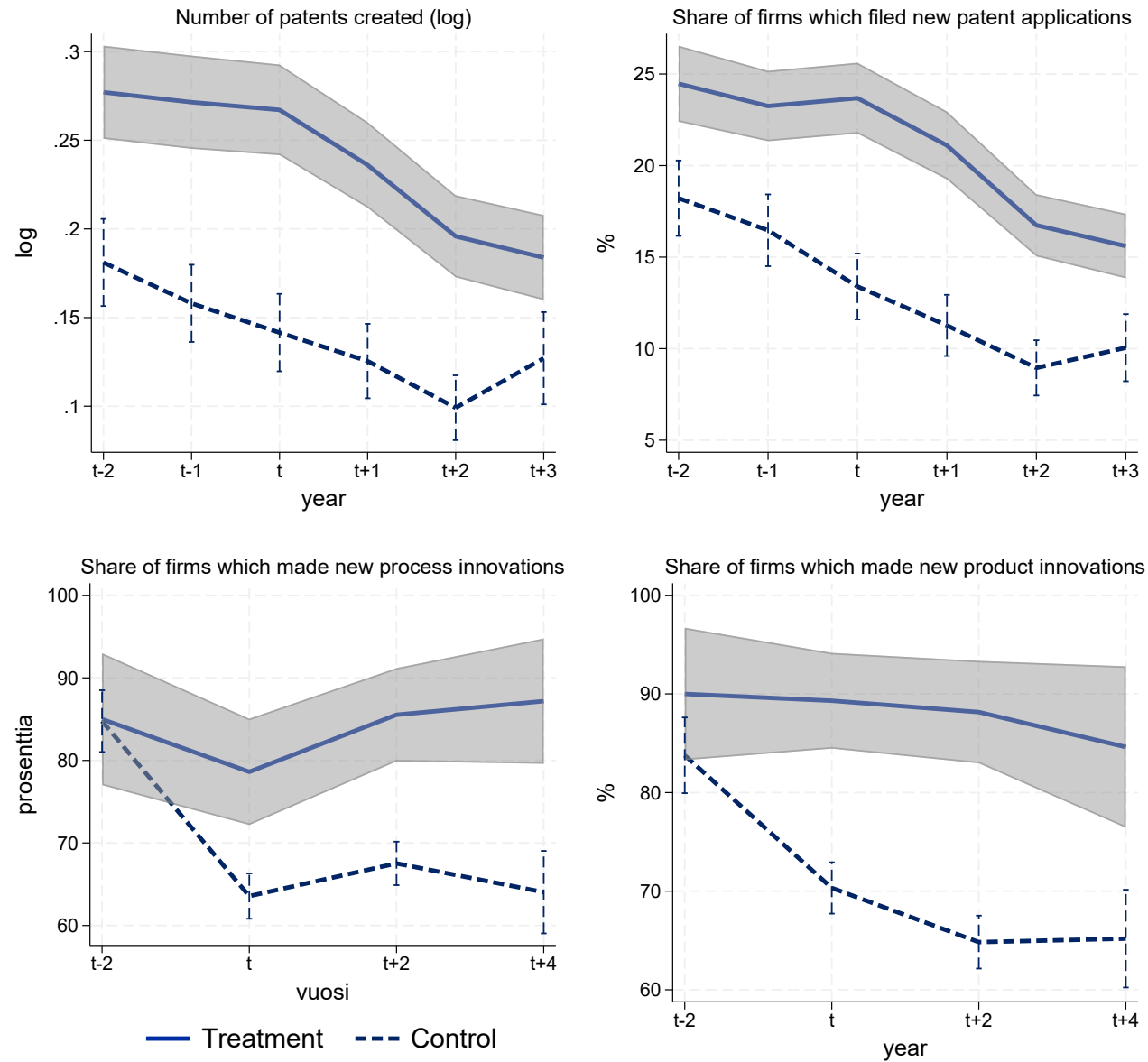


Figure 10. Estimated mean levels of innovation output indicators among supported and matched non-supported firms before and after the receipt of R&D funding.

Notes: The figure presents estimated mean levels of four innovation output indicators for firms receiving Business Finland R&D funding (treatment group) and matched non-supported firms (control group): the number of patents created (log), the share of firms filing new patent applications, the share of firms introducing new process innovations, and the share of firms introducing new product innovations. Year t refers to the year in which R&D funding is received. The shaded areas and error bars indicate 95 percent confidence intervals.

Q3. Do supported firms improve their economic performance as a result of public support?

The supported firms grow significantly faster than comparable non-supported firms. This is already the case before the receipt of support, which is consistent with the targeting of funding towards firms with credible growth potential. However, the analysis does not show strong statistical evidence of productivity gains within the observed time horizon.

The results show that supported firms perform better than comparable non-supported firms on several firm performance indicators, although the timing and magnitude of the effects differ across outcomes (Table 7).

For several outcomes, including employment and assets, the estimated differences between supported and non-supported firms are already positive and statistically significant before the receipt of support. This suggests that firms receiving support differ systematically from non-supported firms prior to receiving funding and are, on average, characterised by more growth-oriented trajectories. This pattern is consistent with the targeting of funding towards firms with credible growth potential, technological capabilities and sufficient resources to implement demanding R&D

projects. At the same time, it indicates that some differences between supported and non-supported firms may remain even after matching.

After the receipt of support, employment effects are positive and statistically significant in all observed post-support periods. This indicates that supported firms grow faster in terms of employment than comparable non-supported firms. The results are consistent with the view that R&D support contributes to firm expansion and strengthens firms' capacity to scale up their activities. Over the whole 3-year period, employment growth among supported firms is over 20 per cent higher than among non-supported firms.

The estimated effects on turnover are also positive, but they emerge with a delay. The results become statistically significant approximately two years after the receipt of support. This timing is plausible given that R&D projects typically require time before they translate into commercial outputs, sales growth or market expansion. The delayed effect on turnover suggests that the economic benefits of R&D support materialise gradually rather than immediately. Over the whole 3-year period, turnover growth among supported firms is almost 40 per cent higher than among non-supported firms.

The estimated effects on productivity are generally positive but not statistically significant. This implies that the evaluation does not provide strong statistical evidence of productivity gains within the observed time horizon. The result is consistent with existing literature, where productivity effects of R&D support are often more difficult to detect and may take longer to materialise than effects on R&D inputs, employment, or innovation activity.

The effects on tangible and intangible assets are positive and statistically significant. This suggests that R&D support is associated with an increase in firms' asset base, possibly reflecting investments related to project implementation, technological capabilities or complementary production and commercialisation activities. Over the whole 3-year period, growth in tangible and intangible assets among supported firms is over 50 per cent higher than among non-supported firms.

Figure 11 confirms the positive effects on tangible and intangible assets, employment, and turnover. In the turnover figure, the patterns of the two groups begin to diverge only after period $t+2$, when firms in the treatment group increase their turnover, while firms in the control group experience a decline in turnover.

Direct effects		Time period						
Question	Outcome, change	Δ t-2	Δ t-1	Δ t	Δ t+1	Δ t+2	Δ t+3	Δ (t,t +3)
Q3	Tangible and intangible assets (log)	0.399*** (0.061)	0.426*** (0.063)	0.321*** (0.074)	0.241*** (0.062)	0.095 (0.066)	0.180** (0.072)	0.555*** (0.104)
Q3	Employment (birch index)	2.389*** (0.351)	2.373*** (0.367)	1.333*** (0.348)	2.024*** (0.353)	2.077*** (0.312)	1.403*** (0.344)	5.633*** (0.997)
Q3	Employment (log)	0.122*** (0.018)	-0.151** (0.073)	0.030** (0.015)	0.095*** (0.011)	0.100*** (0.017)	0.068*** (0.023)	0.222*** (0.031)
Q3	Turnover (log)	0.073 (0.097)	0.321*** (0.096)	0.031 (0.081)	0.055 (0.083)	0.205*** (0.079)	0.224*** (0.086)	0.386*** (0.132)
Q3	Value added (log)	-0.207 (0.226)	0.615*** (0.196)	0.057 (0.205)	0.027 (0.210)	-0.005 (0.188)	0.294 (0.218)	0.239 (0.278)

Table 7. Estimation results of the PSM-DID models: impact of R&D support on economic performance.

Notes: The table presents the estimated average treatment effects of R&D support on treated firms. The estimates compare changes in outcomes between supported and matched non-supported firms three years before and after the receipt of the subsidy. Birch index is calculated by multiplying absolute change by relative change. Standard errors are robust and presented in parenthesis. Δ indicates change in the ratio from the previous year. $\Delta(t, t+3)$ examines the whole 3-year period (not estimated for dummy variables). Statistical significance levels are denoted as follows: *** $p < 0.01$, ** $p < 0.05$, * $p < 0.10$. Number of observations for different variables: Tangible and intangible assets (log), treated 2,390–2,735, controls 3,533–4,713; Employment (birch index), 2,365–2,735, controls 3,538–4,712; Employment (log), treated 2,395–2,735, controls 3,538–4,712; Turnover (log), treated 2,395–2,735, controls 3,537–4,716; Value added (log), treated 2,364–2,733, controls 3,373–4,690. The number of observations is smallest in periods t-2 (since the change is measured from period t-3) and t+3.

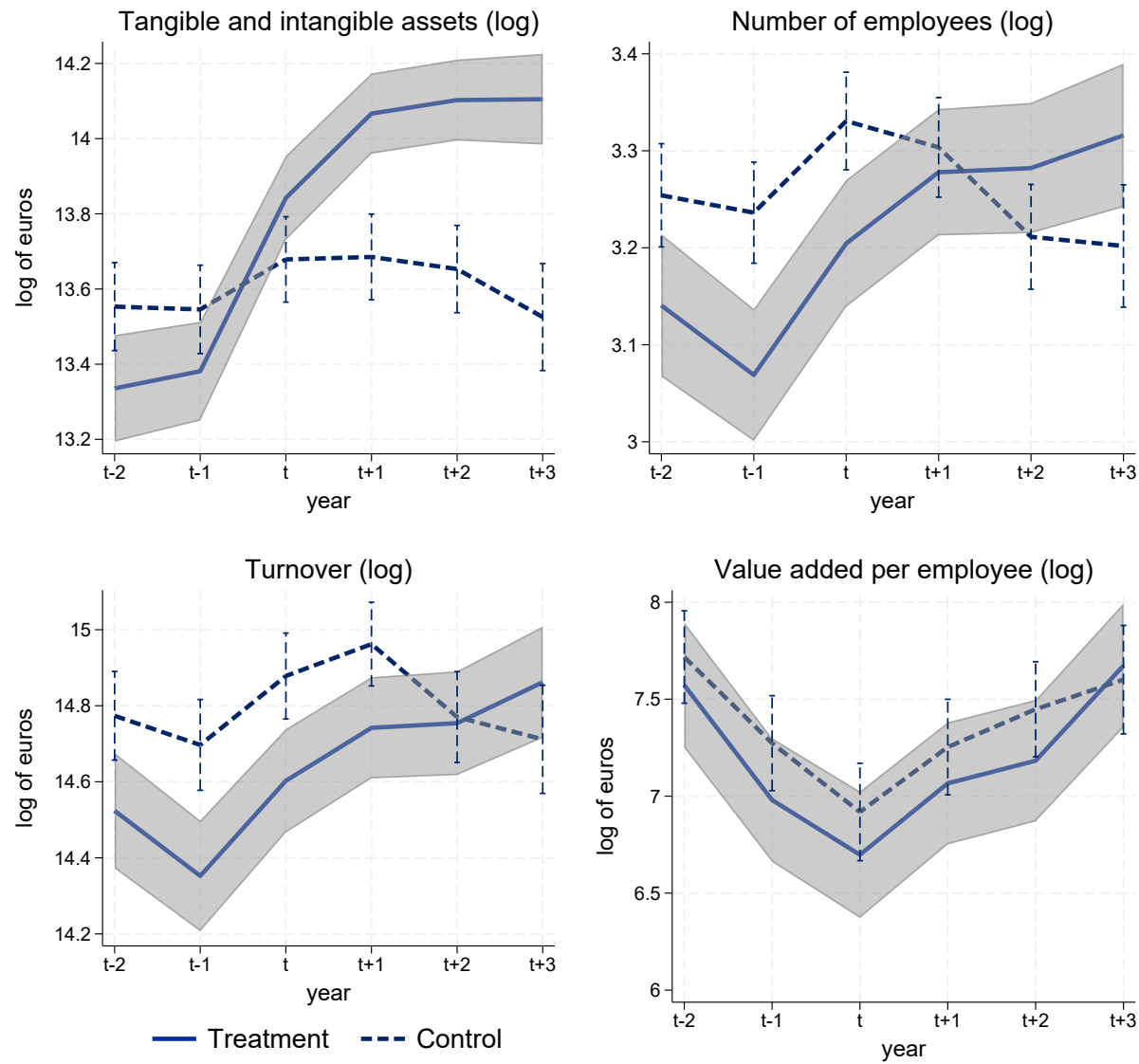


Figure 11. Estimated mean levels of firm performance indicators among supported and matched non-supported firms before and after the receipt of R&D funding.

Notes: The figure presents estimated mean levels of four firm performance indicators for firms receiving Business Finland R&D funding (treatment group) and matched non-supported firms (control group): tangible and intangible assets (log), number of employees (log), turnover (log), and value added per employee (log). Year t refers to the year in which R&D funding is received. The shaded areas and error bars indicate 95 percent confidence intervals.

Q4. Do supported firms increase networking in technological development projects with other businesses and research organizations?

The analysis does not show strong statistical evidence that Business Finland's R&D funding increases firms' collaboration and networking activities within the observed time horizon. However, the analysis of networking is based on biennial survey data, resulting in substantially smaller sample sizes than those in the register-based analyses and consequently in a lack of statistical power.

The effects of R&D support on collaboration and networking activities are examined using data from the Community Innovation Survey (CIS). The analysis focuses on firms' collaboration with other firms, customers, and universities and research organisations (Table 8).

The results provide only limited evidence that R&D support increases collaboration activities. No statistically significant effect is found for the share of firms collaborating with competitors. The estimated effect on collaboration with customers is positive with a p-value less than 0.1 during the first two-year period after funding, but the effect disappears during the second two-year period (2Δ t+4).

The analysis also examines collaboration with universities and public research organisations,

which constitutes one of the key channels through which public R&D support may strengthen the innovation system and facilitate knowledge spill-overs. The estimated effects are positive, indicating that supported firms are somewhat more likely to collaborate with universities and research institutions than comparable non-supported firms. However, the estimated effects are not statistically significant.

Overall, the results do not provide strong statistical evidence that Business Finland's R&D funding increases firms' collaboration and networking activities within the observed time horizon. While most estimated effects are positive, they are generally not statistically significant. Consequently, the evaluation provides only limited evidence of behavioural additionality.

It should, however, be noted that the analysis is based on biennial survey data, resulting in substantially smaller sample sizes than those in the register-based analyses. The resulting lack of statistical power reduces the ability of the analysis to detect potential modest effects on collaboration and networking activities.

Figure 12 shows the mean levels of collaboration indicators among supported and matched non-supported firms.

Direct effects		Time period			
Question	Outcome, change	2Δ t-2	2Δ t	2Δ t+2	2Δ t+4
Q2	Share of firms which collaborate with competitors	0.300 (0.201)	0.054 (0.119)	0.000 (0.106)	-0.099* (0.058)
Q2	Share of firms which collaborate with customers	0.075 (0.072)	-0.056 (0.121)	0.182* (0.107)	-0.204 (0.186)
Q2	Share of firms which collaborate with universities or research organizations	-0.072 (0.126)	-0.062 (0.116)	0.071 (0.051)	0.094 (0.093)

Table 8. Estimation results of the PSM-DID models: impact of R&D support on networking.

Notes: The table presents the estimated average treatment effects of R&D support on treated firms. The estimates compare changes in outcomes between supported and matched non-supported firms several years before and after the receipt of the subsidy. Standard errors are robust and presented in parenthesis. Since data of outcome variables are available only every other year, 2Δ indicates the change in the ratio compared to the value two years earlier. Statistical significance levels are denoted as follows: *** $p < 0.01$, ** $p < 0.05$, * $p < 0.10$. Number of observations for all variables: treated 78–159, controls 358–1,220. The number of observations is smallest in periods t-2 (since the change is measured from period t-4) and t+4.

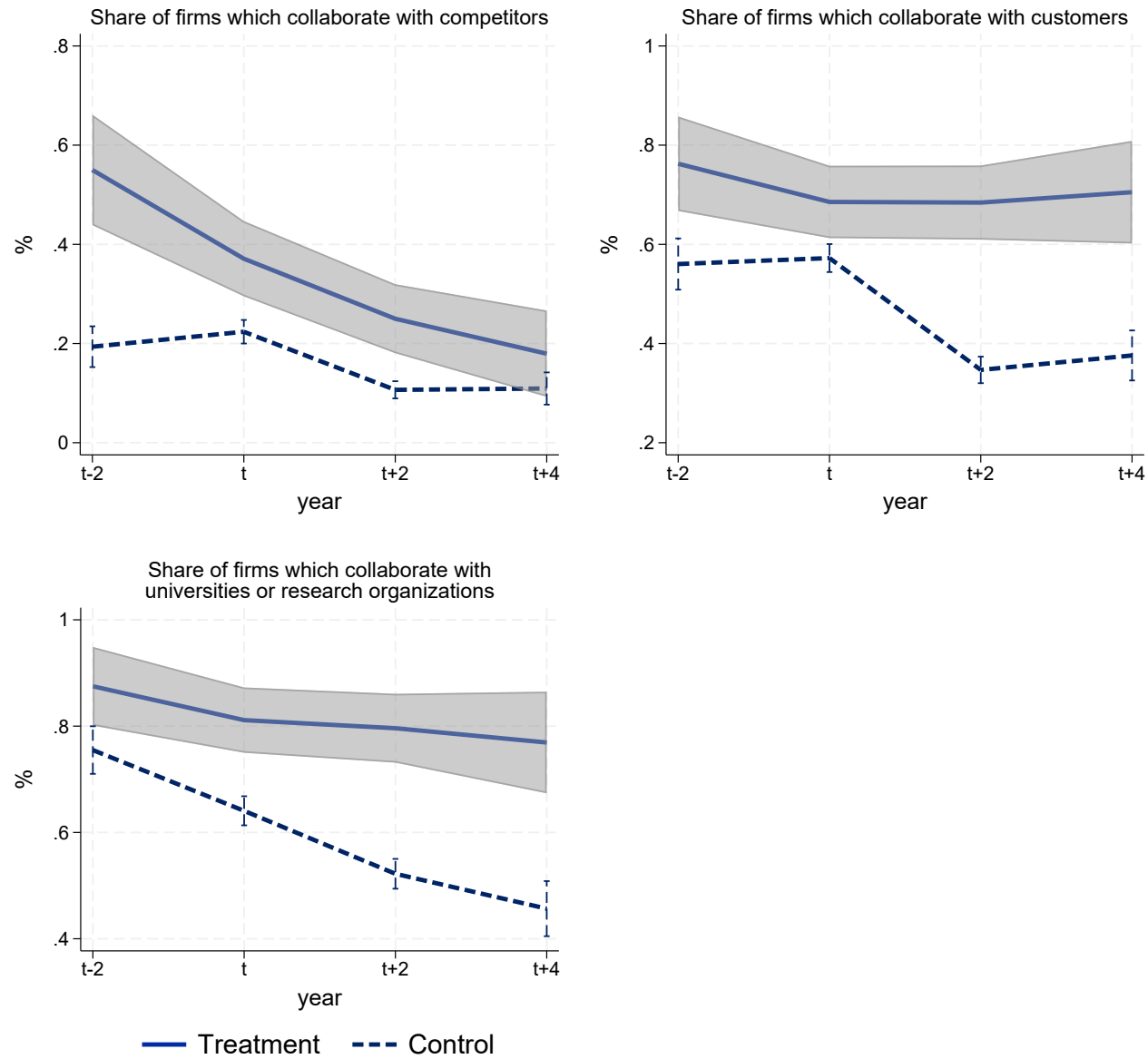


Figure 12. Estimated mean levels of collaboration indicators among supported and matched non-supported firms before and after the receipt of R&D funding.

Notes: The figure presents estimated mean levels of three collaboration indicators for firms receiving Business Finland R&D funding (treatment group) and matched non-supported firms (control group): the share of firms collaborating with competitors, the share of firms collaborating with customers, and the share of firms collaborating with universities or research organisations. Year t refers to the year in which R&D funding is received. The shaded areas and error bars indicate confidence intervals.

Heterogeneous effects by firm size, sector and financial position

Potential heterogeneity in the effects of R&D funding is examined by firm size, sector and financial position. The analyses are conducted separately for micro firms, SMEs and large firms, for firms operating in industries with high and low R&D-support intensity within manufacturing and services, and for firms with different levels of indebtedness. When interpreting the results, it is worth noting that the number of observations for innovation-related variables is very small, and thus the results should be interpreted with caution. Due to an insufficient number of observations, the estimations of innovation expenditures as a percentage of turnover could not be conducted for service firms.

Effects by firm size

The analysis by firm size focuses on firm performance outcomes due to an insufficient number of observations for other outcomes. The results indicate heterogeneity across firm size classes (Table 9).

The positive employment effects are concentrated among SMEs and large firms, for which the estimated impacts are positive and statistically significant in all periods. For micro firms, the employment effects are mostly positive but statistically insignificant in most periods.

Turnover effects are positive in all firm size classes, but for micro firms, in particular, the estimates are mostly statistically insignificant. However, the estimates are positive and statistically significant in all size classes when considering the cumulative change in the whole three-year period ($\Delta(t, t+3)$).

For value added, the estimated effects are statistically insignificant across all firm size classes. The only exception is for micro firms, for which the cumulative three-year effect is positive and statistically significant, although the estimates for individual time periods are insignificant and partly contradictory.

The estimated effects on tangible and intangible assets are generally positive across all firm size classes. For SMEs and large firms, however, the estimates are mostly statistically insignificant. The results are more pronounced for micro firms, for which the results are positive and statistically significant in most periods, suggesting that R&D funding contributes to asset accumulation among the smallest firms.

Overall, the results suggest that employment effects are strongest among SMEs and large firms. For micro firms, positive effects are found especially for asset accumulation.

Micro firms	Time period						
	$\Delta t-2$	$\Delta t-1$	Δt	$\Delta t+1$	$\Delta t+2$	$\Delta t+3$	$\Delta (t, t+3)$
Employment (Birch index)	1.540*** (0.250)	0.955*** (0.326)	-0.346 (0.487)	-0.192 (0.609)	0.314 (0.307)	0.805*** (0.219)	0.700 (1.561)
Turnover (log)	0.347 (0.271)	0.344 (0.261)	0.109 (0.219)	0.108 (0.228)	0.095 (0.168)	0.255 (0.172)	0.553** (0.259)
Value added (log)	-0.445 (0.597)	0.415 (0.446)	0.619 (0.497)	0.526 (0.518)	-0.133 (0.649)	1.345 (1.048)	1.263** (0.611)
Tangible and intangible assets (log)	0.762*** (0.176)	0.758*** (0.157)	0.469*** (0.166)	0.543*** (0.128)	0.157 (0.161)	0.366** (0.164)	1.147*** (0.214)
SMEs	Time period						
	$\Delta t-2$	$\Delta t-1$	Δt	$\Delta t+1$	$\Delta t+2$	$\Delta t+3$	$\Delta (t, t+3)$
Employment (Birch index)	2.712*** (0.381)	2.931*** (0.384)	1.269*** (0.378)	1.749*** (0.395)	1.538*** (0.393)	1.493*** (0.400)	6.343*** (1.088)
Turnover (log)	0.259*** (0.063)	0.316*** (0.068)	0.100* (0.057)	0.098* (0.058)	0.294 (0.210)	0.139 (0.115)	0.324*** (0.117)
Value added (log)	-0.235 (0.259)	0.277 (0.317)	0.393 (0.295)	-0.028 (0.311)	-0.100 (0.255)	0.256 (0.408)	0.275 (0.372)
Tangible and intangible assets (log)	0.308*** (0.112)	0.357*** (0.104)	0.144 (0.133)	0.259** (0.107)	0.046 (0.083)	-0.013 (0.12)	0.304* (0.174)
Large firms	Time period						
	$\Delta t-2$	$\Delta t-1$	Δt	$\Delta t+1$	$\Delta t+2$	$\Delta t+3$	$\Delta (t, t+3)$
Employment (Birch index)	3.186** (1.558)	3.925*** (1.291)	4.871*** (1.383)	5.715*** (1.328)	5.102*** (1.305)	5.395*** (1.274)	16.705*** (3.472)
Turnover (log)	0.029 (0.047)	0.050 (0.055)	0.014 (0.056)	0.012 (0.063)	0.092* (0.048)	0.199** (0.08)	0.229* (0.120)
Value added (log)	0.176 (0.388)	0.329* (0.198)	-0.236 (0.279)	0.518 (0.426)	-0.156 (0.198)	0.326 (0.236)	0.617 (0.473)
Tangible and intangible assets (log)	0.097 (0.059)	0.045 (0.043)	0.139*** (0.048)	0.038 (0.062)	0.065 (0.064)	0.063 (0.080)	0.145 (0.117)

Table 9. Estimation results of the PSM-DID model: impact of R&D support on firm performance separately by firm size.

Notes: The table presents the estimated average treatment effects of R&D support on treated firms. The estimates compare changes in outcomes between supported and matched non-supported firms three years before and after the receipt of the subsidy. Standard errors are robust and presented in parenthesis. Δ indicates change in the ratio from the previous year. $\Delta(t, t+3)$ examines the whole 3-year period. Statistical significance levels are denoted as follows: *** $p < 0.01$, ** $p < 0.05$, * $p < 0.10$. Number of observations for micro firms: treated 609–846, controls 1,534–2,189. Number of observations for SMEs: treated 1,079–1,243, controls 1,367–1,869. Number of observations for large firms: treated 507–568, controls 440–608. The number of observations is smallest in periods $t-2$ (since the change is measured from period $t-3$) and $t+3$.



Effects by sector and R&D-support intensity

Tables 10, 11, 12, and 13 examine whether the effects of R&D funding differ across sectors and according to the R&D-support intensity of the industry.

In service industries, the results are broadly similar regardless of whether firms operate in industries with high or low R&D-support intensity (Tables 10 and 11). The most consistent innovation-related effect is observed for the number of RDI jobs created. In both groups, the results for most other innovation outcomes are statistically insignificant. For firm performance outcomes, positive effects are observed particularly for assets, employment and turnover. In service industries with high R&D-support intensity, positive and statistically significant effects are found mainly on total assets and turnover. In service industries with low R&D-support intensity, the results indicate positive effects on total assets and employment. Moreover, for the number of patents, the cumulative effect over the three-year period is negative and statistically significant, although all estimates for the individual years after funding are statistically insignificant.

Sectoral effects		Time period						
Question	Outcome, change	$\Delta t-2$	$\Delta t-1$	Δt	$\Delta t+1$	$\Delta t+2$	$\Delta t+3$	$\Delta (t, t+3)$
Q1	Share of firms deciding to invest in RDI	0.073 (0.048)	0.000 (0.071)	-0.046 (0.040)	-0.018 (0.026)	0.023 (0.029)	0.009 (0.034)	
Q1	Share of firms which create RDI jobs	0.036 (0.073)	-0.099 (0.071)	0.043 (0.089)	0.011 (0.069)	0.049 (0.055)	-0.028 (0.058)	
Q1	Number of RDI jobs created (log)	0.199*** (0.071)	0.123** (0.058)	-0.003 (0.080)	0.148 (0.100)	0.248** (0.104)	0.032 (0.073)	0.308** (0.148)
Q2	Number of patents created (log)	-0.011 (0.031)	0.015 (0.031)	-0.020 (0.033)	0.038 (0.032)	-0.038 (0.031)	0.001 (0.029)	0.001 (0.033)
Q2	Share of firms which filed new patent applications	-0.043 (0.035)	-0.001 (0.034)	-0.021 (0.044)	0.051 (0.043)	-0.057 (0.040)	0.033 (0.040)	
Q3	Tangible and intangible assets (log)	0.545*** (0.148)	0.738*** (0.255)	0.339 (0.239)	0.573* (0.312)	0.093 (0.175)	0.322* (0.190)	0.628** (0.256)
Q3	Employment	1.712*** (0.585)	1.225** (0.614)	-1.069 (0.764)	0.973* (0.572)	0.385 (0.663)	-0.169 (0.793)	0.689 (2.311)
Q3	Turnover (log)	0.290** (0.137)	0.583*** (0.205)	-0.057 (0.156)	0.202 (0.161)	0.309* (0.174)	0.296 (0.185)	0.752*** (0.232)
Q3	Value added (log)	-0.540 (0.490)	1.035*** (0.392)	0.381 (0.494)	-0.150 (0.546)	0.208 (0.596)	0.056 (0.732)	-0.072 (0.675)
		2$\Delta t-2$	2Δt	2$\Delta t+2$	2$\Delta t+4$	2$\Delta (t, t+4)$		
Q1	Innovation expenditures as a percentage of turnover	-	-	-	-	-		
Q2	Share of firms which made new product innovations	0.056 (0.167)	0.045 (0.113)	0.081 (0.092)	-0.023 (0.137)			
Q2	Share of firms which made new process innovations	-0.157 (0.182)	0.015 (0.129)	0.022 (0.122)	-0.238 (0.159)			
Q4	Share of firms which collaborate with competitors	-0.191 (0.129)	0.086 (0.135)	-0.065 (0.095)	-0.040 (0.161)			
Q4	Share of firms which collaborate with customers	0.234 (0.233)	-0.050 (0.162)	0.002 (0.135)	-0.258 (0.201)			
Q4	Share of firms which collaborate with universities and research institutions	-0.129 (0.099)	0.050 (0.112)	0.102 (0.093)	-0.113 (0.174)			

Table 10. Estimation results of the PSM-DID model: impact of R&D support for high R&D-support intensity services.

Notes: The table presents the estimated average treatment effects of R&D support on treated firms. The estimates compare changes in outcomes between supported and matched non-supported firms three years before and after the receipt of the subsidy. Standard errors are robust and presented in parenthesis. Δ indicates change in the ratio from the previous year. $\Delta(t, t+3)$ examines the whole 3-year period. Since data of innovation expenditures, product and process innovations, and collaborations are available only every other year, 2 Δ indicates the change in the ratio compared to the value two years earlier. Statistical significance levels are denoted as follows: *** $p < 0.01$, ** $p < 0.05$, * $p < 0.10$. The number of observations in Appendix 6 in Table 6.1.

Sectoral effects		Time period						
Question	Outcome, change	Δ t-2	Δ t-1	Δ t	Δ t+1	Δ t+2	Δ t+3	Δ (t, t+3)
Q1	Share of firms deciding to invest in RDI	-0.005 (0.036)	-0.039 (0.030)	0.020 (0.041)	0.162** (0.073)	-0.072 (0.056)	-0.026 (0.066)	
Q1	Share of firms which create RDI jobs	-0.046 (0.089)	-0.115 (0.085)	0.283*** (0.081)	-0.054 (0.086)	-0.095 (0.078)	-0.006 (0.101)	
Q1	Number of RDI jobs created (log)	-0.099 (0.149)	0.139** (0.065)	0.284*** (0.087)	0.262** (0.103)	0.161 (0.194)	0.089 (0.094)	0.485** (0.188)
Q2	Number of patents created (log)	-0.003 (0.052)	0.100* (0.054)	0.005 (0.036)	-0.019 (0.040)	-0.035 (0.035)	-0.035 (0.035)	-0.089** (0.039)
Q2	Share of firms which filed new patent applications	0.012 (0.051)	0.077 (0.055)	0.020 (0.042)	-0.031 (0.049)	-0.035 (0.045)	-0.025 (0.050)	
Q3	Tangible and intangible assets (log)	0.375*** (0.143)	0.469*** (0.178)	0.388** (0.159)	0.291** (0.131)	0.011 (0.140)	0.340** (0.152)	0.582*** (0.180)
Q3	Employment	3.006*** (0.651)	2.296*** (0.633)	0.625 (0.727)	2.023*** (0.692)	1.978*** (0.596)	1.326* (0.686)	3.100 (2.250)
Q3	Turnover (log)	0.117 (0.096)	0.244* (0.126)	0.224** (0.113)	-0.035 (0.102)	0.175 (0.174)	0.113 (0.178)	0.132 (0.186)
Q3	Value added (log)	-0.264 (0.384)	0.001 (0.441)	0.417 (0.498)	-0.085 (0.469)	0.164 (0.488)	-0.056 (0.542)	-0.075 (0.702)
		2Δ t-2	2Δ t	2Δ t+2	2Δ t+4	2Δ (t, t+4)		
Q1	Innovation expenditures as a percentage of turnover	-	-	-	-	-		
Q2	Share of firms which made new product innovations	0.143 (0.128)	0.084 (0.112)	0.092 (0.123)	-0.030 (0.106)			
Q2	Share of firms which made new process innovations	-0.012 (0.220)	-0.020 (0.131)	0.030 (0.128)	0.032 (0.163)			
Q4	Share of firms which collaborate with competitors	0.059 (0.209)	-0.070 (0.123)	-0.081 (0.134)	-0.133 (0.160)			
Q4	Share of firms which collaborate with customers	0.069 (0.255)	0.002 (0.138)	0.125 (0.167)	-0.432** (0.189)			
Q4	Share of firms which collaborate with universities and research institutions	0.316 (0.199)	0.106 (0.101)	0.077 (0.142)	-0.141 (0.130)			

Table 11. Estimation results of the PSM-DID model: impact of R&D support for low R&D-support intensity services.

Notes: The table presents the estimated average treatment effects of R&D support on treated firms. The estimates compare changes in outcomes between supported and matched non-supported firms three years before and after the receipt of the subsidy. Standard errors are robust and presented in parenthesis. Δ indicates change in the ratio from the previous year. $\Delta(t, t+3)$ examines the whole 3-year period. Since data of innovation expenditures, product and process innovations, and collaborations are available only every other year, 2 Δ indicates the change in the ratio compared to the value two years earlier. Statistical significance levels are denoted as follows: *** $p < 0.01$, ** $p < 0.05$, * $p < 0.10$. The number of observations in Appendix 6 in Table 6.1.



The results for manufacturing industries differ somewhat from those for services. In manufacturing industries with high R&D-support intensity (Table 12), positive effects are observed for both the share of firms investing in RDI and the number of RDI jobs created. The results also show a strong positive effect on employment and some evidence of positive effects on assets. By contrast, the results for other RDI and innovation outcomes remain mostly statistically insignificant, and no statistically significant effects on turnover are found.

In manufacturing industries with low R&D-support intensity (Table 13), the evidence for innovation-related effects is weaker. The estimated effects for the share of firms investing in RDI and the number of RDI jobs are statistically insignificant. Nevertheless, positive effects are observed

for firm performance outcomes, particularly for assets, employment, and turnover. In addition, the result for new process innovations is positive in $t+2$, although the small sample size for the innovation variables makes the interpretation uncertain.

Overall, the results provide some indication that innovation-related effects may be somewhat stronger in manufacturing industries with high R&D-support intensity. In services, the results are broadly similar across industries with high and low R&D-support intensity. Positive effects on employment and firms' asset base are observed across most industry groups. The differences are not sufficiently systematic to conclude that the effectiveness of R&D support depends strongly on the intensity of R&D support within an industry.

Sectoral effects		Time period						
Question	Outcome, change	$\Delta t-2$	$\Delta t-1$	Δt	$\Delta t+1$	$\Delta t+2$	$\Delta t+3$	$\Delta (t, t+3)$
Q1	Share of firms deciding to invest in RDI	0.025 (0.015)	-0.002 (0.011)	0.028** (0.012)	0.082*** (0.029)	0.064** (0.026)	0.017 (0.020)	
Q1	Share of firms which create RDI jobs	-0.002 (0.079)	-0.039 (0.073)	0.130 (0.081)	-0.001 (0.068)	-0.033 (0.069)	0.012 (0.083)	
Q1	Number of RDI jobs created (log)	0.099 (0.151)	0.016 (0.103)	0.078 (0.072)	0.217** (0.097)	0.195** (0.096)	0.068 (0.113)	0.346*** (0.112)
Q2	Number of patents created (log)	0.065 (0.051)	0.073 (0.057)	0.000 (0.050)	-0.020 (0.048)	0.022 (0.032)	-0.079* (0.047)	-0.077 (0.052)
Q2	Share of firms which filed new patent applications	0.003 (0.038)	0.020 (0.044)	0.026 (0.040)	0.017 (0.037)	-0.004 (0.029)	-0.053 (0.045)	
Q3	Tangible and intangible assets (log)	0.285*** (0.103)	0.128* (0.072)	0.226*** (0.082)	0.170** (0.075)	0.032 (0.066)	0.005 (0.073)	0.615* (0.325)
Q3	Employment	3.241*** (0.873)	2.842*** (0.994)	2.927*** (0.806)	3.153*** (0.883)	3.362*** (0.796)	3.463*** (0.946)	10.660*** (2.485)
Q3	Turnover (log)	0.304** (0.142)	0.230** (0.091)	0.089 (0.103)	-0.064 (0.158)	0.183 (0.234)	0.519 (0.342)	0.353 (0.402)
Q3	Value added (log)	0.202 (0.616)	0.409 (0.304)	-0.140 (0.296)	-0.289 (0.344)	0.082 (0.315)	0.137 (0.347)	0.091 (0.400)
		2$\Delta t-2$	2Δt	2$\Delta t+2$	2$\Delta t+4$	2$\Delta (t, t+4)$		
Q1	Innovation expenditures as a percentage of turnover	-0.003 (0.002)	0.002 (0.002)	-0.002 (0.002)	0.000 (0.001)	0.000 (0.001)		
Q2	Share of firms which made new product innovations	-0.097 (0.117)	-0.027 (0.032)	-0.032 (0.041)	0.021 (0.049)			
Q2	Share of firms which made new process innovations	-0.224 (0.153)	0.018 (0.234)	0.061 (0.121)	0.298 (0.188)			
Q4	Share of firms which collaborate with competitors	0.116 (0.167)	0.080 (0.187)	0.102 (0.191)	-0.136* (0.077)			
Q4	Share of firms which collaborate with customers	0.013 (0.142)	-0.191 (0.193)	0.316* (0.187)	-0.154 (0.243)			
Q4	Share of firms which collaborate with universities and research institutions	-0.142 (0.178)	-0.169 (0.188)	-0.015 (0.056)	0.055 (0.073)			

Table 12. Estimation results of the PSM-DID model: impact of R&D support for high R&D-support intensity manufacturing.

Notes: The table presents the estimated average treatment effects of R&D support on treated firms. The estimates compare changes in outcomes between supported and matched non-supported firms three years before and after the receipt of the subsidy. Standard errors are robust and presented in parenthesis. Δ indicates change in the ratio from the previous year. $\Delta(t, t+3)$ examines the whole 3-year period. Since data of innovation expenditures, product and process innovations, and collaborations are available only every other year, 2Δ indicates the change in the ratio compared to the value two years earlier. Statistical significance levels are denoted as follows: *** $p < 0.01$, ** $p < 0.05$, * $p < 0.10$. The number of observations in Appendix 6 in Table 6.1.

Sectoral effects		Time period						
Question	Outcome, change	$\Delta t-2$	$\Delta t-1$	Δt	$\Delta t+1$	$\Delta t+2$	$\Delta t+3$	$\Delta (t, t+3)$
Q1	Share of firms deciding to invest in RDI	-0.015 (0.031)	-0.018 (0.030)	0.038 (0.039)	-0.011 (0.035)	-0.017 (0.061)	-0.072 (0.054)	
Q1	Share of firms which create RDI jobs	-0.111 (0.072)	0.004 (0.082)	0.189** (0.091)	-0.131 (0.083)	-0.066 (0.081)	0.013 (0.075)	
Q1	Number of RDI jobs created (log)	-0.065 (0.075)	-0.103 (0.106)	0.143 (0.116)	0.064 (0.077)	0.049 (0.130)	-0.033 (0.112)	-0.004 (0.179)
Q2	Number of patents created (log)	0.049 (0.049)	-0.059 (0.052)	0.049 (0.049)	0.004 (0.054)	-0.088* (0.045)	0.008 (0.043)	-0.075 (0.058)
Q2	Share of firms which filed new patent applications	0.000 (0.062)	-0.059 (0.058)	0.078 (0.055)	0.039 (0.053)	-0.070 (0.044)	0.003 (0.043)	
Q3	Tangible and intangible assets (log)	0.104 (0.094)	0.112 (0.093)	0.142 (0.097)	0.065 (0.078)	0.284* (0.156)	0.254 (0.197)	0.412* (0.211)
Q3	Employment	0.857 (0.728)	2.288*** (0.822)	1.524* (0.780)	1.669** (0.704)	3.276*** (0.657)	2.300*** (0.658)	6.906*** (1.623)
Q3	Turnover (log)	0.176* (0.101)	0.180* (0.095)	-0.082 (0.082)	0.119 (0.074)	0.310** (0.128)	0.088 (0.163)	0.441** (0.201)
Q3	Value added (log)	-0.270 (0.335)	0.624* (0.354)	-0.312 (0.361)	0.637* (0.376)	-0.237 (0.452)	0.628 (0.493)	0.357 (0.543)
		2$\Delta t-2$	2Δt	2$\Delta t+2$	2$\Delta t+4$	2$\Delta (t, t+4)$		
Q1	Innovation expenditures as a percentage of turnover	0.003 (0.005)	-0.002 (0.002)	-0.002 (0.003)	-0.001 (0.002)	-0.001 (0.002)		
Q2	Share of firms which made new product innovations	-0.039 (0.000)	0.137 (0.116)	-0.001 (0.110)	-0.082 (0.156)			
Q2	Share of firms which made new process innovations	-0.086 (0.141)	0.008 (0.145)	0.238** (0.120)	0.058 (0.139)			
Q4	Share of firms which collaborate with competitors	0.321 (0.197)	0.005 (0.082)	-0.059 (0.097)	-0.193 (0.117)			
Q4	Share of firms which collaborate with customers	0.151 (0.000)	0.103 (0.181)	0.101 (0.152)	-0.198 (0.151)			
Q4	Share of firms which collaborate with universities and research institutions	0.163 (0.113)	0.021 (0.131)	0.134 (0.144)	-0.017 (0.159)			

Table 13. Estimation results of the PSM-DID model: impact of R&D support for low R&D-support intensity manufacturing.

Notes: The table presents the estimated average treatment effects of R&D support on treated firms. The estimates compare changes in outcomes between supported and matched non-supported firms three years before and after the receipt of the subsidy. Standard errors are robust and presented in parenthesis. Δ indicates change in the ratio from the previous year. $\Delta(t, t+3)$ examines the whole 3-year period. Since data of innovation expenditures, product and process innovations, and collaborations are available only every other year, 2Δ indicates the change in the ratio compared to the value two years earlier. Statistical significance levels are denoted as follows: *** $p < 0.01$, ** $p < 0.05$, * $p < 0.10$. The number of observations in Appendix 6 in Table 6.1.

Effects by financial position

Tables 14 and 15 examine whether the effects of R&D support differ according to firms' net indebtedness.

For firms with high net indebtedness (Table 14), the results are positive for the number of RDI jobs created. The results for patenting activity are mixed, with a negative cumulative effect observed for the number of patents, although the estimates for individual years are inconsistent. With respect to firm performance, the results provide strong evidence of positive effects on total assets, employment, and turnover.

The results for firms with low net indebtedness (Table 15) are broadly similar. Positive effects are observed for the number of RDI jobs created, while the estimated effects for the number of patents are statistically insignificant. Firm performance outcomes show positive and statistically significant effects on assets and employment, broadly mirroring the findings for firms with high net indebtedness.

Sectoral effects		Time period						
Question	Outcome, change	$\Delta t-2$	$\Delta t-1$	Δt	$\Delta t+1$	$\Delta t+2$	$\Delta t+3$	$\Delta (t, t+3)$
Q1	Share of firms deciding to invest in RDI	0.006 (0.016)	0.006 (0.017)	0.015 (0.016)	0.053** (0.023)	0.023 (0.028)	0.018 (0.033)	
Q1	Share of firms which create RDI jobs	-0.035 (0.057)	-0.012 (0.049)	0.173*** (0.058)	-0.082* (0.048)	0.027 (0.043)	-0.017 (0.040)	
Q1	Number of RDI jobs created (log)	0.039 (0.076)	0.055 (0.055)	0.149*** (0.049)	0.195*** (0.072)	0.227*** (0.086)	0.007 (0.060)	0.390*** (0.111)
Q2	Number of patents created (log)	0.020 (0.025)	0.025 (0.029)	0.000 (0.025)	0.006 (0.023)	-0.022 (0.023)	-0.044* (0.024)	-0.060** (0.029)
Q2	Share of firms which filed new patent applications	-0.011 (0.027)	0.007 (0.031)	0.036 (0.026)	0.012 (0.026)	-0.031 (0.024)	-0.027 (0.027)	
Q3	Tangible and intangible assets (log)	0.424*** (0.072)	0.513*** (0.077)	0.307*** (0.084)	0.251*** (0.082)	0.059 (0.088)	0.181* (0.097)	0.516*** (0.136)
Q3	Employment	2.118*** (0.405)	2.427*** (0.388)	0.955** (0.402)	1.505*** (0.391)	1.707*** (0.335)	1.440*** (0.366)	4.460*** (1.042)
Q3	Turnover (log)	0.122 (0.114)	0.350*** (0.119)	0.058 (0.105)	0.181** (0.084)	0.242** (0.101)	0.265** (0.118)	0.650*** (0.144)
Q3	Value added (log)	-0.154 (0.270)	0.704** (0.286)	0.349 (0.279)	0.134 (0.291)	-0.241 (0.252)	0.416 (0.312)	0.399 (0.398)
		2$\Delta t-2$	2Δt	2$\Delta t+2$	2$\Delta t+4$	2$\Delta (t, t+4)$		
Q1	Innovation expenditures as a percentage of turnover	0.026 (0.027)	0.014 (0.016)	0.005 (0.006)	0.000 (0.001)	0.002 (0.002)		
Q2	Share of firms which made new product innovations	0.022 (0.046)	0.143 (0.122)	0.049 (0.055)	0.009 (0.074)			
Q2	Share of firms which made new process innovations	0.031 (0.072)	-0.114 (0.109)	0.124* (0.071)	0.142 (0.100)			
Q4	Share of firms which collaborate with competitors	0.320 (0.235)	0.130 (0.140)	-0.004 (0.117)	-0.114 (0.075)			
Q4	Share of firms which collaborate with customers	-0.012 (0.081)	0.134 (0.084)	0.200* (0.119)	-0.262 (0.183)			
Q4	Share of firms which collaborate with universities and research institutions	-0.007 (0.065)	-0.023 (0.095)	0.085 (0.070)	0.082 (0.099)			

Table 14. Estimation results of the PSM-DID model: impact of R&D support for firms with high net indebtedness.

Notes: The table presents the estimated average treatment effects of R&D support on treated firms. The estimates compare changes in outcomes between supported and matched non-supported firms three years before and after the receipt of the subsidy. Standard errors are robust and presented in parenthesis. Δ indicates change in the ratio from the previous year. $\Delta(t, t+3)$ examines the whole 3-year period. Since data of innovation expenditures, product and process innovations, and collaborations are available only every other year, 2Δ indicates the change in the ratio compared to the value two years earlier. Statistical significance levels are denoted as follows: *** $p < 0.01$, ** $p < 0.05$, * $p < 0.10$. The number of observations in Appendix 6 in Table 6.1.

Sectoral effects		Time period						
Question	Outcome, change	Δ t-2	Δ t-1	Δ t	Δ t+1	Δ t+2	Δ t+3	Δ (t, t+3)
Q1	Share of firms deciding to invest in RDI	0.046* (0.026)	-0.023 (0.024)	0.007 (0.027)	0.086* (0.046)	0.032 (0.026)	-0.006 (0.019)	
Q1	Share of firms which create RDI jobs	0.050 (0.060)	-0.044 (0.069)	0.122** (0.062)	-0.021 (0.065)	-0.058 (0.061)	0.047 (0.056)	
Q1	Number of RDI jobs created (log)	0.110 (0.097)	0.018 (0.074)	0.111* (0.057)	0.248*** (0.082)	0.018 (0.060)	0.120 (0.074)	0.346*** (0.102)
Q2	Number of patents created (log)	0.076*** (0.026)	-0.003 (0.024)	-0.004 (0.037)	-0.014 (0.037)	0.002 (0.026)	-0.008 (0.028)	-0.020 (0.030)
Q2	Share of firms which filed new patent applications	0.056** (0.027)	-0.014 (0.023)	0.001 (0.031)	0.010 (0.031)	-0.024 (0.029)	-0.007 (0.033)	
Q3	Tangible and intangible assets (log)	0.240** (0.094)	0.308*** (0.107)	0.336*** (0.104)	0.199** (0.088)	0.204** (0.102)	0.249** (0.109)	0.658*** (0.140)
Q3	Employment	2.834*** (0.686)	2.028** (0.808)	0.651 (0.877)	2.968*** (0.783)	2.716*** (0.643)	2.534*** (0.591)	9.481*** (1.662)
Q3	Turnover (log)	-0.032 (0.165)	0.282*** (0.062)	0.047 (0.058)	-0.031 (0.091)	0.107 (0.101)	0.227* (0.117)	0.133 (0.208)
Q3	Value added (log)	-0.496 (0.437)	0.436* (0.238)	-0.141 (0.293)	-0.110 (0.294)	0.426* (0.241)	0.071 (0.365)	0.011 (0.441)
		2Δ t-2	2Δ t	2Δ t+2	2Δ t+4	2Δ (t, t+4)		
Q1	Innovation expenditures as a percentage of turnover	0.016 (0.017)	-0.008 (0.006)	-0.002 (0.003)	-0.001 (0.001)	-0.001 (0.003)		
Q2	Share of firms which made new product innovations	-0.217 (0.197)	0.189* (0.109)	0.040 (0.054)	0.072 (0.080)			
Q2	Share of firms which made new process innovations	-0.319 (0.232)	0.041 (0.121)	0.134* (0.068)	-0.002 (0.099)			
Q4	Share of firms which collaborate with competitors	0.070 (0.134)	0.091 (0.120)	-0.026 (0.070)	-0.109 (0.086)			
Q4	Share of firms which collaborate with customers	0.244* (0.130)	-0.028 (0.157)	0.034 (0.118)	0.039 (0.135)			
Q4	Share of firms which collaborate with universities and research institutions	0.005 (0.258)	0.080 (0.083)	0.026 (0.104)	-0.014 (0.115)			

Table 15. Estimation results of the PSM-DID model: impact of R&D support for firms with low net indebtedness.

Notes: The table presents the estimated average treatment effects of R&D support on treated firms. The estimates compare changes in outcomes between supported and matched non-supported firms three years before and after the receipt of the subsidy. Standard errors are robust and presented in parenthesis. Δ indicates change in the ratio from the previous year. $\Delta(t, t+3)$ examines the whole 3-year period. Since data of innovation expenditures, product and process innovations, and collaborations are available only every other year, 2Δ indicates the change in the ratio compared to the value two years earlier. Statistical significance levels are denoted as follows: *** $p < 0.01$, ** $p < 0.05$, * $p < 0.10$. The number of observations in Appendix 6 in Table 6.1.

Overall, the findings provide limited evidence that the effectiveness of R&D support depends systematically on firms' financial position. Although some differences are observed across individual outcomes, the overall pattern of results is broadly similar for firms with high and low indebtedness.

4.2.2 Indirect effects

The analysis of indirect effects examines whether R&D support generates spillovers, market effects or other impacts beyond the supported firms themselves. Particular attention is given to potential knowledge spillovers, effects on non-supported firms, and possible adverse impacts on competition.

The indirect effects are analysed using descriptive and exploratory econometric methods to assess whether non-supported firms in sectors with high R&D-support intensity differ from non-supported firms in sectors with lower R&D-support intensity. The analysis is conducted separately for manufacturing and services, including subsamples of firms with a prior patenting history. A further analysis compares non-supported applicants with non-supported non-applicants to examine potential spillover and competition effects. Other public subsidies, prior patenting activity, and year are controlled for. When comparing non-supported applicants with non-supported non-applicants, two-digit industry classifications are also controlled for. Given

the descriptive focus and the lack of a proper identification strategy, the analysis concentrates on differences in outcome means rather than on difference-in-differences. Given these methodological limitations and the descriptive nature of the analysis, the results should be interpreted as indicative evidence rather than definitive causal estimates.

The indirect effects are examined through two evaluation questions. The first question focuses on potential positive spillover effects and indirect additionality among non-supported firms, while the second examines whether the scheme generates adverse effects on rival firms and competition.

Q5. Does public support induce input, output or behavioural additionality among non-supported firms?

The analysis shows that non-supported firms operating in industries with high levels of R&D support tend to exhibit stronger innovation-related outcomes than firms operating in industries with lower support intensity. However, this should not be interpreted as causal evidence. Since the industries receiving high levels of R&D support are also likely to differ from other industries, the analysis does not allow robust conclusions regarding whether public support induces input, output or behavioural additionality among non-supported firms.

The first indirect-effect question examines whether non-supported firms operating in environments with high levels of R&D support differ systematically from firms operating in environments with lower levels of support. If public R&D support generates knowledge spillovers or strengthens innovation ecosystems, such effects may be reflected in the behaviour and performance of non-supported firms. However, the analysis cannot directly identify whether any observed differences are caused by public support itself or by broader structural differences between industries.

Tables 16 and 17 compare non-supported firms operating in service and manufacturing industries with high R&D-support intensity with those operating in industries with low R&D-support intensity. In both sectors, non-supported firms in highly supported industries generally exhibit higher levels of innovation-related activity than firms operating in industries with lower exposure to support. In services, statistically significant differences are observed for most variables, and the difference between the groups in the share of firms deciding to invest in RDI increases over time. A broadly similar pattern is observed in manufacturing, where non-supported firms operating in highly supported industries appear more actively engaged in RDI activities than firms operating in industries with lower support intensity.

Indirect effects	Time period		
Outcome, change	t	t+1	t+2
Share of firms deciding to invest in RDI	0.113*** (0.013)	0.142*** (0.013)	0.141*** (0.015)
Number of RDI jobs (log)	0.092*** (0.003)	0.090*** (0.003)	0.085*** (0.003)
Number of patents created (log)	0.002*** (0.001)	0.003*** (0.001)	0.002*** (0.001)
Net debt ratio	0.004 (0.004)	0.008** (0.004)	0.007* (0.004)
Market share	0.023*** (0.005)	0.023*** (0.005)	0.025*** (0.005)
Share of firms which made new process innovations	0.085*** (0.027)		0.070** (0.030)
Share of firms which made new product innovations	0.184*** (0.026)		0.160*** (0.030)

Table 16. Descriptive results for non-supported service-sector firms, comparing firms in sectors with high versus low R&D support intensity.

Notes: The table presents differences in variable means between treatment and control firms. Data of product and process innovations are available only every other year. Standard errors are robust and presented in parenthesis. Statistical significance levels are denoted as follows: *** $p < 0.01$, ** $p < 0.05$, * $p < 0.10$.

Indirect effects	Time period		
Outcome, change	t	t+1	t+2
Share of firms deciding to invest in RDI	0.247*** (0.014)	0.257*** (0.015)	0.227*** (0.015)
Number of RDI jobs (log)	0.204*** (0.009)	0.200*** (0.009)	0.194*** (0.009)
Number of patents created (log)	0.011* (0.005)	0.020*** (0.005)	0.016*** (0.005)
Net debt ratio	-0.052*** (0.006)	-0.050*** (0.006)	-0.050*** (0.006)
Market share	0.020 (0.030)	0.020 (0.030)	0.019 (0.031)
Share of firms which made new process innovations	0.032 (0.022)		0.049* (0.025)
Share of firms which made new product innovations	0.148*** (0.023)		0.129*** (0.027)

Table 17. Descriptive results for non-supported manufacturing firms, comparing firms in sectors with high versus low R&D support intensity.

Notes: The table presents differences in variable means between treatment and control firms. Data of product and process innovations are available only every other year. Standard errors are robust and presented in parenthesis. Statistical significance levels are denoted as follows: *** $p < 0.01$, ** $p < 0.05$, * $p < 0.10$.

Tables 18 and 19 repeat the analysis for firms with a patenting history. Restricting the analysis to patenting firms substantially reduces the sample size and therefore the statistical power of the comparisons. Consequently, fewer statistically significant differences are observed. Nevertheless, the overall pattern remains broadly similar. In services, significant differences are observed primarily for RDI employment and selected financial indicators. In manufacturing, non-supported firms operating in highly supported industries exhibit higher levels of RDI activity, RDI employment and patenting than firms operating in industries with lower support intensity.

Indirect effects	Time period		
Outcome, change	t	t+1	t+2
Share of firms deciding to invest in RDI	-0.018 (0.028)	-0.012 (0.032)	-0.037 (0.029)
Number of RDI jobs (log)	0.498*** (0.045)	0.480*** (0.045)	0.433*** (0.045)
Number of patents created (log)	0.014 (0.016)	0.028** (0.014)	0.033*** (0.013)
Net debt ratio	0.050* (0.030)	0.073** (0.031)	0.080** (0.032)
Market share	0.055 (0.079)	0.050 (0.077)	0.053 (0.073)
Share of firms which made new process innovations	-0.101 (0.091)		-0.092 (0.102)
Share of firms which made new product innovations	0.021 (0.097)		-0.153 (0.102)

Table 18. Descriptive results for non-supported service-sector firms with patenting history, comparing firms in sectors with high versus low R&D support intensity.

Notes: The table presents differences in variable means between treatment and control firms. Data of product and process innovations are available only every other year. Standard errors are robust and presented in parenthesis. Statistical significance levels are denoted as follows: *** $p < 0.01$, ** $p < 0.05$, * $p < 0.10$.

Indirect effects	Time period		
	t	t+1	t+2
Share of firms deciding to invest in RDI	0.065*** (0.020)	0.069*** (0.021)	0.062*** (0.021)
Number of RDI jobs (log)	0.787*** (0.042)	0.769*** (0.042)	0.739*** (0.042)
Number of patents created (log)	0.085** (0.033)	0.116*** (0.032)	0.092*** (0.031)
Net debt ratio	-0.023 (0.017)	-0.012 (0.018)	-0.001 (0.018)
Market share	-0.229 (0.173)	-0.231 (0.176)	-0.244 (0.182)
Share of firms which made new process innovations	-0.047 (0.042)		0.012 (0.052)
Share of firms which made new product innovations	0.048 (0.037)		0.022 (0.046)

Table 19. Descriptive results for non-supported manufacturing firms with patenting history, comparing firms in sectors with high versus low R&D support intensity.

Notes: The table presents differences in variable means between treatment and control firms. Data of product and process innovations are available only every other year. Standard errors are robust and presented in parenthesis. Statistical significance levels are denoted as follows: *** $p < 0.01$, ** $p < 0.05$, * $p < 0.10$.

Overall, the results indicate that non-supported firms operating in industries with high levels of R&D support tend to exhibit stronger innovation-related outcomes than firms operating in industries with lower support intensity. However, these differences should not be interpreted as evidence that public support causes positive spillovers. Industries receiving high levels of R&D support are also likely to differ from other industries in terms of technological opportunities, innovation intensity, market structure, and growth potential. Consequently, the analysis does not allow robust conclusions regarding whether public support induces input, output or behavioural additivity among non-supported firms.

Q6. What are the potential indirect negative effects of the scheme on the rivals of the supported firms?

The analysis shows no indication that non-supported firms are adversely affected by operating in sectors with high levels of R&D support. Similarly, no evidence is found that firms which applied for but did not receive support perform worse than other firms operating in the same sectors. While these findings should not be interpreted as causal evidence of positive spillovers, they provide no indication of substantial negative competition effects arising from the scheme.

The second indirect-effect question concerns potential adverse effects of the aid scheme on rival

firms and competition. Public support may distort competition if supported firms gain advantages at the expense of non-supported firms operating in the same markets. Assessing such effects directly is challenging because market boundaries and competitive relationships are difficult to identify using administrative data. Therefore, the analysis compares firms that applied for support but did not receive funding with firms that did not apply for support.

Tables 20 and 21 present the results for service and manufacturing industries. In both sectors, non-supported applicant firms exhibit higher levels of innovation activity, patenting and RDI engagement than non-supported non-applicant firms. This pattern suggests that firms applying for R&D support differ systematically from firms that do not apply for support and are generally more innovation-oriented.

Indirect effects	Time period		
	t	t+1	t+2
Share of firms deciding to invest in RDI	0.306*** (0.029)	0.338*** (0.030)	0.309*** (0.032)
Number of RDI jobs (log)	0.541*** (0.049)	0.507*** (0.048)	0.471*** (0.048)
Number of patents created (log)	0.054*** (0.012)	0.050*** (0.011)	0.047*** (0.012)
Net debt ratio	0.357*** (0.028)	0.361*** (0.028)	0.369*** (0.029)
Market share	0.455*** (0.104)	0.443*** (0.099)	0.426*** (0.095)
Share of firms which made new process innovations	0.172** (0.083)		0.224** (0.092)
Share of firms which made new product innovations	0.390*** (0.070)		0.445*** (0.076)

Table 20. Descriptive results comparing non-supported applicant firms with non-supported non-applicant firms operating in the services sector.

Notes: The table presents differences in variable means between treatment and control firms. Data of product and process innovations are available only every other year. Standard errors are robust and presented in parenthesis. Statistical significance levels are denoted as follows: *** $p < 0.01$, ** $p < 0.05$, * $p < 0.10$.



Indirect effects	Time period		
Outcome, change	t	t+1	t+2
Share of firms deciding to invest in RDI	0.274*** (0.022)	0.240*** (0.027)	0.239*** (0.025)
Number of RDI jobs (log)	1.580*** (0.119)	1.536*** (0.119)	1.579*** (0.122)
Number of patents created (log)	0.570*** (0.072)	0.533*** (0.071)	0.483*** (0.070)
Net debt ratio	0.143*** (0.026)	0.179*** (0.028)	0.204*** (0.030)
Market share	3.823*** (0.608)	3.790*** (0.613)	3.895*** (0.628)
Share of firms which made new process innovations	0.276*** (0.062)		0.295*** (0.064)
Share of firms which made new product innovations	0.340*** (0.053)		0.411*** (0.053)

Table 21. Descriptive results comparing non-supported applicant firms with non-supported non-applicant firms operating in the manufacturing sector.

Notes: The table presents differences in variable means between treatment and control firms. Data of product and process innovations are available only every other year. Standard errors are robust and presented in parenthesis. Statistical significance levels are denoted as follows: *** $p < 0.01$, ** $p < 0.05$, * $p < 0.10$.

Indirect effects	Time period		
Outcome, change	t	t+1	t+2
Share of firms deciding to invest in RDI	0.204*** (0.043)	0.182*** (0.062)	0.186*** (0.069)
Number of RDI jobs (log)	0.900*** (0.170)	0.829*** (0.169)	0.810*** (0.176)
Number of patents created (log)	0.135*** (0.044)	0.116*** (0.042)	0.107** (0.047)
Net debt ratio	0.271*** (0.078)	0.237*** (0.075)	0.250*** (0.073)
Market share	0.992** (0.495)	0.934** (0.466)	0.886** (0.445)
Share of firms which made new process innovations	0.401** (0.197)		0.472 (-)
Share of firms which made new product innovations	0.251 (0.225)		0.472 (-)

Tables 22 and 23 repeat the analysis for firms with a patenting history. The results remain broadly unchanged. In both services and manufacturing, non-supported applicant firms continue to exhibit higher levels of innovation-related activity than comparable non-applicant firms. Restricting the analysis to patenting firms therefore does not alter the overall interpretation of the findings.

Table 22. Descriptive results comparing non-supported applicant firms with non-supported non-applicant firms with patenting history operating in the services sector.

Notes: The table presents differences in variable means between treatment and control firms. Data of product and process innovations are available only every other year. Standard errors are robust and presented in parenthesis. Statistical significance levels are denoted as follows: *** $p < 0.01$, ** $p < 0.05$, * $p < 0.10$.

The comparison between applicant and non-applicant firms does not reveal patterns that would be consistent with substantial adverse effects on firms that did not receive support. However, the analysis does not provide a direct test of competition effects, nor does it identify the specific rivals of supported firms. Consequently, while the results do not indicate substantial negative effects on rival firms, they should not be interpreted as conclusive evidence that such effects are absent.

Overall, the indirect-effect analysis provides no indication that non-supported firms are adversely affected by operating in sectors with high levels of R&D support. If anything, the descriptive results suggest that firms operating in highly supported innovation environments tend to exhibit stronger innovation-related outcomes, although these differences may reflect underlying characteristics of the industries rather than spillover effects arising from R&D funding. Similarly, no evidence is found that firms which applied for but did not receive support perform worse than other firms operating in the same sectors. While these findings should not be interpreted as causal evidence of positive spillovers, they provide no indication of substantial negative competition effects arising from the scheme.

Indirect effects	Time period		
	t	t+1	t+2
Share of firms deciding to invest in RDI	0.204*** (0.043)	0.182*** (0.062)	0.186*** (0.069)
Number of RDI jobs (log)	0.900*** (0.170)	0.829*** (0.169)	0.810*** (0.176)
Number of patents created (log)	0.135*** (0.044)	0.116*** (0.042)	0.107** (0.047)
Net debt ratio	0.271*** (0.078)	0.237*** (0.075)	0.250*** (0.073)
Market share	0.992** (0.495)	0.934** (0.466)	0.886** (0.445)
Share of firms which made new process innovations	0.401** (0.197)		0.472 (-)
Share of firms which made new product innovations	0.251 (0.225)		0.472 (-)

Table 23. Descriptive results comparing non-supported applicant firms with non-supported non-applicant firms with patenting history operating in the manufacturing sector.

Notes: The table presents differences in variable means between treatment and control firms. Data of product and process innovations are available only every other year. Standard errors are robust and presented in parenthesis. Statistical significance levels are denoted as follows: *** $p < 0.01$, ** $p < 0.05$, * $p < 0.10$.

4.2.3 Proportionality and appropriateness

The analysis of proportionality and appropriateness assesses whether the chosen aid instruments are suitable for achieving the objectives of the scheme and whether similar outcomes could potentially have been achieved through alternative funding structures.

The analysis focuses primarily on differences between grants and repayable advances (loans). Using the same matching and difference-in-differences framework as in the direct impact analysis, the evaluation compares the development of firms receiving different types of support. Particular attention is paid to differences in R&D intensity, innovation outputs, and economic performance.

The assessment is limited to grants and loans because, in Finland, other forms of R&D support, such as R&D tax incentives, have been used infrequently. Consequently, it is difficult to identify a sufficiently large number of comparable firms receiving alternative forms of support for a meaningful economic comparison.

Q7. Could similar effects have been achieved with a different structure of aid instruments?

The analysis shows that both grants and loans contribute to the objectives of the R&D scheme. When compared with non-supported firms, recipients of both instruments exhibit positive effects on R&D-related employment and several indicators of firm performance. In contrast, the evidence for innovation outputs, collaboration activities and productivity remains limited for both instruments. The evaluation does not provide evidence that either instrument, grant or loan, is systematically more effective in achieving the objectives of the scheme. The findings therefore support the view that both grants and loans constitute appropriate instruments for supporting firms' R&D activities.

Table 24 presents the results for R&D grants, comparing grant recipients with non-supported firms. The results indicate that R&D grants have positive effects, particularly, on the number of RDI jobs and on the decision to invest in RDI, although the statistical evidence is weaker for the latter. Grants also have positive effects on firm performance, namely on employment, turnover, and firms' tangible and intangible assets. However, no statistically significant effect is found on value added. For several innovation-related outcomes,

including innovation expenditure, product and process innovations and collaboration activities, the estimates are subject to considerable uncertainty because of the limited sample size and the weaker covariate balance achieved in the matching procedure.

Table 25 shows the corresponding results for R&D loans. As with grants, R&D loans have a positive effect on the creation of new RDI jobs. However, unlike grants, loans do not have a statistically significant positive effect on the decision to invest in RDI. Loans also appear to have positive effects on firm performance, although the estimates are subject to greater statistical uncertainty than the corresponding results for grants. Somewhat surprisingly, the effect on patents appears to be negative when considering the full three-year period. However, this result should be interpreted with caution, as the estimates for all individual years between t and $t+3$ are statistically insignificant. The estimations for innovation expenditure as a share of turnover could not be conducted because of an insufficient number of observations.

Sectoral effects		Time period						
Question	Outcome, change	Δ t-2	Δ t-1	Δ t	Δ t+1	Δ t+2	Δ t+3	Δ (t, t+3)
Q1	Share of firms deciding to invest in RDI	0.027* (0.016)	0.000 (0.015)	0.007 (0.015)	0.062*** (0.018)	0.038* (0.021)	0.017 (0.024)	
Q1	Share of firms which create RDI jobs	-0.044 (0.044)	-0.009 (0.043)	0.123*** (0.045)	-0.012 (0.039)	0.012 (0.035)	-0.006 (0.036)	
Q1	Number of RDI jobs created (log)	0.006 (0.060)	-0.007 (0.048)	0.092** (0.039)	0.216*** (0.052)	0.181*** (0.060)	0.054 (0.052)	0.401*** (0.080)
Q2	Number of patents created (log)	0.031 (0.024)	0.026 (0.024)	-0.010 (0.023)	-0.005 (0.025)	-0.015 (0.020)	-0.040 (0.025)	-0.060** (0.026)
Q2	Share of firms which filed new patent applications	0.012 (0.026)	0.016 (0.026)	0.015 (0.022)	0.013 (0.024)	-0.024 (0.020)	-0.022 (0.025)	
Q3	Tangible and intangible assets (log)	0.166*** (0.059)	0.125** (0.063)	0.048 (0.078)	0.148** (0.075)	0.047 (0.072)	0.254*** (0.088)	0.436*** (0.099)
Q3	Employment	3.009*** (0.466)	2.936*** (0.469)	2.184*** (0.440)	3.204*** (0.442)	3.347*** (0.420)	2.397*** (0.439)	8.926*** (1.232)
Q3	Turnover (log)	-0.096 (0.117)	0.091 (0.107)	-0.116 (0.093)	-0.020 (0.078)	0.157* (0.081)	0.231*** (0.066)	0.251** (0.113)
Q3	Value added (log)	-0.234 (0.244)	0.372* (0.200)	0.173 (0.231)	-0.232 (0.261)	-0.295 (0.183)	0.229 (0.223)	-0.345 (0.320)
		2Δ t-2	2Δ t	2Δ t+2	2Δ t+4	2Δ (t, t+4)		
Q1	Innovation expenditures as a percentage of turnover	0.012 (0.009)	0.002 (0.005)	-0.001 (0.002)	0.000 (0.001)	0.002 (0.002)		
Q2	Share of firms which made new product innovations	-0.111 (0.124)	0.085 (0.069)	0.057 (0.041)	0.032 (0.053)			
Q2	Share of firms which made new process innovations	-0.107 (0.132)	0.070 (0.118)	0.131** (0.063)	0.151 (0.094)			
Q4	Share of firms which collaborate with competitors	0.297 (0.201)	0.046 (0.126)	-0.015 (0.107)	-0.120** (0.060)			
Q4	Share of firms which collaborate with customers	0.064 (0.073)	-0.068 (0.122)	0.185* (0.107)	-0.204 (0.193)			
Q4	Share of firms which collaborate with universities and research institutions	-0.074 (0.130)	-0.104 (0.121)	0.064 (0.055)	0.109 (0.098)			

Table 24. Estimation results of the PSM-DID models: impact of R&D grants on firm outcomes (grant receivers vs. non-supported).

Notes: The table presents the estimated average treatment effects of R&D grants on treated firms. The estimates compare changes in outcomes between supported and matched non-supported firms three years before and after the receipt of the subsidy. Standard errors are robust and presented in parenthesis. Δ indicates change in the ratio from the previous year. $\Delta(t, t+3)$ examines the whole 3-year period. Since data of innovation expenditures, product and process innovations, and collaborations are available only every other year, 2Δ indicates the change in the ratio compared to the value two years earlier. Statistical significance levels are denoted as follows: *** $p < 0.01$, ** $p < 0.05$, * $p < 0.10$.

Sectoral effects		Time period						
Question	Outcome, change	Δ t-2	Δ t-1	Δ t	Δ t+1	Δ t+2	Δ t+3	Δ (t, t+3)
Q1	Share of firms deciding to invest in RDI	0.031 (0.026)	-0.031 (0.030)	-0.001 (0.019)	0.040* (0.023)	0.027 (0.032)	0.024 (0.031)	
Q1	Share of firms which create RDI jobs	-0.020 (0.052)	-0.091* (0.049)	0.197*** (0.052)	-0.102** (0.047)	-0.046 (0.042)	0.039 (0.042)	
Q1	Number of RDI jobs created (log)	0.090 (0.086)	0.054 (0.049)	0.207*** (0.045)	0.248*** (0.078)	0.059 (0.063)	0.045 (0.061)	0.315*** (0.099)
Q2	Number of patents created (log)	0.042* (0.024)	0.016 (0.026)	0.030 (0.025)	-0.021 (0.031)	-0.012 (0.025)	-0.056 (0.040)	-0.090** (0.044)
Q2	Share of firms which filed new patent applications	-0.010 (0.030)	-0.005 (0.028)	0.051* (0.027)	-0.022 (0.034)	-0.018 (0.031)	-0.037 (0.034)	
Q3	Tangible and intangible assets (log)	0.736*** (0.099)	0.828*** (0.094)	0.658*** (0.088)	0.396*** (0.071)	0.121 (0.084)	0.088 (0.076)	0.692*** (0.140)
Q3	Employment	1.576*** (0.379)	2.029*** (0.382)	0.393 (0.365)	0.881** (0.350)	0.601* (0.315)	0.303 (0.346)	2.002* (1.026)
Q3	Turnover (log)	0.324*** (0.112)	0.621*** (0.108)	0.184 (0.115)	0.127 (0.089)	0.320*** (0.112)	0.182 (0.128)	0.526*** (0.172)
Q3	Value added (log)	-0.127 (0.291)	0.881*** (0.289)	-0.097 (0.265)	0.324 (0.264)	0.401 (0.265)	0.351 (0.297)	1.023*** (0.373)
		2Δ t-2	2Δ t	2Δ t+2	2Δ t+4	2Δ (t, t+4)		
Q1	Innovation expenditures as a percentage of turnover	-	-	-	-	-		
Q2	Share of firms which made new product innovations	0.016 (0.000)	0.186 (0.166)	0.014 (0.104)	0.310 (0.322)			
Q2	Share of firms which made new process innovations	-0.015 (0.000)	0.001 (0.229)	0.037 (0.126)	-0.170 (0.187)			
Q4	Share of firms which collaborate with competitors	0.267 (0.000)	0.120 (0.162)	0.092 (0.121)	0.239 (0.185)			
Q4	Share of firms which collaborate with customers	0.292 (0.218)	0.101 (0.244)	0.195 (0.176)	-0.196 (0.193)			
Q4	Share of firms which collaborate with universities and research institutions	0.279 (0.218)	0.419** (0.181)	0.104 (0.111)	-0.171 (0.192)			

Table 25. Estimation results of the PSM-DID models: impact of R&D loans on firm outcomes (loan receivers vs. non-supported).

Notes: The table presents the estimated average treatment effects of R&D loans on treated firms. The estimates compare changes in outcomes between supported and matched non-supported firms three years before and after the receipt of the subsidy. Standard errors are robust and presented in parenthesis. Δ indicates change in the ratio from the previous year. $\Delta(t, t+3)$ examines the whole 3-year period. Since data of innovation expenditures, product and process innovations, and collaborations are available only every other year, 2Δ indicates the change in the ratio compared to the value two years earlier. Statistical significance levels are denoted as follows: *** $p < 0.01$, ** $p < 0.05$, * $p < 0.10$.

Table 26 presents the results comparing grant recipients with loan recipients. In this specification, effects could not be estimated for innovation expenditure as a share of turnover, the share of firms introducing new product innovations, the share of firms introducing new process innovations, or the shares of firms collaborating with

competitors, customers, universities, and research institutions, due to an insufficient number of observations. However, as could be tentatively inferred from the results in Tables 24 and 25, we do not find any statistically significant differences in the development of outcome variables between grant and loan recipients. We therefore conclude

that there is no systematic difference between these two instruments in terms of achieving the objectives of the scheme.

The analysis of proportionality and appropriateness suggests that both grants and loans contribute to the objectives of the R&D scheme. When compared with non-supported firms, recipients of both instruments exhibit positive effects on R&D-related employment and several indicators of firm performance, particularly employment, turnover and firms' asset accumulation. In contrast, the evidence for innovation outputs, collaboration activities and productivity remains limited for both instruments.

The direct comparison between grants and loans does not reveal statistically significant differences in the development of the analysed outcome variables. Consequently, the evaluation does not provide evidence that either instrument is systematically more effective in achieving the objectives of the scheme. The findings therefore support the view that both grants and loans constitute appropriate instruments for supporting firms' R&D activities.

Table 26. Estimation results of the PSM-DID models: impact of R&D support on firm outcomes (grant receivers vs. loan receivers).

Notes: The table presents the estimated average treatment effects of R&D grants compared to R&D loans. The estimates compare changes in outcomes between supported and matched non-supported firms three years before and after the receipt of the subsidy. Standard errors are robust and presented in parenthesis. Δ indicates change in the ratio from the previous year. $\Delta(t, t+3)$ examines the whole 3-year period. Statistical significance levels are denoted as follows: *** $p < 0.01$, ** $p < 0.05$, * $p < 0.10$.

Sectoral effects		Time period						
Question	Outcome, change	$\Delta t-2$	$\Delta t-1$	Δt	$\Delta t+1$	$\Delta t+2$	$\Delta t+3$	$\Delta(t, t+3)$
Q1	Share of firms deciding to invest in RDI	-0.020 (0.053)	0.028 (0.070)	0.033 (0.035)	0.018 (0.018)	-0.007 (0.015)	0.038 (0.035)	
Q1	Share of firms which create RDI jobs	-0.043 (0.132)	0.028 (0.086)	-0.005 (0.112)	-0.042 (0.081)	0.035 (0.129)	-0.022 (0.138)	
Q1	Number of RDI jobs created (log)	-0.119 (0.161)	0.031 (0.084)	0.157 (0.207)	-0.119 (0.085)	0.001 (0.115)	0.029 (0.079)	-0.090 (0.173)
Q2	Number of patents created (log)	0.030 (0.044)	-0.033 (0.065)	-0.020 (0.061)	0.046 (0.057)	-0.033 (0.053)	0.037 (0.036)	0.050 (0.093)
Q2	Share of firms which filed new patent applications	0.029 (0.054)	0.006 (0.058)	-0.016 (0.050)	0.001 (0.040)	-0.041 (0.053)	0.091 (0.057)	
Q3	Tangible and intangible assets (log)	-0.246 (0.294)	-0.144 (0.101)	-0.160 (0.107)	0.014 (0.073)	-0.012 (0.071)	0.065 (0.090)	0.105 (0.132)
Q3	Employment	-2.451 (1.825)	-2.322 (1.538)	1.914 (1.436)	0.539 (1.393)	0.759 (1.446)	-0.881 (1.508)	4.123 (3.818)
Q3	Turnover (log)	-0.038 (0.071)	-0.188** (0.089)	0.025 (0.059)	-0.007 (0.046)	0.088 (0.125)	0.055 (0.069)	0.163 (0.153)
Q3	Value added (log)	1.703* (0.979)	-1.204 (0.786)	0.183 (0.305)	-0.003 (0.361)	0.121 (0.424)	-0.036 (0.448)	0.142 (0.561)

5. Additional analysis

In addition to the analyses specified in the European Commission's Evaluation Plan, this study includes two complementary analyses that provide further insights into the effects of Business Finland's R&D funding. The first examines how receiving R&D funding is associated with firms' capital structure and external financing (section 5.1). In particular, the analysis investigates whether firms attract additional external financing following the receipt of R&D support and whether this financing takes the form of debt or equity. The second analysis focuses on firm survival and market dynamics by examining how firm productivity, the receipt of R&D funding and other firm characteristics are associated with the probability of market exit (section 5.2).

5.1 Signalling effect for external finance

One potential additional effect of R&D support is a signalling effect, whereby an approved R&D funding decision provides external financiers with information about the quality and potential of an R&D project. This may make it easier for the firm to attract additional external capital for new

investments, thereby fostering firm growth and innovation. Some international empirical evidence supports the existence of such a mechanism, but further research using high-quality and comprehensive register data is needed (Meuleman and De Maeseneire, 2012; Söderblom et al., 2015). Evidence on whether such a signalling effect exists in the Finnish context remains limited.

In this section, we examine how firms' external financing and capital structure respond to the receipt of R&D funding. Firms receiving R&D funding are compared with similar firms that do not receive funding. External financing is decomposed into debt and equity financing.

The methodology follows that used in the analysis of direct effects (subsection 4.2.1). Using propensity score matching combined with difference-in-differences (PSM-DID), supported firms are compared with non-supported firms that have applied for R&D funding at least once in the matching year or earlier but have not received R&D funding during the three years before or after the

matching year. Covariate balance between the supported and non-supported groups is assessed using standardized bias. Balance is considered sufficient when the standardized bias for each individual covariate is below 10 per cent and the mean standardized bias across all covariates is below 5 per cent (see Rosenbaum and Rubin 1985). The covariate balance appears to be similar to the balances reported in Table 3. Hence, we consider the balance to be acceptable.

Table 27 presents the estimated effects on external financing for all firms. The results indicate that the receipt of R&D funding increases both short- and long-term debt financing. By contrast, no statistically significant effects are observed for external equity financing. The results are therefore consistent with R&D funding facilitating access to additional debt financing, but provide no evidence of a corresponding increase in external equity investment.

However, it should be noted that positive and statistically significant differences in debt financing are already observed before the receipt of R&D

funding. This is consistent with the finding elsewhere in the study that supported firms tend to be on stronger growth trajectories already prior to receiving R&D funding, with this growth financed primarily through debt.

Table 28 presents the results separately by firm size. The effects on external financing are most pronounced among micro firms, for which the increase is primarily associated with debt financing. No statistically significant effects on equity financing are observed in any firm size category.

Overall, the results suggest that the increase in external financing following the receipt of R&D funding occurs primarily through debt rather than additional equity investment. This pattern is consistent with a potential signalling effect towards lenders, although the pre-funding differences and the empirical approach do not allow such a mechanism to be identified directly. In contrast, the results provide no evidence of a signalling effect operating through increased equity-based investment.

All firms	Time period						
	$\Delta t-2$	$\Delta t-1$	Δt	$\Delta t+1$	$\Delta t+2$	$\Delta t+3$	$\Delta (t, t+3)$
Equity-based investments	0.823 (0.505)	-0.254 (0.488)	0.389 (0.462)	0.375 (0.412)	-0.353 (0.411)	0.135 (0.503)	0.398 (0.528)
Short-term debt	0.163*** (0.041)	0.194*** (0.035)	0.134*** (0.035)	0.156*** (0.046)	0.170*** (0.064)	0.049 (0.076)	0.364*** (0.067)
Long-term debt	0.443*** (0.161)	0.464** (0.191)	0.588*** (0.185)	0.573** (0.234)	0.150 (0.189)	0.263 (0.219)	0.836** (0.345)

Table 27: Estimation results of the PSM-DID models: impact of R&D support on external financing.

Notes: The table presents the estimated average treatment effects of R&D support on treated firms. The estimates compare changes in outcomes between supported and matched non-supported firms three years before and after the receipt of the subsidy. Standard errors are robust and presented in parenthesis. Δ indicates change in the ratio from the previous year. $\Delta(t, t+3)$ examines the whole 3-year period. Statistical significance levels are denoted as follows:

*** $p < 0.01$, ** $p < 0.05$, * $p < 0.10$.

Micro firms	Time period						
	$\Delta t-2$	$\Delta t-1$	Δt	$\Delta t+1$	$\Delta t+2$	$\Delta t+3$	$\Delta (t, t+3)$
Equity-based investments	1.865* (0.954)	0.691 (0.844)	-0.329 (1.05)	0.600 (0.776)	-0.408 (0.847)	-1.269 (1.107)	-1.248 (0.934)
Short-term debt	0.323*** (0.087)	0.271*** (0.081)	0.114 (0.09)	0.183** (0.077)	0.089 (0.077)	0.203*** (0.072)	0.524*** (0.108)
Long-term debt	0.791*** (0.229)	0.600*** (0.200)	1.400*** (0.250)	0.796*** (0.256)	0.084 (0.145)	0.190 (0.159)	0.957** (0.424)
SMEs	Time period						
	$\Delta t-2$	$\Delta t-1$	Δt	$\Delta t+1$	$\Delta t+2$	$\Delta t+3$	$\Delta (t, t+3)$
Equity-based investments	0.698 (0.698)	-0.430 (0.673)	-0.142 (0.69)	0.336 (0.527)	-0.420 (0.667)	-1.111 (0.781)	-0.239 (0.622)
Short-term debt	0.142*** (0.054)	0.175*** (0.048)	0.056 (0.043)	0.108* (0.055)	0.083 (0.059)	0.011 (0.087)	0.193** (0.086)
Long-term debt	0.579*** (0.218)	0.924*** (0.307)	0.454 (0.292)	0.517** (0.258)	0.048 (0.315)	-0.210 (0.406)	0.082 (0.456)
Large firms	Time period						
	$\Delta t-2$	$\Delta t-1$	Δt	$\Delta t+1$	$\Delta t+2$	$\Delta t+3$	$\Delta (t, t+3)$
Equity-based investments	2.268 (1.485)	-1.665 (1.698)	-0.265 (1.637)	1.315 (1.842)	0.723 (1.947)	0.943 (2.159)	3.380 (2.116)
Short-term debt	0.042 (0.039)	0.061* (0.035)	0.111 (0.078)	0.302 (0.232)	-0.004 (0.067)	-0.052 (0.237)	0.279** (0.129)
Long-term debt	0.024 (0.348)	-0.024 (0.487)	-0.355 (0.517)	0.451 (0.429)	0.299 (0.428)	1.132* (0.599)	1.991** (0.830)

Table 28. Estimation results of the PSM-DID models: impact of R&D support on external financing by firm size.

Notes: The table presents the estimated average treatment effects of R&D support on treated firms. The estimates compare changes in outcomes between supported and matched non-supported firms three years before and after the receipt of the subsidy. Standard errors are robust and presented in parenthesis. Δ indicates change in the ratio from the previous year. $\Delta(t, t+3)$ examines the whole 3-year period. Statistical significance levels are denoted as follows: *** $p < 0.01$, ** $p < 0.05$, * $p < 0.10$.

5.2 R&D funding, productivity, and market exit

The empirical literature shows that firm productivity typically declines several years before market exit (e.g., Carreira and Teixeira, 2011; Koski and Pajarinen, 2015). In this section, we examine whether Business Finland's R&D funding attenuates the relationship between productivity and market exit and, consequently, whether it has implications for the renewal capacity of markets. According to economic theory, market dynamics allocate resources efficiently by allowing less productive firms to contract and exit while more productive firms grow and strengthen their market positions (e.g., Aghion et al., 2021). If public funding enables low-productivity firms to remain in the market longer than they otherwise would, the relationship between productivity and market exit may weaken, potentially slowing structural transformation and the reallocation of resources towards more productive firms.

Empirical evidence on the effects of business subsidies on market dynamics remains relatively scarce. In Finland, Koski and Pajarinen (2015) find that the weakening of creative destruction does not appear to be primarily associated with public R&D support. Similarly, Fornaro et al. (2020) show that the effects of R&D support on firm survival are broadly similar for younger and older firms, although their results do not allow definitive conclusions regarding the effects of subsidies on

the process of creative destruction. In contrast, Martikainen et al. (2023) provide evidence that R&D support attenuates the relationship between productivity and market exit, suggesting that it may slow down the process of creative destruction.

To examine whether Business Finland R&D funding attenuates the relationship between firm productivity and market exit, we estimate random-effects probit models in which firm exit is the dependent variable.

The analysis uses Statistics Finland's business register and financial statement data. As in the other analyses presented in this study, the sample is restricted to private limited liability companies. Only firms with employees are included in the analysis. Information on Business Finland R&D funding and other Business Finland subsidies is merged from the funding application database. The R&D funding measures correspond to the instruments analysed elsewhere in this evaluation (see section 1). In addition, information from the Business Enterprise Research and Development Survey (RDINNO) is used to identify firms engaged in R&D activities.

We estimate four separate random-effects probit models (equation 2). The dependent variable, EXIT, takes a value of one if firm *i* exits the market in year *t* and zero otherwise.¹² The key explanatory variables are interaction terms between lagged labour productivity (PROD) and receipt of Business Finland R&D funding (RD)¹³. The

model also includes calendar-year fixed effects (YEAR) and a set of firm-specific control variables (*X*), including firm size, age, turnover, industry, engagement in R&D activities and the receipt of other Business Finland subsidies. The four specifications differ in the lag applied to labour productivity, which is measured one, two, three and four years prior to the potential exit, respectively. The random-effects specification additionally accounts for unobserved time-invariant heterogeneity across firms.

$$(2) \quad EXIT_{it} = \alpha + \beta_1 RD_{it} * PROD_{it-k} + \beta_2 (1 - RD_{it}) * PROD_{it-k} + \beta_3 X_{it} + \beta_4 YEAR_t + \theta_i + \epsilon_{it}$$

We estimate the models for two different samples. The first sample consists of firms that were included in the RDINNO survey at least once during 2013–2024. This sample contains approximately 11,000 firms and 180 firm exits per year on average. The second sample is restricted to firms that reported engaging in R&D activities during the observation period.¹⁴ This restriction reduces the sample to approximately 4,000 firms and 70 firm exits per year on average. The second sample therefore focuses more narrowly on firms actively engaged in R&D, while the first provides a larger number of observations and exits for estimation.

Appendix 5 (Table 5.1) presents the estimation results for the first sample. Higher lagged productivity is associated with a lower probability of

¹² Due to data limitations, our exit variable includes all types of firm exits (e.g., liquidations, mergers and acquisitions).

¹³ RD is a time-varying indicator that takes the value one from the year in which the firm is first observed to receive Business Finland R&D funding onwards, and zero before that.

¹⁴ In the RDINNO survey, there is a variable "tk_toim", which takes a value of one if the firm has reported being engaged in R&D activities during the survey year.



market exit among both supported and non-supported firms. However, the negative relationship between productivity and exit is stronger among firms receiving Business Finland R&D funding. Wald tests indicate that the differences between the productivity coefficients for supported and non-supported firms are statistically significant. For both groups, the relationship between productivity and market exit becomes weaker as productivity is measured further back in time, particularly among non-supported firms.

Table 29 presents the main estimation results for the second sample, which is restricted to firms that reported engaging in R&D activities during the observation period. Appendix 5 (Table 5.2) reports the full estimation results for the specification in which productivity is lagged by one year ($k = 1$). The estimates indicate that, among supported firms, productivity measured one or two years prior to exit is negatively and statistically significantly associated with the probability of market exit. Among non-supported firms, no corresponding negative relationship is observed: the estimated coefficients are positive and mostly statistically insignificant. Thus, also within the more narrowly defined sample of R&D-active firms, the results suggest a stronger negative relationship between productivity and market exit among supported firms than among non-supported firms.

The positive association between productivity and market exit observed among non-supported firms in the second sample is contrary to the conventional market-selection mechanism, according to which less productive firms should be more likely to exit. One possible explanation is that the exit measure also captures exits resulting from mergers and acquisitions. The exit variable is constructed using the date on which a firm ceases operations in the business register, and the data do not allow us to distinguish between different reasons for exit. Consequently, some observed exits may reflect acquisitions or mergers involving relatively productive firms rather than the market exit of poorly performing firms.

Overall, the results provide no evidence that Business Finland's R&D funding weakens the market-selection mechanism by allowing less productive firms to remain in the market. The relationship between productivity and market exit appears somewhat stronger among supported firms. However, these differences should not be interpreted as causal effects of R&D funding. They may reflect the targeting of funding towards firms with particular characteristics, other underlying differences between supported and non-supported firms, or a combination of these factors.

Dependent variable: EXIT	k=1 Coeff.	k=2 Coeff.	k=3 Coeff.	k=4 Coeff.
RD x PROD(t-k)	-0.021*** (0.005)	-0.015*** (0.005)	-0.006 (0.006)	-0.008 (0.006)
NO_RD x PROD(t-k)	0.006 (0.006)	0.006 (0.007)	0.015** (0.007)	0.017** (0.007)
Wald test for RD x PROD(t-k) vs NO_RD x PROD(t-k)	15.94***	14.94***	9.49**	13.80***
Observations	46,157	40,980	35,997	31,183
Firms	5,177	5,041	4,846	4,662
Wald (model)	803.49***	698.78***	642.26***	551.30***
Log likelihood	-3728.89	-3448.31	-3081.27	-2735.87

Table 29. Random-effects probit estimates of firm exit for firms engaged in R&D activities during 2014–2024. The models use alternative lags of firm productivity, with k denoting the lag length in years..

Notes: Firm's market exit is the dependent variable. The model includes the following control variables: four dummies for firm size (micro, small, medium and large), four dummies for firm age (0-4, 5-9, 10-14, and at least 15), logarithmic turnover, a dummy for the receipt of other Business Finland subsidies, four dummies for industry groups (manufacturing; information and communication; professional, scientific and technical activities, and others) and 11 calendar year dummies.

6. Concluding remarks

The study evaluates the impacts of Business Finland's R&D funding on firm performance with respect to input additionality, output additionality, behavioural additionality, and indirect effects. In addition, the proportionality and appropriateness of the aid are assessed by comparing the impacts of different funding instruments. The study is based on a linked firm-level dataset covering the years 2013–2024. The econometric evaluation is based on combined propensity score matching and difference-in-differences (PSM-DID) methods. Indirect effects are examined primarily through descriptive and exploratory analysis. The evaluation is based on the European Commission's evaluation framework, and it covers specific R&D instruments.

The evaluation provides evidence that Business Finland's R&D funding affects firms' innovation inputs and economic activity, although the results vary across outcome measures. The strongest evidence is observed for R&D employment and overall employment, indicating that supported

firms experience stronger growth in R&D employment and overall employment than comparable non-supported firms. Positive effects are also observed for turnover and firms' tangible and intangible assets. However, positive differences between supported and non-supported firms are observed for some firm performance outcomes already before the receipt of R&D funding. This pattern is consistent with the aim of targeting funding towards firms with credible growth potential, technological capabilities, and sufficient resources to implement demanding R&D projects. At the same time, it suggests that supported firms may differ from non-supported firms in ways that cannot be fully captured by observable characteristics, a possibility that should be taken into account when interpreting the estimated impacts.

The evaluation finds only limited evidence of effects on innovation outputs and behavioural additionality. No robust evidence is found for patenting activity, product and process innovations, or collaboration with other firms and research organi-

sations. Similarly, the estimated effects on productivity are not statistically significant, which is in line with the existing literature. While R&D support may affect productivity over a longer period, establishing causality becomes increasingly challenging as the time since the receipt of R&D funding increases. It should be noted, however, that several outcome variables related to innovation outputs and networking activities are derived from biennial survey data, resulting in substantially smaller sample sizes than in the register-based analyses. Consequently, the statistical power of these estimates is lower, making it more difficult to determine whether modest effects exist.

Overall, the results suggest that R&D funding is associated with increases in innovation-related inputs and firm growth. However, the evidence that these additional inputs translate into measurable innovation outputs, productivity improvements or wider behavioural changes remains limited within the observed period. The results are consistent with the international research literature, which

generally finds stronger and more immediate effects of R&D support on innovation inputs than on innovation outputs and productivity.

The heterogeneous-effects analysis indicates that the impacts of R&D funding vary across firms, although the differences are not always systematic. Employment effects appear strongest among SMEs and large firms, whereas the most consistent effects for micro firms are observed in the accumulation of tangible and intangible assets. Some evidence also suggests stronger innovation-related effects in manufacturing industries with high R&D support intensity. However, the overall pattern of results does not indicate that the effectiveness of the scheme depends strongly on firm size, sectoral R&D intensity, or firms' financial position.

The analysis of indirect effects provides no evidence that R&D support adversely affects non-supported firms. On the contrary, non-supported firms operating in high-R&D-intensity industries appear to be more actively engaged in RDI activities than those operating in low-R&D-intensity industries. In addition, non-supported applicant firms are more involved in RDI activities than non-supported non-applicant firms. However, given the descriptive nature of the analysis, these findings should not be interpreted as causal evidence of positive spillovers. Rather, these findings suggest that R&D support is concentrated in more innovation-oriented environments and that firms applying for support differ systematically from other non-sup-

ported firms in terms of their RDI activity. The analysis also provides no indication of substantial adverse competition effects arising from the scheme.

When assessing whether the selected aid instruments are suitable for achieving the objectives of the scheme and whether similar outcomes could potentially have been achieved through alternative funding structures, the evaluation finds no systematic difference between grants and loans. Recipients of both instruments exhibit positive effects on R&D-related employment and several indicators of firm performance, particularly employment, turnover and asset accumulation. The direct comparison between grant recipients and loan recipients reveals no statistically significant differences in the analysed outcomes. These findings support the view that both grants and loans constitute appropriate instruments for supporting firms' R&D activities.

Moreover, the results suggest that the scheme is successful in targeting firms operating in R&D-intensive sectors and firms exhibiting stronger growth trajectories. This is consistent with the objective of supporting technologically ambitious projects with high expected economic returns, although it also implies that a substantial share of support is allocated to firms that are already relatively strong performers prior to receiving aid.

Despite comprehensive register-based data, identifying causal effects using observational data

remains challenging. A central source of uncertainty is the potential role of unobservable firm characteristics, which may affect both selection into subsidy and subsequent firm outcomes. Although there are some important limitations in identifying causal effects, we consider this method – propensity score matching combined with difference-in-differences – to be the best feasible approach given the available data.

Additional analyses

In addition to the analyses specified in the European Commission's Evaluation Plan, this study includes two complementary analyses that provide further insights into the effects of Business Finland's R&D funding.

The first examines how receipt of R&D funding affects firms' capital structure and external financing, with the analysis conducted separately by firm size. The outcome of interest is external financing, which is decomposed into debt and equity-based financing. The results suggest an increase in external financing following the receipt of R&D funding, but the increase is primarily associated with debt rather than external equity investment. These effects are most pronounced among micro firms.

The second analysis focuses on firm survival and market dynamics by examining how firm productivity and the receipt of R&D funding are associated with the probability of market exit. The results of the second analysis provide no evidence



that Business Finland's R&D funding weakens the market-selection mechanism by allowing less productive firms to remain in the market. Rather, the negative relationship between productivity and market exit appears somewhat stronger among supported firms. However, these differences should not be interpreted as causal effects of R&D funding.

Policy implications

Given limited public resources, the allocation of R&D support should continue to focus on projects where public funding is most likely to generate additional private R&D activity and broader societal benefits. In practice, identifying such projects remains challenging because funding decisions must be made under uncertainty and with incomplete information about future project outcomes.

From an economic perspective, the rationale for public intervention is strongest when firms face financing constraints or when innovation projects generate substantial knowledge spillovers. The results do not provide strong evidence that the effectiveness of support differs systematically by firms' financial position. Nevertheless, SMEs and other firms with limited access to external financing remain important target groups for R&D support from a policy perspective, since the risk of crowding out private investment may be lower than among larger firms with greater access to capital markets.

The evaluation finds stronger effects on innovation inputs and employment than on innovation outputs or productivity. This highlights the importance of continuing to monitor supported firms over longer time horizons, as innovation outputs, commercialisation outcomes and productivity gains may materialise only several years after project completion.

Methodological implications

Future evaluations could benefit from the use of more credible comparison groups. The finding that supported firms differ from non-supported firms prior to receiving funding suggests that some selection effects may remain despite the matching procedure. In particular, comparing accepted and rejected applicants with similar project characteristics would improve the identification of causal effects by reducing concerns related to unobserved differences between firms.

The use of application scoring information, funding thresholds or variation across evaluators could further strengthen causal identification. However, the feasibility of such approaches may be constrained by the relatively limited number of rejected applications and the availability of detailed evaluation data.

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