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The impact of R&D grants on firms' access to external equity financing: Evidence from the Norwegian industry.

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Abstract

We examine the impact of government support on a firm's access to external equity financing. Using data on grant applications to SkatteFUNN between 2012 and 2022, we find grants to have a positive impact on the growth of external equity for early-stage firms with respect to a carefully selected control group. Additionally, we find that government R&D support facilitates proof-of-concept work and has a significant impact on the certification effect for early-stage firms. This indicates that such grants serve as a quality endorsement for external investors, reducing information asymmetry. Based on our findings, policymakers should prioritize allocating government R&D subsidies towards early-stage firms to maximize their effectiveness in fostering innovation and to support the growth of young firms.

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1. Introduction

Research and development (R&D) investments are essential for promoting innovation, sustainable economic growth, and the overall welfare of society. Norwegian enterprises make substantial investments yearly in this area, reaching a combined expenditure of 38,3 billion NOK in 2021 (Langhoff & Berrios, 2023). Nevertheless, private firms' investments in R&D are less than the socially optimal level of investments (Jones & Williams, 2000), and the collective R&D expenditures as a share of GDP are considerably lower in Norway than in other Nordic countries (Fagerberg & Fosaas, 2014).

To support these efforts, governments offer various financial subsidies and grants that either raise the marginal rate of return or reduce costs (David et al., 2000). These subsidies include cash injections, loans, and tax deductions, fostering development and driving outcomes that align more closely with the socially optimal solution (Becker, 2014). Norwegian policymakers acknowledge the crucial significance of supporting and encouraging the facilitation of R&D investments (Stortinget, 2015) and such grants can potentially assist in fostering innovation (Howell, 2017).

Innovation can be financed in various ways, whether by internal or external parties. In the early stages of a firm, internal parties, such as family and friends or the founders themselves are typically highly influential, whereas external parties become more pivotal as the firm matures. Obtaining external financing through equity, debt, or a combination of the two can be challenging for a young firm with inherent uncertainty and risk (Brown et al., 2009), which is not surprising given that nearly nine out of ten start-ups fail (Patel, 2015). Financial constraints are also evident in Norway, as access to financing is considered a primary factor hindering innovation (Fagerberg & Fosaas, 2014). This fact emphasizes the importance of government support, and why many early-stage firms apply for these subsidies to finance their R&D activities.

Early-stage firms often face financial constraints due to limited funding access and revenue streams. As small firms generally lack access to public capital markets, private capital financing is often the desired outcome for these small firms. The primary sources of private capital are equity investments from venture capitalists (VCs), corporate venture capitalists (CVCs), angel investors, and more recently, crowdfunding and accelerators/incubators. However, some of these actors are notoriously selective when sourcing deals. Despite being the most well-known form of private equity financing, VCs adhere to stringent due diligence procedures and fund only a small percentage of start-ups (Drover et al., 2017). Moreover, research shows that information asymmetries are essential in explaining why early-stage firms experience underinvestment from external investors and how this places a financial constraint on R&D investments (Meuleman & De Maeseneire, 2012).

Because of underinvestment from external investors, government subsidies become particularly important for smaller firms. One of the most substantial grants in Norway is the one provided by SkatteFUNN (SKF), which is the program that provides the most in terms of monetary incentives (SSB, 2022). Data from SKF regarding applications are also open and free to use. We chose to use SKF as a source for our research due to its vital role in driving technological advancement, fostering economic growth, and enhancing the competitiveness of Norwegian firms.

Prior studies have explored this field, some examining the impact of government subsidies on innovation by analyzing patent applications (Ulku, 2004; Bronzini & Piselli, 2016), some by researching the effect of external financing from governments support (Meuleman & De Maeseneire, 2012; Guo et al., 2022), and some examining the effect of tax deduction schemes (Hall & Van Reenen, 2000; Cappelen et al., 2012). However, there is still a lack of empirical evidence on the effectiveness of government subsidies (Howell, 2017) and how they impact a firm's ability to obtain external funding (Guo et al., 2022).

Meuleman & De Maeseneire (2012) find that government R&D grants enable a positive certification effect promoting small and medium enterprises (SMEs)' external financing access. Guo et al. (2022) demonstrate that firms supported by government subsidies generally raise more equity. Inspired by the work and findings of Meuleman & De Maeseneire (2012) and Guo et al. (2022), we first hypothesize that acquiring government R&D subsidies increases firms' access to external equity financing.

Furthermore, Howell (2017) shows that grants for early-stage firms positively affect finance and suggest that governments should prioritize these firms. Based on this finding and the theory surrounding early-stage firms, we hypothesize that the impact of government R&D subsidies on firms' access to external equity financing is more significant for early-stage firms than mature firms.

Our main contribution to the literature is to examine the Norwegian government subsidies' effect on a firm’s access to external equity, both for mature and younger firms. We find early-stage firms particularly interesting because R&D investments can be especially advantageous for these firms (Brown et al., 2009; Howell, 2017).

To research this topic, we utilize SKF and Proff Forvalt (PF) to collect our data. Using these databases, we can collect information about Norwegian firms that have applied for R&D grants and their complete financial history. Our data collection begins with examining a dataset containing information about each firm that applied for a grant from SKF between 2002 and 2022. SKF is a Norwegian tax credit scheme that allows businesses to claim a tax deduction for certain R&D expenses. Most firms that receive the tax reduction provided by SKF pay very little taxes, meaning that even though it is a tax credit, they can acquire most of it as a grant (Fagerberg & Fosaas, 2014; SkatteFUNN, 2022).

The program was implemented in 2002 to increase R&D expenditure in the Norwegian private sector (Benedictow et al., 2018). To qualify for the grant, firms must undertake an R&D project that will introduce or enhance a product, service, or process while facilitating the development of new knowledge and skills (SkatteFUNN, 2022).

Additionally, as the subsidy is a tax deduction, they must already be subject to corporate tax obligations to the Norwegian government and be registered in Brønnøysundregistrene (Forskningsrådet, 2022). For all firms, the deduction rate is 19 percent of the cost related to the accepted project. The Research Council of Norway handles and assesses all SKF applications, and the project must be approved before a firm can receive the R&D tax credit. During the evaluation, they prioritize the R&D details of the project plan (SkatteFUNN, 2022). The basis of the deduction is the cost related to the R&D project, and each firm's annual maximum for eligible expenditures is 25 million NOK (Igaidi, 2023).

To evaluate the post-implementation effect of SKF on firms' ability to attract external equity, we use a difference-in-differences (DID) approach, which compares financing differences between SKF-backed firms and non-SKF-backed firms before and after the SKF infusion to identify a causal relationship. However, we acknowledge that the selection process for government subsidies may favor specific types of firms, potentially biasing our analysis. Therefore, we use a matched DID approach incorporating conventional DID estimations with propensity score matching (PSM) to address this. The propensity score represents the likelihood of receiving treatment (SKF support) based on observed baseline characteristics and it enables us to effectively account for observable and unobservable factors that could influence the outcome. By matching SKF-backed firms with non-SKF-backed firms applying the nearest-neighbor method, we can create a more rigor comparison and reduce systematic differences between the two groups, thus enabling us to examine the causal effect of SKF support on firms' ability to attract external equity.

Our findings challenge the first hypothesis that receiving government R&D subsidies increases firms' access to external financing. On the contrary, we demonstrate that receiving an SKF subsidy does not directly influence a firm's ability to raise external equity. This result suggests that the benefits of SKF grants might not link directly to every firm's raise of external equity. Instead, the advantage of such subsidies may vary depending on other firm-specific factors or conditions.

However, our results strongly support Hypothesis 1b that the effect of government R&D subsidies on a firm's access to external equity financing is more evident for early-stage firms than their mature counterparts. This effect implies that these subsidies can play a vital role in the financial development of early-stage firms, potentially facilitating their growth and innovation efforts.

We also find that government-backed R&D grants significantly influence the certification effect for early-stage firms, indicating that receiving such a grant provides proof of quality to external investors. Empirical evidence suggests that this result is mainly caused by the fact that younger firms experience more issues connected to information asymmetries.

Furthermore, our observations on funding mechanisms suggest that government subsidies do not seem to improve firms' financial performance in Norway. Consequently, it does not show a presence of the funding effect through the equity channel. Instead, we find that government support primarily operates through the prototyping channel, meaning that it facilitates proof-of-concept work that firms would otherwise struggle to finance. This observation implies that early-stage firms might use the subsidy to demonstrate the viability of their technology, thereby reducing investor uncertainty (Howell, 2017).

These findings highlight the importance of governmental support in promoting the growth and development of early-stage firms. It indicates that policymakers should consider a more robust strategy in designing and allocating R&D subsidies, targeting early-stage firms in a phase of growth that are also facing financial constraints. This approach could maximize the impact of government R&D subsidies, boosting innovation and potentially pushing economic growth.

2. Literature review

2.1 R&D investments and their effect on innovation

Our study aligns with the existing body of research that investigates the relationship between R&D investments and a firm's innovation capability. R&D investments play a crucial role in fostering innovation and driving growth within organizations. Several studies, such as those conducted by Szewczyk et al. (1996) and Bae & Kim (2003), show that these expenditures positively impact firms. In particular, Acs & Audretsch (1988) show that there is a direct link between small enterprises (SEs) R&D input and an increase in innovation. Notably, R&D expenditures tend to benefit young firms more significantly than mature firms, as demonstrated by Brown et al. (2009). Research conducted by Wakelin (1998) indicates that corporations' behavior is strongly influenced by their ability to innovate, underscoring the vital role of proper R&D expenditure in driving smaller firms forward. Additionally, R&D investments enhance profitability (Morbey & Reithner, 1990), promote employment growth (Koski & Pajarinen, 2012), and lead to higher average employee wages (Howell & Brown, 2023).

We find that the grant provided by SKF significantly benefits early-stage firms, and given the pivotal role of these firms in driving innovation, our findings underscore the importance of government support in encouraging R&D investments to promote innovation.

2.2 Market failures lead to underinvestment

Meuleman & De Maeseneire (2012) show that various market failures result in underinvestment in R&D, while Hyytinen & Toivanen (2005) demonstrate that it also stalls innovation. There are numerous reasons for this, one of the main ones being that SEs cannot make the necessary investment due to financial constraints (Brown et al., 2012). Internal finances are limiting the development of SEs (Carpenter & Petersen, 2002), and many SEs rely on internal funds to invest adequately in R&D, as it is frequently too risky for them to obtain significant debt (Brown et al., 2009). The likelihood of default in smaller corporations can also account for this lack of debt (Himmelberg & Petersen, 1994). Therefore, equity becomes crucial, and its absence slows down development. Even though firms have the potential to grow faster, their financial capacity limits the firm's development. (Himmelberg & Petersen, 1994).

Information asymmetries are also a leading factor when looking at underinvestment. In most cases, lenders have less internal knowledge than borrowers, leading to this constraint often occurring in financial markets (Leland & Pyle, 1977). This discrepancy in information causes investors to be careful because they need more knowledge to make a socially optimal investment, especially when investing in SEs. Cautiousness also applies to banks, causing the ability to obtain loans large enough to cover the investment cost challenging (Himmelberg & Petersen, 1994). SEs may face challenges when securing debt from capital markets due to the risk associated with their investments (Bougheas, 2004) and the risk of default in early-stage firms, which is higher compared to more mature firms (Brüderl et al., 1992).

One reason for lower R&D investments than the socially optimal level can be due to spillovers. These spillovers refer to the external benefits obtained by parties not directly involved in the R&D process. Such external benefits may diminish the incentives for firms to make the necessary R&D investments, ultimately resulting in suboptimal levels of investment in this area. When firms finance such projects, they cannot always seize the total surplus of benefits and instead produce positive externalities. This spillover means that other corporations can benefit from the firm-specific R&D costs through replications and improvements (Testa et al., 2019).

Because of underinvestment, government subsidies for R&D are essential in pushing innovation. Lerner (2000) and Feldman and Kelley (2006) discover that R&D grants send a positive signal about the quality of SMEs, which facilitates their ability to attract venture capital. Moreover, Lerner and Kortum (2001) find that increased venture capital activity in a given industry is associated with a significant increase in patenting rates. This correlation indicates that R&D grants foster innovation and increase the likelihood of securing VC financing.

The literature's implications align with our results, as we show that early-stage firms benefit more from the SKF grant. Financial constraints cause these firms to underinvest in R&D, explaining why they also might benefit more from the subsidy. Moreover, we demonstrate that firms facing greater challenges related to information asymmetries benefit significantly more from the SKF grant.

2.3 Government support

Busom (2000) suggests that SEs are more likely to apply for and receive R&D grants. This could be attributed to these firms experiencing financial constraints and needing to raise capital for future development and investments. Comparatively, larger businesses do not have these concerns to the same extent, although many apply for these grants as they are still beneficial. Due to financial constraints and market failures leading to underinvestment, government support is essential.

Government subsidies for private R&D projects significantly benefit businesses, and multiple countries fund these initiatives. Because of underinvestment in such projects, the impact of these grants is immense. One of the financial motives for these programs bases itself on the fact that private R&D activities frequently provide more societal benefits than private profits, meaning that specific investments in R&D may not be profitable for the firm. This effect is also known as positive externalities (Becker, 2014). Examples of social benefits are improved knowledge and technological innovations. A subsidy can make these R&D projects worthwhile for the firm and bring it closer to the socially optimal solution by reducing expenses (Wallsten, 2000). While government support programs are generally beneficial, there are cases where poorly executed programs can have more negative than positive effects (Hyytinen & Toivanen, 2005). Thus, it is crucial to ensure high-quality government subsidies.

The Norwegian government has pledged to foster innovation through funding R&D. They see globalization, technological development, the shift for a sustainable future, and increasing international competition as crucial reasons to support R&D investments in the private market (Stortinget, 1999; Regjeringen, 2023). They also acknowledge that during difficult times, R&D expenditures will be prioritized less than they should, and therefore it is their responsibility to aid firms in this aspect (Stortinget, 1999).

R&D subsidies granted through tax incentives, such as SkatteFUNN, are standard government practices to finance innovation. However, there are some indications that more is needed to breach the gap caused by financial constraints. This is because the government provides these subsidies when the firm has already taken the cost upon itself, and the incentive lowers the expenditure afterward. These types of subsidies are more effective as a complimentary to other grants rather than on their own (Radas et al., 2015).

Government support also serves as a certification method that sends positive signals to investors and banks and reduces concerns caused by information asymmetries (Lerner, 2000; Martí & Quas, 2017; Li et al., 2018). It also has the potential to transform the financial trajectory of R&D projects through two different channels, the equity- and prototyping channel (Howell, 2017).

We contribute to the literature showing that the SKF grant gives positive signals to external investors for early-stage firms, proving that government support can act as a certification method for investors that lack information about these types of firms. Additionally, we show that the effect of the funding mechanism related to government support mainly operates through the prototyping channel. These results further emphasize the importance of governments supporting early-stage firms.

3. Hypothesis Development

In surveys conducted among businesses, they often mention that the lack of external funding significantly hinders their investment and innovation efforts (Harhoff & Körting, 1998). Lerner (2000) suggests that R&D subsidies may positively affect firms' access to external financing as R&D can signal a firm's innovation and growth potential. This signaling effect may increase the firm's access to external equity financing as investors often seek out such firms. These findings contribute to our understanding of the factors that influence firms' access to external financing and highlight the role of government policies, such as R&D subsidies, in supporting the growth and development of these firms. Still, we find that there are gaps in the literature when assessing the Norwegian market, and this leads to our first hypothesis:

Hypothesis 1a: *Receiving government R&D subsidies increases firms' access to external equity financing.*

Meuleman & De Maeseneire (2012) and Howell (2017) find that firms in the early stages of their lifecycle seem to benefit substantially from government grants targeted toward R&D investments. Such firms are essential for global economic growth and are often associated with greater risk, development, and innovation (Jasra et al., 2011). Furthermore, they generate numerous employment opportunities in the market (Mead & Liedholm, 1998).

Early-stage firms frequently experience more severe financial constraints than established businesses and depend more heavily on external funding. Nevertheless, these firms might appeal to equity investors since they, in many cases, exhibit more innovation and have more development potential. It is also highly advantageous for these businesses to have backing as soon as possible to put their creative ideas into action (Guo et al., 2022). Given these characteristics, government R&D subsidies may impact early-stage firms' access to external equity to a greater extent than their mature counterparts. This idea provides us with the following hypothesis:

Hypothesis 1b: *The impact of government R&D subsidies on firms' access to external equity financing is greater for early-stage firms than for mature firms.*

As presented by Howell (2017), R&D subsidies can convert a losing project into a profitable one through two different funding mechanisms, the equity channel and the prototyping channel.

Government R&D grants can enhance early-stage firms' ability to attract external equity if there is evidence of improved performance because of the R&D implementation. The grant allows these firms to retain more equity, invest more in R&D projects, and potentially improve the likelihood of attracting external financing. Howell (2017) refers to this funding mechanism as the equity channel, and we present the following hypothesis to test if this mechanism is present:

Hypothesis 2a: *If the equity channel acts as a mechanism for government R&D grants, it should be evident that these grants have a dual positive impact on a firm - boosting profitability and facilitating access to external equity.*

Since early-stage firms utilize R&D grants for their respective R&D projects, the subsidy can improve the viability of a firm's technology, hence reducing the uncertainty for investors. This mechanism is known as the prototyping channel (Howell, 2017), and we introduce the following hypothesis to observe if this effect is present:

Hypothesis 2b: *If the prototyping channel functions as a mechanism for government R&D support, we should observe that these grants simultaneously strengthen the technological viability of the firm and improve its access to external equity.*

The certification mechanisms caused by government R&D programs can impact a firm's ability to obtain external financing by signaling to potential investors that a firm is of high quality, hence reducing the problems caused by information asymmetries (Lerner, 2000). This effect could benefit early-stage firms in particular because they do not have to encounter the usual proprietary costs, which tend to be high when disclosing business information (Li et al., 2018). To assess the presence of quality certification effects for firms facing higher levels of information issues, we provide the following hypothesis:

Hypothesis 2c: *If government R&D programs work through the quality certification effects, the impact of government R&D subsidies on firms' access to external equity should be greater for firms associated with higher levels of information asymmetries.*

4. Data

In this section, we present a detailed account of our dataset collection and our variables' construction. First, we outline our data acquisition process for SKF and PF and explain how we process and treat the obtained data. Subsequently, we describe our construction of the main regressors, and the model design chosen to test our hypotheses. Finally, we provide summary statistics for the final sample.

4.1 Sample

We utilize data from two primary sources to construct our dataset. The first source is the SKF program, for which information on applicants is collected from the official SKF website (https://www.skattefunn.no). This website provides a regularly updated database containing the names of all firms that have applied for SKF since 2002. The publicly available information includes details such as the firm's name, address, organization number, project nature and duration, application date, and approval status. The second source of data is the PF database, which offers financial information and other firm-level characteristics for Norwegian firms and enables us to extract data for each firm in our sample from 2012 to the present day.

The next step in this study is data matching, as the firm names in the two databases may not always be consistent. To address this issue, we perform matching based on the organization number while retaining the most up-to-date firm names from the PF database. By cross-referencing the SKF data with the PF data, we identify firms that have applied for SKF. Between 2012 and 2023, the SKF program received a total of 39,094 applications and provided support for 29,653 projects, with several firms submitting multiple applications. To ensure data accuracy, only the first grant application submitted by each firm is included, and any applications before January

1, 2012, and after December 31, 2022, are removed. Similarly, PF data after December 31, 2022, is excluded.

To ensure the robustness of our findings and minimize any potential bias caused by a specific matching method, we generate the control group through multiple steps. As SKF does not have clearly defined selection criteria, determining the eligibility of a firm for SKF support is challenging in our study. To address this, we assign a random number to the remaining 241,004 firms in the PF that have not applied for SKF and select 20,000 firms that have not received SKF support based on a random number range (1-20,000) as part of our final sample. Since the approval rate for SKF support is approximately 74%, the number of firms that applied but did not receive SKF support is not sufficient to create a control group. Therefore, we combine the non-backed SKF applicants with firms that did not apply to construct the control group. In total, our final sample consists of 25,004 unique firms. Among these, 3,770 firms received support from SKF, while 1,335 firms were declined support.

4.2 Variables

The objective of this study is to investigate the impact of the SKF program on a firm's ability to attract external equity. We use the natural logarithm of external equity (***External_Equity***) as our dependent variable. It is worth noting that after transforming the dependent variable to a logarithmic form, the unit change becomes a percentage change. Therefore, we interpret our results in terms of percentage change rather than unit change. Consequently, our dependent variable represents a growth rate when interpreting the economic implications of our estimates.

We create a dummy variable for SKF-backed firms (***SKF***) that take on the value of one if they received SKF support and zero otherwise. A positive coefficient on this variable indicates that SKF-backed firms had better access to external equity financing than non-SKF-backed firms prior to receiving the grant. To capture changes before and after the SKF infusion, we include another dummy variable called ***After***, which divides the entire period into two parts. It takes the value of one for the period after the SKF infusion and zero otherwise. This variable is used to capture changes in the control group before and after the SKF support, and its value for the control group firms is determined by their pairs in the SKF-backed group.

Finally, we include an interaction term of ***SKF*** and ***After*** in our DID estimates to measure the changes of differences in external equity financing between the two groups before and after the grant award, thereby identifying the causal relationship between SKF support and firms' access to external equity financing.

To ensure the accuracy of our analysis, we control for various firm-specific characteristics that are likely to impact a firm's financing ability. These variables are extracted from the PF database spanning from 2012 to 2023. First, we control for the age of the firm (***Firm_Age***), measured by taking the logarithm of the firm's age in a given year. Second, we consider the size of the firm (***Total_Assets***), which we measure by taking the logarithm of the firm's total assets. We also take into account the firm's leverage level from the previous year, measured by the ratio of total liabilities to total assets in the previous year, which we refer to as ***Leverage_Lag***. We believe a firm's financing decision at time t is associated with its leverage level at time $t-1$. Additionally, we control for the return on assets (***ROA***) of a firm to account for the influence of the firm's financial situation on its external funding. Overall, these variables help us to better isolate the effects of SKF on firms' access to external equity financing. The variables used are winsorized at the 1st and 99th percentiles to eliminate outliers. Table 1 provides abbreviations and definitions of all the variables used in our thesis.

4.3 Summary Statistics

Table 2 reports the summary statistics. Panel A presents the mean and median values, standard deviations, minimum and maximum equity investment, and other variables for the SKF-backed firms. Panel B presents the summary statistics for non-SKF-backed firms.

Table 2

Summary Statistics for SKF-backed and non-SKF-backed firms.

	Panel A: SKF-backed firms					
Variable	Mean	Median	Std. Dev	Min	Max	Obs
External_Equity	6.63	6.58	2.57	2.89	12.25	17,512
Firm_Age	1.53	1.60	0.57	0.14	2.48	17,512
Total_Assets	8.53	8.53	2.05	2.71	13.25	17,512

ROA	-0.028	0.013	0.35	-1.440	0.927	17,512
Leverage_Lag	0.56	0.60	0.28	0.00	1.00	17,512

	Panel B: Non-SKF-backed firms					
Variable	Mean	Median	Std. Dev	Min	Max	Obs
External_Equity	5.04	4.54	2.15	2.89	12.25	69,184
Firm_Age	1.43	1.47	0.60	0.14	2.48	69,184
Total_Assets	7.54	7.50	2.04	2.71	13.25	69,184
ROA	0.084	0.041	0.28	-1.440	0.927	69,184
Leverage_Lag	0.57	0.63	0.31	0.00	1.00	69,184

5. Empirical Methodology

In this section, we introduce the empirical strategy employed to assess the impact of the SKF program on firms' ability to attract external equity financing. To overcome biases from the government selection process and other confounding factors, we use a matched difference-in-differences approach. We employ propensity score matching to construct a rigor control sample, and further conduct balancing tests on major variables included in the PSM. Finally, we specify the models that test Hypothesis 1a and 1b.

5.1 Matched Difference-in-differences

To assess the post-implementation impact of SKF on firms' ability to attract external equity, we employ a DID approach. This approach examines differences in financing between SKF-backed firms and non-SKF-backed firms before and after the SKF infusion, aiming to identify a causal relationship. It is important to note that the selection processes for government subsidies tend to favor firms with specific characteristics, leading to a biased selection process (Irwin and Klenow, 1996; Lerner, 2000; Wallsten, 2000; Zhao and Ziedonis, 2020). Consequently, the firms selected for SKF support may have already possessed stronger financing abilities prior to receiving the subsidy. Additionally, there may be other underlying factors that coincide with government support, such as management expertise, technological advancements, or favorable market conditions, all of which can influence a firm's access to external funding.

To address these potential sources of bias, we use a matched difference-in-differences approach, which incorporates both conventional DID estimations and propensity score matching. DID, as a quasi-experimental method, enables us to estimate the differences in outcome variables' changes over time between the treatment group (SKF-backed firms) and the control group (non-SKF-backed firms). This method effectively accounts for both the between and within-group differences, thereby mitigating concerns regarding unobservable factors that could potentially bias our analysis. By employing the DID method, we can identify the causal effect of SKF support on firms' financing capabilities, while adequately controlling for any confounding factors. It is worth noting that although there may still be unobservable variables that can influence the outcome of interest, the matched DID approach offers a robust methodology for estimating the effect of SKF support on firms' ability to secure external equity financing.

5.2 Propensity Score Matching

We start by employing the PSM algorithm to construct a control sample. The propensity score represents the likelihood of receiving treatment based on the observed baseline characteristics, allowing us to design a nonrandomized study and mitigate selection issues that may arise in a randomized trial (Austin, 2011). In our study, we use the PSM approach developed by Rosenbaum and Rubin (1985) because it can reduce systematic differences in baseline characteristics between treated and untreated subjects more effectively than stratification on propensity score or covariate adjustment using the score (Austin et al., 2007). Further, we set the caliper to 0.2 of the standard deviation of the logit of the propensity score, as proposed by Austin (2011). However, it is important to note that the PSM methodology has its limitations as it cannot account for the impact of unobservable variables. Certain unobservable variables rather than SKF support may have contributed to the improved financing capability of the selected firms. Despite these limitations, we employ a matched DID approach in our panel analysis based on the PSM sample to mitigate such concerns.

We match firms that have received support from SKF with those that have not, based on multiple dimensions the year before SKF support. The propensity score in our study refers to the predicted probability of a firm receiving SKF support. To enhance the balance of the matching process, we adopt the approach proposed by Austin et al. (2007) and choose matching variables that are relevant to both the treatment and outcome of the PSM models. The SKF program places utmost importance on innovation capability when selecting projects. Thus, we incorporate firms' patent stock (***Patent***), in logarithmic format, during the matching process as it is a major indicator of firms' innovation capabilities. Data on patents are collected from the official Patentstyret website (https://www.patentstyret.no). Furthermore, we control for the size and age of firms, as well as their financial situation, which may affect their ability to accumulate capital and attract external equity. Thus, we include return on assets (ROA) as a control variable for the PSM. Moreover, we also control for the output variable in the PSM, which refers to external equity. To estimate the propensity score, we lag all explanatory variables for one period before applying the one-to-three nearest-neighbor PSM to identify non-SKF-backed firms. Finally, 17,614 firms and 60,747 firm-year observations are obtained.

As Guo et al. (2022) recognize, although the DID and PSM allow us to address identification problems, this approach enables us to control only unobserved time-invariant individual effects. In contrast, it may not be able to control some unobserved time-variant factors.

5.2.1 Balancing Test

To assess the quality of the matching process, we conduct balancing tests on key matching variables, and the results are presented in Table 3. This table includes a comparison between the matched and non-matched samples on various measures, including standardized mean differences (SMD), variance ratios, mean eCDFs and maximum eCDFs. The use of hypothesis tests, such as t-tests, to assess covariate balance has sparked some debate. Ho et al. (2007) and Imai et al. (2008) describe some of the issues in which hypothesis tests are inappropriate as balancing tests. Thus, we choose to rely on the abovementioned measures to assess the balance.

The literature suggests that an SMD close to 0 indicates a good balance, with values below 0.1 generally considered acceptable. Our major variables fall within this range, aligning with the recommended thresholds. Belitser et al. (2011), Ali et al. (2014), and Stuart et al. (2013) show a high correlation between the absolute SMD and the presence of bias in the treatment effect. Moreover, variance ratios close to 1 indicate good balance because they suggest that the variances of the samples are comparable (Austin, 2009). However, ratios between 0.5 and 2 are considered acceptable. While patents have a variance ratio of 1.43, all major variables remain within the recommended range. Additionally, eCDF statistics, reflect the difference in covariate distribution between treatment groups, ranging from 0 to 1, with lower values indicating better balance. In summary, our measurements align with the literature's acceptable ranges, confirming that the matching variables are properly balanced. Further examination of matching quality is discussed in Section 6.2.

Table 3

Balancing test on major matching variables

	Panel A: Summary balance for all data			
Variables	SMD	Var. Ratio	eCDF Mean	eCDF Max
ROA	-0.261	1.506	0.069	0.150
Total_Assets	0.354	1.062	0.096	0.165
Firm_Age	0.094	0.929	0.019	0.047
External_Equity	0.479	1.388	0.112	0.237
Patent	0.216	13.167	0.009	0.061
	Panel B: Summary balance for matched data			
Variables	SMD	Var. Ratio	eCDF Mean	eCDF Max
ROA	-0.029	1.141	0.041	0.092
Total_Assets	-0.010	0.852	0.022	0.037
Firm_Age	0.011	0.959	0.008	0.016
External_Equity	-0.014	0.909	0.015	0.029
Patent	0.029	1.430	0.001	0.010

5.3 Model Specification

To test Hypothesis 1a, we employ the DID approach on our rigorously matched sample. The regression specification is as follows:

$$Y_{it+1} = \beta_0 + \beta_1 SKF_i + \beta_2 After_{it} + \beta_3 SKF_i * After_{it} + \beta_4 Z_{it} + \theta_t + e_{it} \quad (1)$$

where Y_{it+1} is firm i's access to external equity (*External_Equity*) in year $t + 1$, in logarithmic format. SKF_i is a dummy variable indicating whether firm i received the SKF award during our examination period. It takes a value of one if the firm received the SKF award and zero otherwise. The variable $After_{it}$ is a dummy variable that distinguishes between the periods before and after the SKF infusion for both the treated group (SKF-backed firms) and the control group (non-SKF-backed firms) at time t. To identify the ex-post effects of the SKF intervention, we include the interaction term of SKF_i and $After_{it}$ in the DID estimates. The coefficient β_3 captures the differences between the treated and control groups, as well as the within-group differences over time, specifically regarding firms' access to external equity. In addition to these variables, we control for a vector of firm-level characteristics denoted as Z_{it}. This vector includes variables such as *Firm_Age*, *Total_Assets*, *Leverage_Lag*, and *ROA*. By controlling for these firm-level characteristics, we account for any potential confounding factors that may influence a firm's access to external equity. Furthermore, we incorporate year-fixed effects denoted as θ_t to control for time trends in a firm's access to external equity.

To estimate Hypothesis 1b we perform a similar procedure as in the previous case. We construct a new dummy variable ***Early*** that takes on the value of 1 if a firm's total assets and firm age at the application date is less than the median of total assets and firm age for all firms in our sample at each firm's application date. Otherwise, the value of this variable is zero. All other variables are defined similarly as in Equation (2). The regression specification is as follows:

$$Y_{it+1} = \beta_0 + \beta_1 SKF_i + \beta_2 After_{it} + \beta_3 SKF_i * After_{it} * Early_{it} + \beta_4 Z_{it} + \theta_t + e_{it} \quad (2)$$

Where the interaction term of SKF_i, $After_{it}$, and $Early_{it}$ capture the ex-post effects of SKF infusion for early-stage firms.

6. Findings

In the following subsections, we provide and examine the findings on the effects of SKF on firms' access to external equity financing. First, we discuss our main results from the two regressions presented in the previous section. We then conduct a placebo test to enhance the robustness of our findings. Lastly, we examine the mechanisms by which government R&D programs impact a firm's access to external equity.

6.1 Main Results

Table 4 presents the results. Panel A reports the estimation results on the relationship between the increase of external equity and the interaction term. We find no statistically significant relationship between *SKF* and firms' access to external equity. These results are consistent with our PSM that there are no systematically significant differences between firms receiving a subsidy from SKF and those in the control group in terms of access to external equity prior to SKF infusion. Moreover, we do not observe a statistically significant relationship between the interaction term of *SKF* and *After*, and a firm’s growth in external equity. Thus, we cannot confirm that SKF support helps firms access more external equity.

Table 4

Government R&D programs and firms’ external equity financing

Panel A: DID with SKF and After		Panel B: DID with SKF, After and Early	
	External_Equity		External_Equity
SKF	0.069 (0.080)	***SKF***	0.073 (0.084)
After	0.071 (0.059)	***After***	0.076 (0.061)
Firm_Age	-0.179*** (0.012)	***Firm_Age***	-0.182*** (0.012)
Total_Assets	0.837*** (0.003)	***Total_Assets***	0.838*** (0.003)
ROA	-1.971*** (0.021)	***ROA***	-1.968*** (0.021)
Leverage_Lag	-1.209*** (0.020)	***Leverage_Lag***	-1.208*** (0.020)

SKF*After	-0.021 (0.029)	***SKF*After*Early***	0.134*** (0.033)
Observations	60,747	***Observations***	60,747
Year FE	YES	***Year FE***	YES
Adjusted-R2	0.60	***Adjusted-R2***	0.60
F-statistic	13375***	***F-statistic***	13381***

Note: * = p < 0.1; ** = p < 0.05; *** = p < 0.01.

We find that firm size, as measured by *Total_Assets*, is significantly and positively correlated with the growth of external equity, implying that larger firms are more attractive to equity investors. The reason behind this can be attributed to the fact that as firms grow, they accumulate more tangible assets and establish a track record of performance. Consequently, this reduces the information gap and enhances their attractiveness to external financiers. On the other hand, we find that firm age is significantly and negatively correlated with the outcome variable, indicating that younger firms attract more external equity. This may appear contradictory, as firm age typically shows a positive correlation with firm size. However, the correlation between firm age and size is approximately 0.31, implying that younger firms do not necessarily have less total assets than older firms. It is worth noting that since we measure firm size by total assets, the results could be different if measured by the number of employees.

Interestingly, we find a significant and negative correlation between the previous year's leverage ratio and the growth of external equity. Such results are understandable because the average leverage ratio of firms in our sample is not high (56%), and according to the pecking order of external financing (Myers and Majluf, 1984), debt is generally cheaper than equity if the firm is solvent. Consequently, firms with a higher likelihood of securing debt from external financiers may opt not to seek equity investment. Finally, *ROA* is significantly and negatively associated with external equity, indicating that more profitable firms have a higher probability of attracting outside equity.

Meuleman & De Maeseneire (2012) show that businesses in their early stages can benefit significantly from government R&D grants. With this in mind, we examine whether there are any differences for early-stage firms receiving the SKF grant.

Panel B shows the relationship between the increase in external equity and the interaction term, now including the variable *Early*. The results resemble those presented in Panel A. The new interaction term *SKF*After*Early* is significantly and positively correlated with the outcome variable. The growth of external equity of SKF-backed firms is significantly higher by 13.4% than that of non-SKF-backed firms after the SKF infusion. This is consistent with our finding that younger firms have a higher probability of acquiring external equity.

To summarize, the results presented in Table 4 indicate that after controlling the within-group differences, early-stage SKF-backed firms experience significantly higher growth in external equity compared to non-SKF-backed firms. Using the matched DID approach, we controlled the observable and unobservable variables, enabling us to establish a causal relationship between the SKF subsidy and firms' access to external equity financing. These results challenge Hypothesis 1a, which suggests that receiving government R&D subsidies increases firms' access to external equity financing. However, they support Hypothesis 1b, which suggests that the impact of government R&D subsidies on firms' access to external equity financing is greater for early-stage firms than for mature firms.

Meuleman & De Maeseneire (2012) demonstrates that R&D subsidies result in better access to long-term debt financing for SMEs, Howell (2017) observes that early-stage grants make firms a more viable investment opportunity, while Guo et al. (2022) find significant impacts of government subsidies on a firm's ability to secure external funding. We contribute to this literature by showing that the subsidy provided by SKF impacts early-stage firms' access to external equity financing to a greater extent than mature firms. These findings provide additional empirical evidence in this field of research and indicate the importance of policymakers focusing on early-stage firms and facilitating these firms' growth.

Since the effectiveness of government subsidies appears to be dependent on specific firm characteristics, future research should aim to delve into these factors. Aspects such as industry sector, location, leadership, and business model might significantly influence how a firm leverages these subsidies. Understanding these interactions could further improve the literature.

6.2 Placebo Test

As discussed, selection biases are present in government R&D support and firms selected for SKF support may have already possessed stronger financing abilities prior to receiving the subsidy. Although the matched firms selected after the PSM should possess similar characteristics, and hence reduce the selection bias, we want to ensure that the observed effects in the treatment group are not merely due to pre-existing differences between the treated and control group. To assess the parallel trends assumption and the validity of the DID design, we examine the pre-treatment trends in the outcome variable between the two groups. To test whether the SKF-backed firms have better access to external equity financing than non-SKF-backed firms at the time of winning the grant, we run a falsification placebo test on the firms in our matched sample. We construct pooled pre-periods and introduce "fake" treatments that occurred one year before the SKF infusion. The regression is specified as follows:

$$Y_{it-1} = \beta_0 + \beta_1 PseudoSKF_{it} + \beta_2 Z_{it-1} + \theta_t + e_{it} \tag{3}$$

where Y_{it-1} is firm i's access to external equity one year before SKF infusion, transformed into a logarithmic format. $PseudoSKF_{it}$ is a dummy variable, and it equals one if firm i received the SKF award at time t and equals zero if otherwise. The coefficient β_1 captures the estimated effect of SKF selection on a firm's access to external equity. Additionally, we incorporate a vector of firm-level characteristics (Z_{it-1}) to control for other factors that might influence a firm's access to external equity. These include $Firm\_Age$, *Total_Assets*, $Leverage\_Lag$, and ROA. To account for potential time-related effects, we introduce year-fixed effects (θ_t).

Table 5 presents the results. It shows that the dummy variable *PseudoSKF* is not statistically significant one year before the grant, implying that the observed effects in the treatment group are not due to pre-existing differences between the treated and control group. These results support our evidence that the rigorous PSM design enables us to construct a control group with similar characteristics, minimizing confounding factors. Similarly, it validates the parallel trends assumption, which that assumes in the absence of the treatment, the average outcome for the treatment and control groups should follow parallel paths over time. Ideally, we would perform the same estimation on a random sample of firms eligible for SKF support to investigate whether the ex-ante selection exists when government provides R&D subsidies. As discussed, SKF does not have any quantifiable firm-specific selection criteria, thus we are unable to examine a non-matched sample. Nonetheless, the placebo test strengthens the robustness of our findings and shows that our matched control firms do not suffer from selection bias prior to receiving SKF support.

6.3 Mechanisms

Utilizing the DID method, we established a causal relationship between the SKF grant and a firm's ability to attract external equity. This section investigates the mechanisms by which government R&D programs impact a firm's access to external equity.

6.3.1 Funding Mechanisms

First, we explore the funding mechanisms, specifically the equity channel and the prototyping channel, and their impact on firms' ability to access external equity. To test the validity of the equity channel, we examine the relationship between the SKF grant and firms' financial performance. We employ three measurements, the return over total assets (***ROA***), return over total equity (***ROE***) and return over total sales (***ROS***), to capture the financial performance of a firm. This analysis serves as an indirect test, where we evaluate whether the SKF grant leads to improved financial performance. If there is evidence of performance improvements, we can infer that the enhanced external financing obtained by SKF-backed firms is a result of their improved performance, thereby confirming the presence of the equity channel in the funding mechanism.

To assess the prototyping channel, we use R&D expenses as a proxy to capture the proof-of-concept effect. We create a variable (***Ln_RD***) representing the natural logarithm of firms' R&D expenditures in a given year. Due to a limited number of firms with incurred R&D expenses, the sample size is significantly reduced. However, it is noteworthy that approximately three-quarters of the firms in the sample have received SKF support, indicating a higher likelihood of engagement in R&D activities among SKF-backed firms. Consequently, in our PSM, we were not able to find suitable matches for all treated firms, as the control group is considerably smaller. Nevertheless, we use the matched DID approach in our estimations. The regression model used is as follows:

$$Y_{it+1} = \beta_0 + \beta_1 SKF_i + \beta_2 After_{it} + \beta_3 SKF_i * After_{it} + \beta_4 Z_{it} + \theta_t + e_{it} \quad (4)$$

where Y_{it+1} represents the firm's financial performance or proof-of-concept in year $t + 1$, including ROA, ROE, ROS, and Ln_RD. SKF_i, $After_{it}$, and θ_t are defined similarly as in Equation (2). Z_{it} is a vector of firm-level characteristics, which includes *Firm_Age*, *Total_Assets*, and *Leverage_Lag*.

Table 6 reports the results. As shown in Columns (1) to (3), we do not observe any statistical relationship between the interaction term and firms' financial performance measured by ROE. On the other hand, there is a slight negative relationship between the interaction term and ROA. Additionally, we observe a significant and considerable negative relationship between the interaction term and *ROS*. This is, however, understandable given the increased R&D expenses of firms after the SKF award. Overall, the findings from Columns (1) to (3) suggest that government support does not appear to enhance firms' financial performance in Norway. Consequently, these results do not support the funding effects through the equity channel.

Column (4) present the relationship between SKF support and a firm's R&D expenditures. It shows a significant and positive relationship between the interaction term and the prototyping measurement. Notably, Column (4) demonstrates that the change in the growth rate of R&D expenses for SKF-backed firms after winning the grant is 51.9% higher than that of non-SKF-backed firms.

The results presented in Table 6 indicate that government subsidies do not appear to contribute to firms' financial performance. However, they do facilitate proof-of-concept work that firms would otherwise struggle to finance. We acknowledge the limitation of solely relying on R&D expenses as a proxy to study the prototyping and examine whether firms utilize the grant for R&D activities. Furthermore, there is a lack of consistency as some SKF-backed firms opt to reduce labor costs instead of accounting for R&D expenses. By combining the findings from Tables 4 and 6, we find support for Hypothesis 2b, while Hypothesis 2a is rejected. The funding effects of government support primarily operate through the prototyping channel.

These results align with those of Howell's study (2017) based on US data, and Guo et al. (2022) on Chinese data.

Table 6

Government R&D support and the performance of firms: Examinations on funding mechanisms.

	(1)	(2)	(3)	(4)
	ROA	ROE	ROS	Ln_RD
SKF	-0.095*** (0.003)	-0.340*** (0.027)	-0.955*** (0.067)	0.084 (0.109)
After	-0.018*** (0.003)	-0.117*** (0.018)	-0.077 (0.051)	0.182* (0.089)
Firm_Age	0.012*** (0.002)	0.092*** (0.015)	0.621*** (0.042)	-0.529*** (0.065)
Total_Assets	0.010*** (0.001)	0.054*** (0.004)	-0.146*** (0.011)	0.631*** (0.016)
Leverage_Lag	0.076*** (0.004)	0.462*** (0.025)	1.423*** (0.076)	-0.426*** (0.103)
SKF*After	-0.011* (0.005)	-0.021 (0.036)	-0.292** (0.089)	0.519*** (0.133)
Observations	62,350	65,179	40,882	2,276
Year FE	YES	YES	YES	YES
Adjusted-R2	0.035	0.015	0.035	0.438
F-statistic	375.23	173.58	247.54	298.72

Note: * = p < 0.1; ** = p < 0.05; *** = p < 0.01.

6.3.2 Certification Mechanisms

Hypothesis 2c suggests that R&D grants have a greater impact on early-stage firms than mature firms, partly due to the certification effect caused by positive signals received by investors from government grant decisions (Howell, 2017). To assess the certification effect, we employ a new model that examines the level of information asymmetries associated with firms and how R&D subsidies affect these firms. As Guo et al. (2022) discuss, if firms experience more problems associated with information asymmetries, they should also experience a significantly positive relationship with R&D grants. Additionally, they state that finding suitable measures for problems caused by information asymmetries is challenging, especially for privately held firms. Nevertheless, we use firm age as one of the proxies for information asymmetries, as younger firms are significantly affected by such issues (Krishnaswami et al., 1999; Guo et al., 2022). Moreover, Aboody & Lev (2000) identify R&D intensity as a major contributor to information asymmetry, thus we include firm-specific R&D intensity as another proxy. The regression is specified as follows:

$$Y_{it+1} = \beta_0 + \beta_1 SKF_i + \beta_2 After_{it} + \beta_3 SKF_i * After_{it} + \beta_4 SKF_i * After_{it} * C_{it} + \beta_5 Z_{it} + \theta_t + e_{it} \quad (5)$$

where Y_{it+1} is firm i's access to external equity financing in year $t+1$, in logarithmic format. SKF_i, Z_{it}, and θ_t are defined the same as in Equation (2). To assess information asymmetries related to firm quality identification, we include the variable C_{it}, which represents either firm age or firm-specific R&D intensity. Following Blonigen & Taylor (2003) and Lin et al. (2006), we measure R&D intensity as the ratio of a firm's R&D expenditures to total assets. To test Hypothesis 2c, we add the interaction terms of the measurements for information issues associated with firm quality (C_{it}), the SKF award (SKF_i), and $After_{it}$ into our regression model. β_4 captures the effect of information issues on the impact of SKF subsidies on firms' access to external equity.

Tables 7 and 8 report the results for estimating the presence of certification mechanisms for SKF-backed firms. Table 7 presents the regression results in which firm age is used as a proxy for information asymmetry. It shows that firm age is negatively associated with a firm's access to external equity, consistent with our previous examinations. The interaction effect between SKF and After demonstrates a positive relationship with the growth of external equity. This indicates that after the SKF infusion, the growth of external equity for SKF-backed firms is substantially higher than that of non-SKF-backed firms. Notably, in Table 4, Panel A, we initially found the interaction term between SKF and After to be statistically insignificant. However, by introducing a triple interaction term with firm age, our findings remain robust, confirming that the SKF effect depends on firm age.

Furthermore, we observe that the three-way interaction term *SKF*After*Firm_Age* is negative and statistically significant. This implies that younger firms are more appealing to equity investors. Our findings align with previous examinations and support the notion that government subsidies serve as a certification mechanism. Moreover, this aligns with existing literature, which suggests that older firms, due to their track record and established reputation, experience less severe information asymmetries, thereby reducing their reliance on subsidies as a certification mechanism.

Table 8 presents the regression results in which R&D intensity is used as a proxy for information asymmetry. It shows that firms' R&D intensity is significantly and positively associated with external equity. With SKF to stimulate R&D activities in which new products, services, or processes facilitate the development of new knowledge and skills, such results may suggest that innovative tech-enabled firms have greater access to external equity than mature industries. However, we do not observe a statistically significant relationship between the interaction term *SKF*After*RD_Intensity* and a firm's growth in external equity. As discussed, due to a limited number of firms with incurred R&D expenses, the sample size is relatively small compared to other measures.

The results in Tables 7 and 8 indicate that the effect of SKF on firms' access to external equity financing alleviates some of the problems related to information asymmetries, effectively giving a sign of quality to external investors. This outcome supports Hypothesis 2c, demonstrating that government support functions as a certification mechanism, especially for early-stage firms. Martí & Quas (2017) and Li et al. (2018) show that government support provides a certification effect, enabling firms, especially SMEs, to receive external debt financing. Meuleman & De Maeseneire (2012) find that the certification mechanism related to R&D grants is more apparent in the case of higher asymmetric information. We add to the literature demonstrating that this effect is evident when observing external equity financing for younger firms. Additionally, it challenges the findings of Guo et al. (2022), who find no evidence for a quality certification effect as a consequence of government support. We acknowledge that the discrepancy in how different parts of the world implement and execute government support could account for the disparity in findings.

7. Conclusion

Government R&D subsidies and tax credit programs are essential in enabling innovation through financing R&D projects, especially for early-stage firms. Research in this field is necessary because the observations and results provide knowledge on what factors government officials need to prioritize going forward. This importance is amplified by the fact that there is little empirical evidence on the effectiveness of government grants (Howell, 2017) and how they influence a firm's ability to acquire external funding (Guo et al., 2022).

Utilizing data from SKF and PF, we contribute to the literature by studying the effect of government support provided through the SKF tax credit program and its effect on receiving external equity financing. Additionally, we analyze the presence and impact of funding- and certification mechanisms as a consequence of government grants.

We find that while receiving a grant from SKF does not directly affect the overall ability of firms to raise external equity, early-stage firms derive the greatest benefits from these government initiatives. This suggests that the advantages of the subsidies may vary depending on firm-specific characteristics or circumstances, such as firm age or size.

To further enhance our findings, we examine the underlying funding- and certification mechanisms of the SKF grant. We find that the effects of government R&D support primarily operate through the prototyping channel, enabling firms to demonstrate the viability of their technology. Our results also show that government-backed R&D grants significantly impact the certification effect for early-stage firms, suggesting a signal mechanism where such grants are seen by external investors as a quality endorsement, thus reducing information asymmetry.

Our research suggests that early-stage firms benefit most from government R&D grants in terms of accessing external equity. This implies that government policies should focus on these grants towards start-ups and early-stage firms, as they stand to gain the greatest advantage. By doing so, policymakers can maximize the effectiveness and impact of government initiatives in fostering innovation and supporting the growth of young firms.

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Appendix

Table 1: Variable definitions and abbreviations

Variable definitions

Variable	Description	Source
ROA	Return on assets: A firm's net income divided by its average total assets.	Proff Forvalt
ROE	Return on equity: A firm's net income divided by its average total equity.	Proff Forvalt
ROS	Return on sales: A firm's operating profit divided by its net sales.	Proff Forvalt
SKF	Dummy variable that is equal to 1 if a firm received SKF support and 0 otherwise.	SkatteFUNN
After	Dummy variable that is equal to 1 for the period after the SKF infusion and 0 otherwise.	SkatteFUNN
Early	Dummy variable that is equal to 1 if a firm's total assets and firm age at the application date is less than the median of total assets and firm age for all firms at each firm's application date. Otherwise, this variable is equal to 0.	Proff Forvalt
External_Equity	The natural logarithm of a firm's external equity.	Proff Forvalt
Firm_Age	The natural logarithm of a firm's age.	Proff Forvalt
Total_Assets	The natural logarithm of a firm's total assets.	Proff Forvalt
Leverage_Lag	A firm's leverage in the previous year, measured by the ratio of total liabilities to total assets.	Proff Forvalt
Patent	The natural logarithm of a firm's patent stock.	Patentstyret
Ln_RD	The natural logarithm of a firm's R&D expenditures.	Proff Forvalt
PseudoSKF	Dummy variable that is equal to 1 if a firm received "fake" SKF support one year before SKF infusion. Otherwise, this variable is equal to 0.	SkatteFUNN
RD_Intensity	Firm-specific R&D intensity: A firm's R&D expenditures divided by its total assets.	Proff Forvalt

Abbreviations

R&D	Research & Development	**PF**	Proff Forvalt
VC / CVC	Venture Capital / Corporate Venture Capital	**DID**	Difference-in-Differences
SKF	SkatteFUNN	**PSM**	Propensity Score Matching
SME	Small and Medium Enterprise	**SMD**	Standardized Mean Differences
SE	Small Enterprise	**eCDF**	Empirical Cumulative Distribution Function

Table 5

Test for SKF selection (Matched Sample)

	External_Equity [-1]
PseudoSKF	0.078 (0.118)
Firm_Age	-0.102*** (0.015)
Total_Assets	0.668*** (0.004)
ROA	-1.367*** (0.030)
Leverage_Lag	-1.702*** (0.027)
Observations	54,768
Year FE	YES
Adjusted-R2	0.374
F-statistic	6544.71***

Note: * = p < 0.1; ** = p < 0.05; *** = p < 0.01.

Table 7

Information asymmetry measured by firm age

Variables	External_Equity
SKF	0.076 (0.068)
After	0.089 (0.074)
Firm_Age	-0.153*** (0.013)
Total_Assets	0.837*** (0.003)
ROA	-1.955*** (0.022)
Leverage_Lag	-1.189*** (0.021)
SKF*After	0.409*** (0.083)
SKF*After*Firm_Age	-0.254*** (0.044)
Observations	60,747
Year FE	YES
Adjusted-R2	0.599
F-statistic	11353.3***

Note: * = p < 0.1; ** = p < 0.05; *** = p < 0.01.

Table 8

Information asymmetry measured by R&D Intensity

Panel B:	
	External_Equity
SKF	0.079 (0.082)
After	0.091 (0.087)
Firm_Age	-0.118. (0.063)
Total_Assets	0.983*** (0.016)
ROA	-3.247*** (0.127)
Leverage_Lag	-1.136*** (0.098)
SKF*After	0.079 (0.140)
RD_Intensity	0.477*** (0.118)
SKF*After*RD_Intensity	-0.141 (0.199)
Observations	2,994
Year FE	YES
Adjusted-R2	0.639
F-statistic	598.85***

Note: * = $p < 0.1$; ** = $p < 0.05$; *** = $p < 0.01$.