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Abstract

In the face of climate change, governments are scaling up public investments in mitigation efforts and green technologies. However, critics question the ability of public funding agencies to promote the most promising innovations. This paper contributes to this debate by presenting a long-term database, that directly links Swedish innovations to public funding between 1970 and 2021. We use logistic regression models to analyze what innovations are most likely to receive public funding. A remarkably high share of the most radical innovations relied on public funding: 43% over the whole period, reaching 55% in the last decade. Moreover, renewable energy innovations attracted increasing public support over time. Those developed after 2000 are twice as likely to be publicly funded. Contrary to received notions that governments are unable to pick winners, our findings highlight that public spending in Sweden has shaped market conditions, aptly funding the most radical innovations, and that public funding agencies played a crucial role in climate change mitigation efforts by supporting the development of renewable energy technologies.

1 Introduction

The mitigation of climate change is without doubt among the biggest challenges faced by humanity (IPCC, 2018, Shmelev and Speck, 2018, Fouquet and Pearson, 2012). To avoid global heating by more than 2°C, a rapid reduction in greenhouse gas emissions must be achieved over the next three decades (Lamboll et al., 2023). Reducing fossil fuel combustion is of central importance for the achievement of the climate targets, as it is responsible for about 80% of global greenhouse gas emissions (Akpan and Akpan, 2012).

To counter these challenges, ambitious policy targets, such as the Mission Innovation initiative, have been set to accelerate government spending on clean energy research (Mazzucato, 2013, 2018). Despite these efforts, only a moderate rise in research funding has occurred since 2015 (Chong, 2022). Research has also stressed a lack of private funding for energy innovations, which can be accounted for by the extended development time, additional infrastructure requirements, and resistance of incumbent actors that characterize the energy sector (Mazzucato et al., 2015, Mazzucato and Semieniuk, 2018). To facilitate a successful transition towards renewable sources, research therefore calls for increased public support for energy innovations (Fouquet and Pearson, 2012, Mazzucato et al., 2015, Gallagher et al., 2012), alongside calls for governments to move towards proactive market-shaping approaches (Mazzucato et al., 2015, Mazzucato, 2022).

Nonetheless, public involvement in innovation activity has come under fire for a number of perceived shortcomings. First of all, governments are argued to be unable to effectively *pick winners* or successful innovation since they lack sufficient information on firms' internal affairs. Therefore, public funding may be inefficient, and more likely to fail than privately funded projects. Second, the provision of public support encourages *rent-seeking* behavior. Firms in the targeted sector will try to maximize subsidies, while minimizing the amount of investment that is required to obtain them (Pack and Saggi, 2006, Helm, 2010, Lerner, 2009, McKenzie, 2017).

This paper departs from noting that progress in these debates about the design of public innovation funding has so far been impeded by data availability. Pless et al. (2020) call for the creation of long-term energy innovation data that comprises information on both innovation inputs, innovation outputs, and their direction. In this paper, direction refers to technologies that contribute to climate change mitigation efforts, such as renewable energy technology.

The aim of this paper is to examine what types of innovations have received public funding in Sweden, one of the world's leading innovation economies (Dutta et al., 2023). To this end, we constructed, to our best knowledge, the first database that directly links public funding to actual innovation outputs. One previous study made estimates of macro-level prevalence of public funding in Sweden and Finland based on surveys (Torregrosa-Hetland et al., 2019). A micro-data approach allows us to analyze fine-grained patterns of public funding. While many studies on funding use proxies for innovation such as patents or publications (Pless et al., 2020), our analysis focuses on commercialized innovation output (SWINNO, 2023).

The database consists of 4,853 Swedish innovations commercialized between 1970 and 2021 that have been linked to a database containing 168,135 public funding projects. We use a logistic regression model to analyze what innovations are most likely to receive public funding. Special focus is placed on the questions of whether energy and radical innovations are generally more likely to receive public support and whether public funding bodies specifically target the emergence of renewable and energy saving technologies.

Sweden's public funding system is of broad interest to study for several reasons. Sweden is considered a pioneer in environmental policy and had the lowest greenhouse gas emission per capita among all EU members in 2019 (Shmelev and Speck, 2018). Fuel taxes were introduced already in the 1920s, Sweden implemented the first carbon tax worldwide in 1991 (Andersson, 2019, Ministry of Finance, 2022). Furthermore, Sweden is considered one of the world's most innovative economies. It ranked third in the 2023 Global Innovation Index, second in the 2023 European Innovation Scoreboard and it had the highest investment in research and development among the EU countries in 2022 (Dutta et al., 2023, EU, 2023, Eurostat, 2022). Finally, Sweden has a tradition of active public sector involvement in economic activity, which begs the question of how innovation outcomes relate to public funding policies. Swedish income and general government tax rates topped rankings among developed countries throughout the latter half of the 20th century and government spending accounted for up to two thirds of Swedish GDP (Slemrod et al., 1995, Hessami, 2010, Bastani and Lundberg, 2017).

The results of this study suggest that public innovation funding in general, and for the energy sector in particular, has been allocated towards the most promising technologies. Radical innovations are consistently most likely to receive public support, being estimated to be 2.8 times more likely to attract public funding. Furthermore, public funding has been increasingly directed towards renewable energy innovations. Since 2000 they are twice as likely to receive public support compared to non-renewable technologies, marking a break in Swedish innovation policy and the importance of public funding agencies for climate change mitigation efforts.

2 Controversies about public funding of innovation

The importance of public innovation funding has long been subject to discussion in academia. Traditionally there are two opposing views. One strand of literature endorses government intervention in the presence of *market failure*, while the other generally opposes it. Market failure refers to the over- or under-provision of public goods due to information imbalances or externalities. From a societal perspective, exclusive promotion of innovation activity by private actors will result in an underinvestment in research and development since individual companies do not take positive knowledge externalities into account. According to the first strand of literature, public actors should in this case intervene by providing additional funding and incentives for companies to innovate (Arrow, 1962, Nelson, 1959).

The other strand of literature disapproves of government intervention even in the presence of market failure due to potential *government failures*. This line of literature criticizes public actors for their inability to "pick the winners", viz. selecting particular projects or firms for funding support. This runs two risks. On the one hand it is argued that governments are less efficient than private investors at identifying promising projects. On the other hand, public funding might be wasted in the sense that it was allocated to projects that would have succeeded anyways or crowding out private investment (Helm, 2010, Lerner, 2009, McKenzie, 2017, David et al., 2000).

Clearly, if public funding agencies are inept at "picking the winners", less important or failed innovations should be relatively likely to receive public funding. However, the few quantitative studies that exist suggest that in practice public R& D programs are pursuing "pick the winners" approaches, rather than identifying market failures (Cantner and Kösters, 2012), while others have found that a majority of radical or prize-winning innovations depended on government support (Block and Keller, 2009, 2015).

Moreover, the existence of public subsidies is criticized for creating incentives for *rent-seeking* behavior (Krueger, 1974). Firms will attempt to receive as much public funding as possible to maximize their short-term profits while delivering only a minimum of required results. For the presented reasons, this strand of literature has called for a reduction of governmental involvement in technological development (Kealey, 2001, David, 1997).

Recently, a third strand of literature has emerged that endorses public involvement in innovation activity but challenges the market failure view, arguing for a role of public agents in shaping and creating markets. These arguments especially stress the strong path dependency of technological development and that sustainability is a complex, "wicked problem", both of which make public involvement necessary. To facilitate a transition towards renewable sources, systemic changes are required that are unfeasible to single companies (Mazzucato, 2018, Meckling et al., 2022, Acemoglu et al., 2016, Aiginger and Rodrik, 2020).

Related to this is the problem that private actors tend to be risk averse and biased towards short-term projects, why public agents have emerged as lead investors and risk takers (Mazzucato and Semieniuk, 2018). The innovation process is characterized by fundamental uncertainty and novel technologies may take several years until reaching maturity during which they do not create revenues for the company (Alchian, 1950, Kline, 1985). The failure of a single innovation might therefore result in the bankruptcy of a private company. This is pronounced in the energy sector where the maturation of novel technologies might take up to several decades rather than a few years (Fouquet and Pearson, 2012, Mazzucato et al., 2015). By contrast, public actors have been argued to play an important role in developing high-risk technologies, requiring long-term funding (Fouquet and Pearson, 2012, Mazzucato et al., 2015, Mazzucato and Semieniuk, 2018, 2017). Governments have access to far greater funds than most companies allowing them to provide long-term finance and constructing complementary infrastructure without running the risk of bankruptcy in case of a failed innovation. Moreover, public actors can break the resistance of incumbent actors through compensation payments or laws limiting their market power. Hence, public funding may be more likely to promote radical innovation compared to private actors (Mazzucato, 2013).

If policies are aiming to "pick the winners" and do so efficiently another discussion is what types of technologies should be funded and when in the development of new technologies public funding should enter (Meckling et al., 2022). Research suggests that public support is crucial throughout the innovation process (Mazzucato and Semieniuk, 2018, Gallagher et al., 2012). A US study found a positive relationship between the performance of firms, in terms of e.g., patenting, receiving public support during early development stages (Howell, 2017). If public funding was only obtained during later stages of the innovation process, no similar positive effects on innovation were found.

3 Methods and Data

3.1 Data

3.1.1 SWINNO

The vast majority of micro-based studies on the relationship between public funding and innovation use patents or R&D (Cantner and Kösters, 2012, Howell, 2017, Nast et al., 2024, Pless et al., 2020). However, the relationship between patents and commercialized innovations is complicated by the fact that not all innovations are patented, and not all patents come into economic use. Hence, as noted by Pless et al. (2020) other metrics are needed.

A few earlier studies have investigated smaller selections of major innovations (Block and Keller, 2009, 2015). In this work we source innovation data from the SWINNO database, which captures significant Swedish innovations since 1970 (SWINNO, 2023, Sjöö et al., 2014). For the engineering industry, data is also available from 1908 onwards (Taalbi, 2021). The current database covers 4,853 significant Swedish innovations commercialized between 1970 and 2021 (SWINNO, 2023).

The collection of innovations is based on screening trade journals according to the Literature Based Innovation Output (LBIO) approach (Kleinknecht and Bain, 1993). Trade journals were selected on the basis of having an editorial mission to report about technological and other novelty in their respective field. Together the database covers the manufacturing industry and information and communication technology services. The innovations were included in the database if the trade journal made clear that they are entirely new or significantly improved goods, processes or services that have entered into commercial use (Taalbi, 2021, p. 228). The trade journal articles contain information that allow detailed descriptions of each innovation and key information, including innovating firms, the year of commercialization, collaborating firms and agents and product groups.

To a limited extent, information on public funding access is captured in the trade journals. However, trade journals do not always report such information and it therefore not representative for the actual extent of public innovation funding.[1] For this reason, the systematic collection of public funding data was one of the main tasks faced during the research process.

3.1.2 Public funding data

To build a robust micro-database on public funding of innovations, public funding data is compiled from several Swedish public funding agencies that operated since the 1960s.

It was necessary to combine multiple data sources since the Swedish public funding landscape has undergone frequent restructuring over the study period. Moreover, a comprehensive digitized data set combining information from the majority of Swedish public funding bodies is only available since 2007 in form of the SWECRIS data base (Vetenskapsrådet, 2022a). For previous years multiple data sets need to be combined, and partly digitized.

The first official innovation agency STU (*Styrelsen for teknisk utveckling*) was founded in 1968 and operated until 1991, when it was replaced by Nutek (*Näringsteknikutvecklingsverket*) (Åström et al., 2011). In 2001, Nutek was dissolved and became part of the Swedish Innovation Agency (Vinnova) which is still in operation at the time of writing.

Importantly, responsibilities of the main innovation agency for different sub-sectors shifted multiple times over the study period. An overview over Swedish public funding bodies and their responsibilities can be found in Supplementary Table Overview over Swedish Public funding bodies. For example, responsibility for research activity in the energy sector was coordinated for most of the study period by a specialized government agency. Only with the foundation of NUTEK in 1991 did the main funding organization at the time coordinate research efforts in the energy sector (Åström et al., 2011, Nationalencyklopedin, 2023). However, energy innovation activity was once again transferred to a specialized agency in 1998 and has ever since been controlled by the Swedish Energy Agency (*Energimyndigheten*).

[1] Torregrosa et al. conducted a survey in which 68% of the firms from the Swedish sample reported that they received some public funding, compared to a share of 15% reported in the database (Torregrosa-Hetland et al., 2019).

Table 1: Public funding data

	Time	Observations	Source
Malmfonden	1968-1970	107	Riksarkivet - Manually digitized
STU	1968-1978	4,694	Riksarkivet - Manually digitized
STINS	1979-2001	80,513	Digital Source from Riksarkivet
Energimyndigheten	1998-2008	6,686	Digital Source from Organization
Vinnova	2001-2009	7,426	Digital Source from Organization
VR	2001-2007	10,032	Digital Source from Organization
SWECRIS	2007-2023	58,677	Publicly available database
Total	1968-2023	168,135	

An overview over the different data sources that were combined to form the public funding database can be found in Table 1. The public funding dataset contains in total 168,135 public funding projects from 7 different data sets including both archival and digital sources. Two digitized data sets, STINS and SWECRIS account for over 80% of observations and cover a similar amount of the study period.

STINS is a data system for handling of regional support in Sweden covering the period from 1965 to 2001 (Riksarkivet, 2024). For the period between 1979 until 2001 it even captures public funding projects from the STU, Nutek, and STEV. STINS was discontinued when Nutek was resolved in 2001.

SWECRIS comprises research projects from 10 Swedish public funding agencies since 2008, including Vinnova, Energimyndigheten, Formas, and the Swedish Research council (Vetenskapsrådet, 2022a). It contains information on nearly 60,000 public funding project which received more than 183 billion SEK and is freely available.

Relying on STINS and SWECRIS alone was however insufficient since they do not contain information before 1978 nor between 2001 and 2007. To cover the pre-1978 period, archival data from STU and the Malmfonden from the Riksarkivet has been digitized, adding 4,801 additional observations to the data set.

The remaining gap between 2001 and 2007, was filled by contacting the main public funding agencies operating during this period, Vinnova, Energimyndigheten, and the Swedish Research Council (VR), all of which providing digitized data sets.

3.2 Linking process

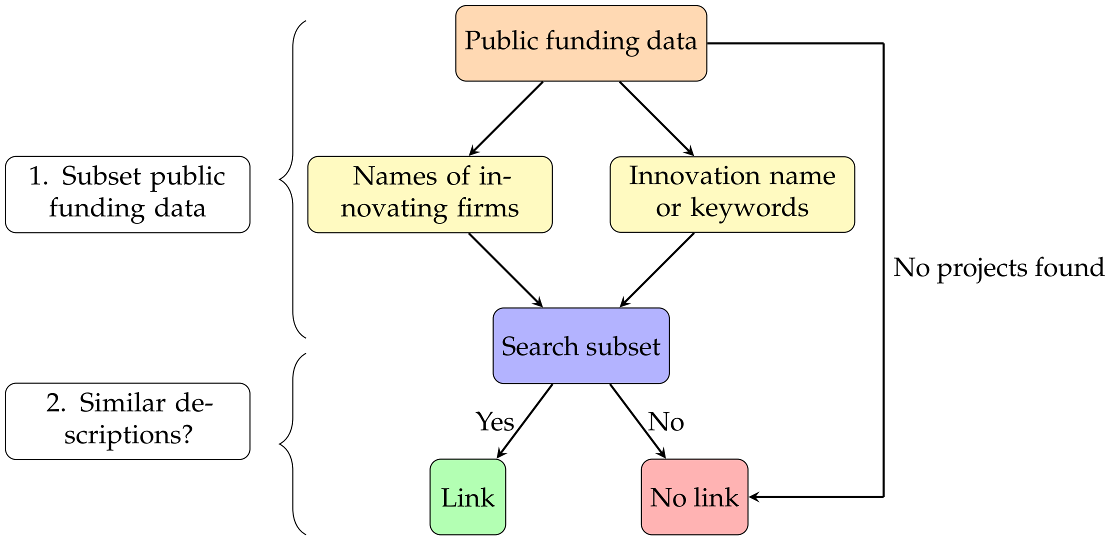
One of the main challenges in this project was the linking of public projects to the innovation data from the SWINNO database. The aim of the linking process is to identify innovations and public funding projects, that based on the descriptions derived from trade journals and the public funding database are deemed to refer to the development of the same product or technology.

Nonetheless, identifying the public funding projects that match the description in SWINNO is challenging due to the sheer size of the public funding database containing nearly 170,000 observations and therefore also potential matches. Moreover, to correctly identify links details in the descriptions in SWINNO and the public funding database must be considered. This is further complicated by the use of both Swedish and English in both databases, making any automatic procedure less likely to identify matches correctly.

To address these challenges, the linking process has been divided into two steps, and any link between SWINNO and the public funding data was manually confirmed.

The linking process is illustrated in 1. In the first

Figure 1: Linking process



step, the public funding data is subsetted to decrease the number of potential matches that need to be manually reviewed. The search is based on innovating firms, innovation names and keywords. If the search is successful the potential matches are manually inspected to identify those projects that best fit the description of the innovation.

Decisions are made for each individual public funding projects. A link is only established if the descriptions of the innovation and the public funding projects are sufficiently similar to one another. Otherwise, the public funding project is dropped from the subset of potential matches. Moreover, matches are non-exclusive, hence, each innovation can be linked to multiple funding projects and each funding project to multiple innovations.

It should be noted that public funding is considered at all stages of the innovation process (Gallagher et al., 2012, Mazzucato and Semieniuk, 2018). This means that public funding is equally considered whether it is provided for the initial research underlying the innovation or for the innovation's commercialization. Hence, all of the results in this paper concern all public funding, regardless of the timing of funding. Considering that the average development time of innovations is 4-5 years from start of development to commercialization (Taalbi, 2017), supporting funding in early development may be challenging (Howell, 2017). However, as illustrated in Figure 4 half of innovations had received public funding two years before commercialization, and 83% of innovations received public funding by the year of commercialization. The remaining 17% only received funding for diffusion and further development after commercialization.

Moreover, the links established between the public funding database and SWINNO can inform data users in two directions. While total public inputs for an innovation can be calculated as the sum of funding for all linked projects, the total innovative output of a research project refers to the number of innovations, opening possibilities for various studies in the future.

Finally, this paper merely focuses on direct financial flows from public financing institutions to innovative firms, in difference to Torregrosa-Hetland et al. (2019) who consider both public funding and collaboration with public actors. Moreover, the analysis does not include innovations by publicly owned firms. Other studies have sometimes also used other definitions, e.g., defining innovations to be publicly funded if the innovating firm relied on funding (Block and Keller, 2009). Our definition achieves better granularity, linkages being established at the level of innovations, but this ignores potential indirect linkages and the potential of projects made possible by access to external funding.

A limitation of this analysis is that the public funding database only contains information from 1968 onwards. For this reason, the matching may omit projects with long development time that received public funding before then. Hence, public funding propensity among innovations developed during the early 1970 are most likely underestimated.

An important question that should be addressed is to what extent the public funding variable in SWINNO and our results from the matching public funding projects to SWINNO are overlapping. This serves both as a quality control of our methodology as well as it highlights the contribution of this study in providing novel information on public innovation funding in Sweden.

Table 2: Comparison of public funding shares based on SWINNO and the public funding data set

	Public Funding Access	
	Yes	No
(1) Swinno	304	4549
(2) Public funding data	1036	3817
(3) Combined	1170	3683

As illustrated in Table 2 Through the inclusion of public funding information from the linking process we create 866 additional public funding links, increasing the share of publicly funded innovations by 18 percentage points.

3.3 Logistic regression model and variable description

To analyze what innovation and firm characteristics correlate with the receiving public funding, we estimated two sets of logistic regressions. The first model specification, presented in equation 1, addresses differences in public funding access between energy and non-energy innovations. All variables included in the model are binary.

$$\begin{aligned} logit(E[PF_{i,t_i}|X_{i,t_i}]) = \beta_0 + \beta_1 E_i + \beta_2 C_i \\ +\beta_4 P_i + \beta_5 S_i + \beta_6 lS + \beta_7 T_i + \beta_8 N_{k(j,t_j)} \\ +\beta_9 PF_{k(j,t_j)} + \tau_{t_i} + \epsilon_i \end{aligned} \tag{1}$$

In a second specification we addressed the direction of public funding for energy innovations, by comparing renewable energy innovations with non-renewable energy innovations.

$$\begin{aligned} logit(E[PF_{i,t_i}|E_i, X_{i,t_i}]) = \beta_0 + \beta_1 R_i + \beta_2 C_i \\ +\beta_4 P_i + \beta_5 S_i + \beta_6 lS + \beta_7 T_i + \beta_8 N_{k(j,t_j)} \\ +\beta_9 PF_{k(j,t_j)} + \tau_{t_i} + \epsilon_i \end{aligned} \tag{2}$$

In the remainder of this section all the regression variables are presented in greater detail.

3.3.1 Public Funding

The outcome variable PF_{i,t_i} takes the value one if the innovation *i* can be directly linked to a public funding project and zero otherwise. Equation 1 estimates the correlation between the public funding propensity of an innovation *i*, based on a number of variables X. t_i refers to *i*'s commercialization year.

3.3.2 Energy innovations

An innovation is considered as an energy innovation E_i if it falls into one or multiple of the subcategories listed in 3. Each energy innovations can fall into several subcategories simultaneously. For example, a novel hybrid electric vehicle would be classified as an innovation related to electricity, fuel, and fossil fuel. Categorization was done manually based on the description obtained from trade journal articles.

Table 3 even presents the number and share of energy innovation categories. Since energy innovation can simultaneously fall into multiple categories neither the numbers nor shares add up to the total of 706 nor 100%, respectively.

Table 3: Number and Share of energy innovations by subcategory

	Number	Share
Distribution	72	11%
Electricity	238	34%
Efficiency	304	43%
Emissions	57	8%
Fuel	245	35%
Heat	223	32%
Storage	45	6%
Biomass	39	6%
Fossil	126	18%
Geo	4	1%
Hydro	12	2%
Nuclear	17	2%
Solar	42	6%
Waste	8	1%
Wind	14	2%
Total	706	100%

Unsurprisingly, there is information on the type of energy use available for all energy innovations, while the energy source is explicitly mentioned only in 252 cases, accounting for 36% of energy innovations. The biggest subgroup of energy innovations, comprising two fifth of all energy innovations are related to the more efficient use of energy. This is followed by innovations related to the use of electricity and fuel which both account for 35% of energy innovations.

Among innovations with explicit information on the energy source, the biggest subgroup are fossil fuel innovations, accounting for nearly half of all innovations with information on the energy source. The number of renewable innovations is with 118 only slightly lower. Solar power is the most popular renewable sources followed by biomass.

3.3.3 Renewable Innovations

In the second model specification merely energy innovations are considered. Therefore, the aim of the second model specification is to estimate the relative public funding propensity of renewable energy innovations. This paper follows the definition by Panwar et al.: *"[r]enewable energy sources are those resources which can be used to produce energy again and again, e.g. solar energy, wind energy, biomass energy, geothermal energy, etc. and are also often called alternative sources of energy. [They] have the potential to provide energy services with zero or almost zero emissions of both air pollutants and greenhouse gases."* (Panwar et al., 2011, p. 1514)

In this paper biomass, geothermal, hydro, solar and wind energy are considered as renewable sources, while fossil, nuclear and waste are classified as non-renewable sources. In total **107** and **151** innovations are classified as renewable and non-renewable, respectively.

3.3.4 Significance

Trade journal information can be used to grade the radicalness of innovations. We prefer to refer to this variable as their “significance”, as trade journals do not strictly report innovations that are radical or disruptive, but significant to the general public, to stakeholders or specialist readerships.

To grade innovations by radicalness or significance according to our trade journal sources we combine information on market novelty, firm novelty and the number of trade journal sources.

Alone, these three indicators capture different types of information on the radicalness or significance according to trade journals, but do not represent a full picture. Combining these indicators we grade innovations as follows.

- *Highly significant innovations* are innovations that were reported at least three times, or were reported twice but were new to the world market or radical from the firm perspective.
- *Significant innovations* are innovations that were reported only once, or were reported twice but were neither new to the world market or radical from the firm perspective.
- *Low significance innovations* are defined as innovations that were reported only once, incremental to the firm, while not reported as new to the world market.

Since these variables are dependent on trade journal sources, we discuss results for major breakthroughs identified through prizes and literature on major Swedish innovations as part of our robustness analysis (see Figure 3).

As a control for size effects for the largest firms, we included a variable for the most innovating firms T_i, indicating the participation of a firm which had developed 20 or more innovations before the launch of the innovation. To avoid truncating the data in 1970 and losing observations, we used historical data available back to 1908 (Taalbi, 2021). Top innovators effectively included the largest corporate groups such as Ericsson, ABB, Volvo, Saab and Scania at the outset.

To understand the impact of the firm's innovation and public funding history we constructed two additional variables: $N_{k(j,t_j)}$ indicates whether at least one of the firm created an innovation in t_j, viz. before the innovation i's commercialization year.

The effect of having received previous public funding is captured by $PF_{k(j,t_j)}$, which takes the value one 1 if the developing firms received public funding in the past.

Time fixed effects τ_{t_i} are included to account for differences in public funding over time.

3.3.5 Patent application before commercialization

Securing intellectual property rights may strengthen the innovations' credibility and viability and hence its likelihood of receiving funding. This is captured in form of P_i which takes the value 1 if an innovation applied for patent prior to its commercialization. Patent information is sourced from Google Patents for 1970-2021 (Johansson et al., 2022, Taalbi, 2022). We count an innovation as having patent applications if there was an application connected to the innovation to any patent offices, including EPO, USPTO, the Swedish Patent Office and e.g., the Japanese Patent Office. The vast majority of innovations were matched manually. For some more complex technologies and large firms with thousands of patents, matches were made through a machine learning procedure, matching keywords from trade journal articles and patent documents. Potential matches from our machine learning method were screened in additional rounds of manual matching. Detailed information about the matching process is available in previous work (Johansson et al., 2022, Taalbi, 2022).

3.3.6 Collaboration

The binary variable C_i indicates whether an innovation has been developed in collaboration with other actors. Information on collaborative innovations is entirely based on SWINNO, viz. collaborations concern reported when they are named in trade journal articles.

Collaboration with national and international partners is crucial for knowledge exchange and idea diffusion among innovative firms (Chaminade et al., 2018, Bommert, 2010) and several studies point to the existence of a positive correlation between collaboration and public funding propensity (Ubfal and Maffioli, 2011, Ebadi and Schiffauerova, 2015).

Moreover, Hottenrott and Lopes-Bento (2014) find that public R&D funding is most effectively translated into innovation outputs by internationally collaborating firms.

3.3.7 Top innovator

A factor that must also be considered is to what extent public funding is targeted towards small, medium or large firms. Some studies have suggested that young and specialized companies are more likely to develop radical innovations compared to older conglomerates (Hottenrott and Lopes-Bento, 2014). Small and medium sized firms have greater financial constraints than large firms, creating R& D underinvestment (Bronzini and Piselli, 2016). Some studies have also suggested that public funding has greater additionality for small firms (Bronzini and Piselli, 2016, Czarnitzki and Delanote, 2015). By contrast, large firms will have ample internal funding and may have low additionality.

The usual approach to measure firm size is to use employee counts, which however is not available in our data. As a rudimentary control for size effects for the largest firms, we included instead a variable for the most innovating firms T_i, indicating the participation of a firm which had developed 20 or more innovations before the launch of the innovation. To avoid truncating the data in 1970 and losing observations, we used historical data available back to 1908 (Taalbi, 2021). Top innovators effectively included the largest corporate groups such as Ericsson, ABB, Volvo, Saab and Scania at the outset.

3.3.8 Past innovation

$N_{k(j,t_j)}$ indicates whether at least one of the firm created an innovation in t_j. It should be noted that t_i is strictly greater than t_j, viz. $t_i > t_j$. The purpose of this is to ensure that $N_{k(j,t_j)}$ only captures innovations that have been developed prior to the innovation*i*'s commercialization year t_i.

3.3.9 Past funding

Indirect effects of public funding are captured by $PF_{k(j,t_j)}$, which takes the value one 1 if the developing firms received public funding in the past. We again prefer a binary variable over a count variable since this variable would be unbalanced for innovations developed in the later phase of the observation period.

3.4 Descriptive statistics

Descriptive statistics for all variables included in the regression are presented in 4. A total of 4,853 innovations were developed over the observation period. Among these, 1,170 innovations, corresponding to 24.1% of the dataset, have been linked to public funding projects, and 706 or 14.5% of total innovations have been identified as energy innovations.

Table 4: Descriptive statistics

Variable	Obs	Mean	Std. Dev.
Public funding	4,853	.241	.428
Energy innovation	4,853	.145	.353
Renewable source	4,853	.022	.147
Collaboration	4,853	.195	.396
Patented	4,853	.120	.325
High significance	4,853	.210	.407
Low significance	4,853	.093	.290
Top innovator	4,853	.156	.362
Past innovation	4,853	.485	.499
Past funding	4,853	.489	.499

4 Results

This section presents the evolution of energy innovation and public funding shares over time as well as the results of the logistic regression analysis.

4.1 Evolution of energy innovation and public funding

As presented in Figure 2a, the number and share of energy innovations has seen two surges, around the mid-1970s and the early 2000s that roughly following movements in oil price. Whereas few energy innovations were developed in the first few years of the period, this changed rapidly after the outbreak of the first oil crisis in 1973 when increasing oil prices created financial incentives for investments in novel energy technologies (Grytten, 2020).

In general, there is a co-movement between the energy innovation share and the oil price (see Supplementary Figure 1). The crude oil price increased threefold between 1973 and peaked at $116 in 1980. Falling oil prices after 1990 could explain reduced interest both from policy makers and companies for energy technologies. Rising resource demand from Asia has driven up once again since the early 2000s (Bértola, 2015). Nonetheless, energy prices alone cannot explain trends in energy innovation funding since neither their share nor public support diminished after the most recent oil price decline in 2014.

Additionally, public innovation policy and climate change mitigation efforts must be considered. The promotion of renewable innovation and energy efficiency is a central part of the Swedish innovation strategy (Regeringskansliet, 2015).

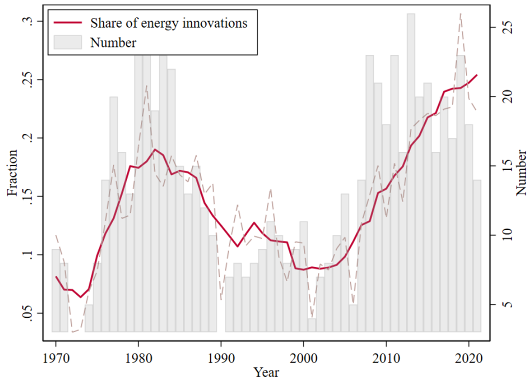
Furthermore, increasing environmental concerns among the population motivate companies to invest into the development of energy technologies to improve their image among potential consumers (Raska and Shaw, 2012).

For most of the period, energy innovations have attracted more public funding than non-energy innovations, as illustrated in Figure 2b. This difference is especially pronounced in the early 1980s and after 2005, when the share of public funding of energy innovations exceeded that of non-energy innovations by approximately 10 percentage points.

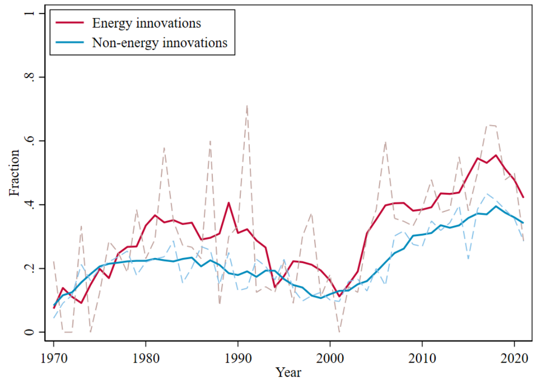
When comparing public funding shares between renewable and non-renewable energy technologies, the directionality of public funding has changed around the year 2000. Figure 2c depicts that prior to 2000 non-renewable innovations constituted the bulk of energy innovations receiving public support. When dis-aggregating this data further for individual renewable sources it becomes apparent that public support was primarily granted to biomass, wind and hydro innovations during this period (see Supplementary Figure 2). However, since the early 2000s, public funding has been strongly channeled towards the development of renewable energy innovations. While 35% of renewable energy innovations developed after 2000 attracted public funding this applied to a mere 10%

Figure 2: Main variables, 1970-2021 (5-year moving average)

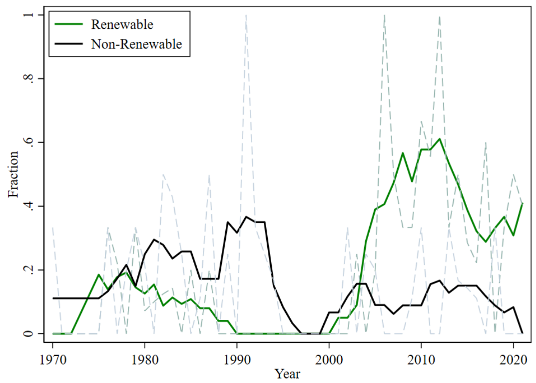
(a) Number and share of energy innovations



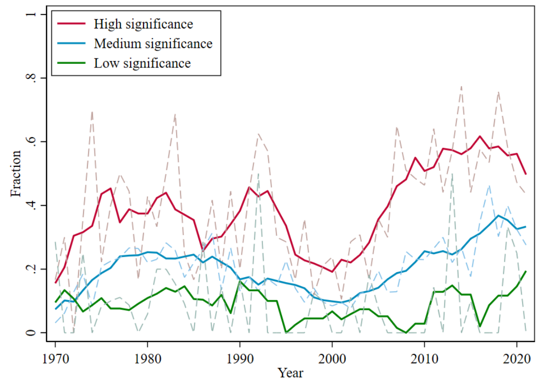
(b) Fraction of publicly funded innovations



(c) Fraction publicly funded by energy source



(d) Fraction publicly funded innovations by significance



of non-renewable innovations. In particular, solar innovations were among the biggest recipients of public funding.

A salient result of our study is that public funding had a strong gradient with respect to the significance, or radicalness, of innovations using trade journal sources. Figure 2d illustrates that public funding is positively correlated with the innovations' degree of significance. Over the period, the share of highly significant innovations relying on public funding was 43% as compared to only 8% of low significance innovations. A remarkably high share of highly significant innovations relied on public funding in the last decade, reaching 55% on average (2010-2021).

Trade journal sources provide an assessment of the significance of innovations around the years of com-

Figure 3: Fraction of publicly funded innovations among highly significant innovations based on trade journal sources and innovations cited ex post as major breakthroughs according to the Polhem prize, academic literature and Wikipedia.

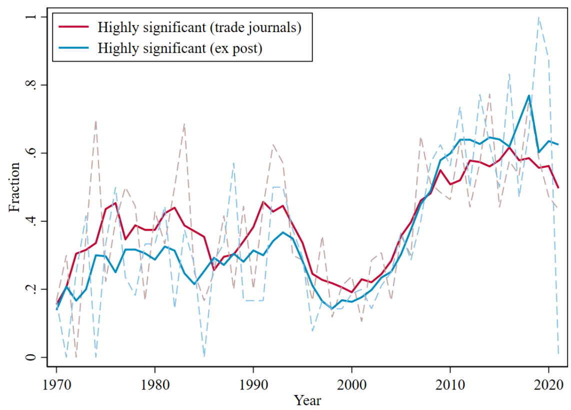
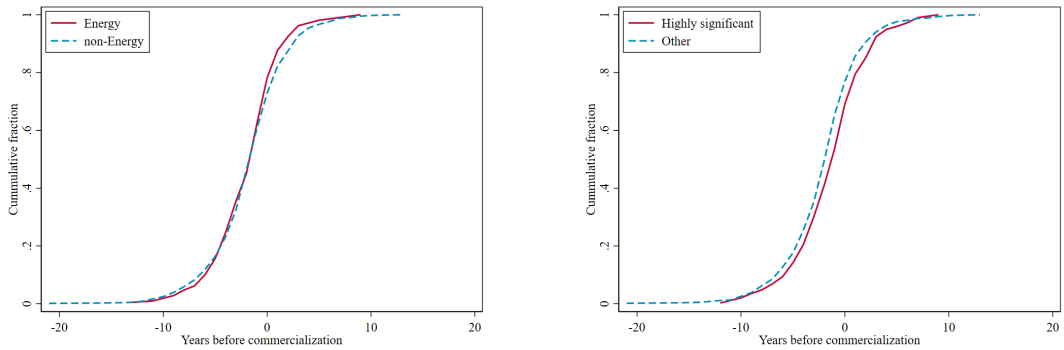


Figure 4: Timing of public funding with respect to year of commercialization, 1970-2021

(a) Energy (b) High significance



mercialization. Figure 3 shows that our results are robust to other definitions of significance, based on independent lists of the *ex post* most radical breakthroughs in Swedish history according to the prestigious Polhem prize, curated lists in academic literature (Wallmark and McQueen, 1991, Sedig and Olson, 2002, Krutmeijer, 2013, Berggren and Krutmeijer, 2023), as well as innovations discussed as major breakthroughs in Wikipedia entries. Regardless of definitions, highly significant innovations had very similar reliance on public funding. This issue is discussed in greater detail in Section 4.3.

A key finding is also that the majority of funding was awarded before the innovations' first commercial product. According to Figure 4, 77% of innovations in general and 69% of the most significant innovations received public support prior to the first product launch, while the corresponding shares for energy and non-energy innovations amount to 78% and 73%, respectively. However, our results also highlight that early-stage funding for developing technologies is relatively rare, the bulk of funding awarded within 3 years before product launch.

4.2 Regression analysis of public funding and innovation characteristics

To further understand the relationship between public funding and characteristics of innovation, we run logistic regressions. The results in Table 5 are presented as odds ratios and separately for all innovations and the energy sector, as well as for the pre- and post-2000 period. The same results as in Table 5 are presented in Figure 5 as marginal effects.

From these results, one may first observe that energy innovations are 1.5 times as likely to receive public funding compared to non-energy innovations. Regarding the direction of innovation, the estimation results indicate a trend shift in the relative public funding propensity between renewable and non-renewable sources around the year 2000 (compare Figure 2c). The correlation between renewable energy innovations and public funding emerges only after 2000, when renewable energy innovations were twice as likely to receive public support compared to non-renewable innovations.

Secondly, our regressions reinforce the existence of a gradient with respect to the significance of innovations. According to the regression results, highly significant innovations are 2.8 times more likely to receive public funding. In the energy sector this estimate goes up to a factor of 5.2. The opposite holds true for innovations with low significance, which are 57% less likely to attract public support. We also observe that this gradient has become somewhat stronger over time. These econometric results are robust for changing our definition of significance to be based on externally validated sources, as discussed in Section 4.3.

The results also reveal other correlations. Innovations developed in collaboration are 1.3 times more likely to receive public support compared to those developed by a single firm. However, this effect is weaker in the post-2000 period and when only energy innovations are considered. The results also suggest that innovations that filed for patent before commercialization were twice as likely to have received public funding, in line with the notion that intellectual property rights may strengthen the innovation's credibility.

Highly innovating firms, "top innovators", were less likely to rely on public funding, in particular during the pre-2000 period. Similarly, innovations developed by firms that had previously participated in the development of another innovation were 53% less likely to receive public funding as first-time innovators. This result is amplified for energy innovations developed before 2000.

Finally, past funding raises the likelihood of receiving public funding under all model specifications. The greatest estimate is reported for energy innovations developed prior to 2000 which are 9 times more likely to receive public support if at least one of the developing firms attracted public funding in the past. This finding points to the possible existence of a "seal of approval" among public funding agencies in Sweden (Wang et al., 2004). Once a company has been deemed promising enough to receive public support, their future innovations are deemed more promising and therefore more likely to attract public interest. However, this result is worrisome since it holds the potential to incentivize rent-seeking behavior among innovating firms.

4.3 Robustness checks

In this subsection we carry out multiple robustness tests for our main regression results in Table 5, specifically concerning our definition of highly significant innovations.

Trade journal sources provide an assessment of the significance or "radicalness" of innovations around the years of commercialization as defined in Logistic regression model and variable description. To address potential concerns about the validity of our indicator, we carry out additional regressions based on alternative measures of significance. Another concern is that trade journals may in theory write articles explicitly to report about news about public funding, which could inflate the correlation between high significance and public funding. For this reason, as a robustness check, we run regressions where we excluded all innovations that were mentioned to have public funding in trade journals.

4.3.1 Data on ex post significance

For our first robustness check we construct an alternative classification of significance or breakthrough innovations. To this end, we assembled information about highly radical breakthrough innovations from three sources. We include recipients of the prestigious Polhem Prize (N=31) awarded annually by the Swedish Association of Graduate Engineers for ingenious solutions of technological problems. We also include major innovations from curated lists in academic independent literature (N=55) (Wallmark and McQueen, 1991, Sedig and

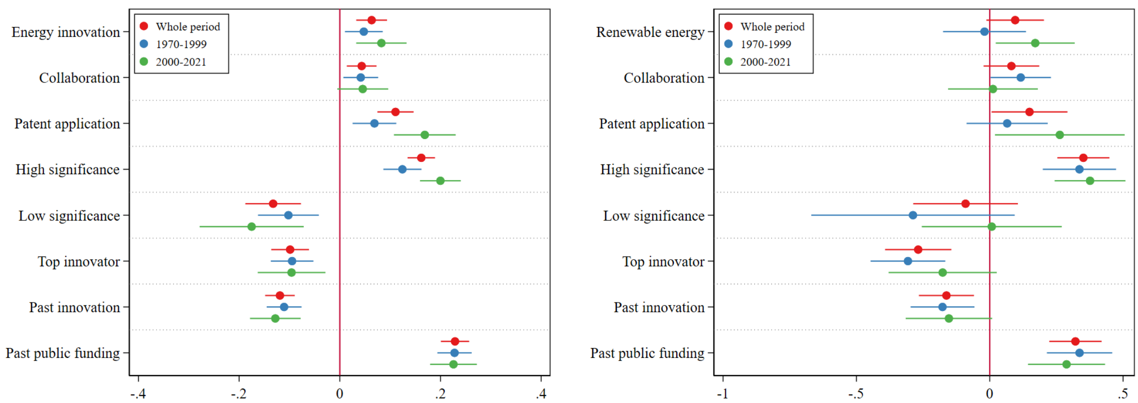
Table 5: Logit regression results. Coefficients are presented as odds ratios. Values above (below) 1 imply a positive (negative) correlation with public funding.

	All innovations			Energy innovations		
	1970-2021	1970-1999	2000-2021	1970-2021	1970-1999	2000-2021
Energy	1.475***	1.424*	1.532**			
	(0.000)	(0.013)	(0.002)			
Renewable				1.508	0.857	1.945*
				(0.120)	(0.762)	(0.036)
Collaboration	1.317**	1.361*	1.282	1.501	2.161*	1.073
	(0.004)	(0.018)	(0.074)	(0.115)	(0.043)	(0.846)
Patent application	2.009***	1.665**	2.476***	2.063*	1.541	2.988*
	(0.000)	(0.002)	(0.000)	(0.039)	(0.392)	(0.035)
High significance	2.755***	2.513***	2.897***	5.240***	9.039***	4.687***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Low significance	0.432***	0.469**	0.388***	0.623	0.110	1.026
	(0.000)	(0.001)	(0.001)	(0.332)	(0.103)	(0.964)
Top innovator	0.537***	0.495***	0.599**	0.270***	0.131***	0.481
	(0.000)	(0.000)	(0.006)	(0.000)	(0.000)	(0.093)
Past innovation	0.473***	0.440***	0.504***	0.480**	0.336**	0.539
	(0.000)	(0.000)	(0.000)	(0.004)	(0.006)	(0.074)
Past funding	4.217***	5.412***	3.339***	4.635***	9.157***	3.307***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Constant	0.060***	0.061***	0.040***	0.295	0.396	0.060**
	(0.000)	(0.000)	(0.000)	(0.150)	(0.294)	(0.002)
Time FE	Yes	Yes	Yes	Yes	Yes	Yes
Observations	4,853	2,681	2,172	706	358	348
R^2	0.159	0.132	0.173	0.234	0.277	0.205

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Figure 5: Marginal effects of binary variables, 1970-2021

(a) All innovations (b) Energy innovations



Olson, 2002, Krutmeijer, 2013, Berggren and Krutmeijer, 2023).

As the main source we also use innovations that were mentioned as notable advances on Wikipedia (N=591). Wikipedia is an online encyclopedia whose content is created, edited and maintained by volunteers. The three core principles behind Wikipedia are verifiability, neutrality and "no original research". In addition, adding pages for companies and corporations is subject to special verifiability rules: no company is considered to have inherent or inherited notability (Wikipedia, 2024). Therefore, although persons closely connected to an idea, innovation, or company could potentially suggest and edit pages, regular edits and monitoring from Wikipedia's community should in principle work as to remove or edit content that is not neutral or cannot be verified to be notable.

Through our searches, we have not detected any references to the SWINNO database that may in theory have influenced the posting of articles on innovations on Wikipedia. None of the authors of this study has edited content about Swedish innovations on Wikipedia. The collection of innovations from Wikipedia was carried out in March and April 2024.

4.3.2 Regressions with alternative significance

The results are presented in Supplementary Table 1 and Supplementary Figure 4. The results support our main conclusions, with similar or higher correlations between high significance and reliance on public funding.

4.3.3 Considering only information from the public funding database

Another possible worry about the construction of significant innovations is that innovations receiving funding could spur further mentions in trade journals, which may drive the correlation. To control for the possibility that the high effect on significance are partially or wholly driven by a reverse effect, we run separate regressions where we exclude all innovations that were reported to have received public funding in at least one trade journal article.

The results are presented in Supplementary Figure 5 and Supplementary Table 2. Again, our main results are corroborated.

5 Discussion

The data presented in this study, linking public funding data to innovation outputs, has allowed a systematic study of long-term trends in innovations and the direction of public innovation funding. Our results reveal that highly significant innovations are consistently most likely to receive public support, being 2.8 times more likely than others to attract public funding. The tendency to fund significant innovations rather than low significance innovations hold up also for major breakthroughs as defined in other sources (see Figure 3 and Supplementary Fig4a). A remarkably high share of the most radical innovations relied on public funding in the last decade, reaching 55% on average in the period 2010-2021. These results support the notion that, contrary to received wisdom, public funding shapes markets, aptly funding more radical projects (Mazzucato and Semieniuk, 2018).

Moreover, the energy sector is indeed targeted by public actors, since energy innovations are 1.5 times more likely to receive public support. However, it should be noted that public support and general interest in energy innovations varied over time and was correlated with economic and financial incentives. This changed only in the 2010s when public support for energy innovations remained high despite falling energy prices. This may reflect an increasing commitment to climate change mitigation efforts among Swedish policy makers and the introduction of Swedish environmental targets that are in line with the Paris agreement and the Mission Innovation incentive (Mazzucato et al., 2015, Mazzucato and Semieniuk, 2018, Mazzucato, 2022, Miljödepartementet, 2019, Regeringskansliet, 2015).

Another important trend is the direction of public funds towards renewable energy technologies since 2000. In the post-2000 period renewable energy innovations were twice as likely to receive public support. Hence, our results suggest that public funding agencies may play a crucial role in climate change mitigation efforts by supporting the development of renewable energy technologies and providing the generally needed support for radical innovation activity in the energy sector.

Nonetheless, the question remains open why policy makers merely show interest for the development of renewable energy innovations during the immediate oil crises and the 2000s. One possible explanation for limited interest in renewable technologies during earlier years is the insecurity around the development of novel energy innovations (Gallagher et al., 2012, Mazzucato et al., 2015). Especially due to the extended development time funding organizations might opt for mature conventional energy technologies which generate marketable outcomes within a few years. This would indicate that public agencies before 2000 displayed high levels of risk adversity in their selection of innovation projects, a characteristic which is typically associated with the private sector.

Moreover, trends in public funding access show great consistency with the study by Torregrosa-Hetland et al. (2019), that has estimated the public funding propensity in SWINNO based on a survey among innovating firms operating in the ICT sector. The discrepancy of public funding access in interviews and in the public funding variable in SWINNO have then been used to estimate the actual public funding propensity of SWINNO innovations.

Their results are compared to the findings from our study in Supplementary Figure 3. The results reveal that despite their estimates being based on an extrapolation rather than on actual data their findings are highly consistent with ours over most of the observation period. Results in both studies are basically identical between 1980 and 1995 and except for the 1970s, our results are consistently within the lower edge of their confidence interval. Supporting the validity of the present estimations as well as of Torregrosa-Hetland et al. (2019).

The present results however also point to challenges. Slightly below 80% of innovations, received public funding before commercialization (4). However, if paired with observations that public funding has greater additionality in early stages (Howell, 2017), our results point to the risk of an early-stage funding gap that requires special attention.

Our results also concern the importance of previous funding access among innovating firms, which might incentivize rent-seeking behavior. Past public funding was a significant predictor of receiving new funding, raising the access to public funding by a factor of 4.2 even when controlling for the effect of previous innovation. These results are not evidence for rent seeking, but recurrent funding may risk promoting such behavior.

We acknowledge that the present study has some limitations. Within this paper we cannot address the issue of additionality, viz. whether public funding of more radical projects actually contributed to bringing radical innovations into fruition. This would require information on innovations where the developing firms applied for but were denied public funding.

Nevertheless, the here-presented data offers possibilities for future research. Possible applications include the analysis of innovation networks and synergies, and whether public funding is crowding out private R&D.

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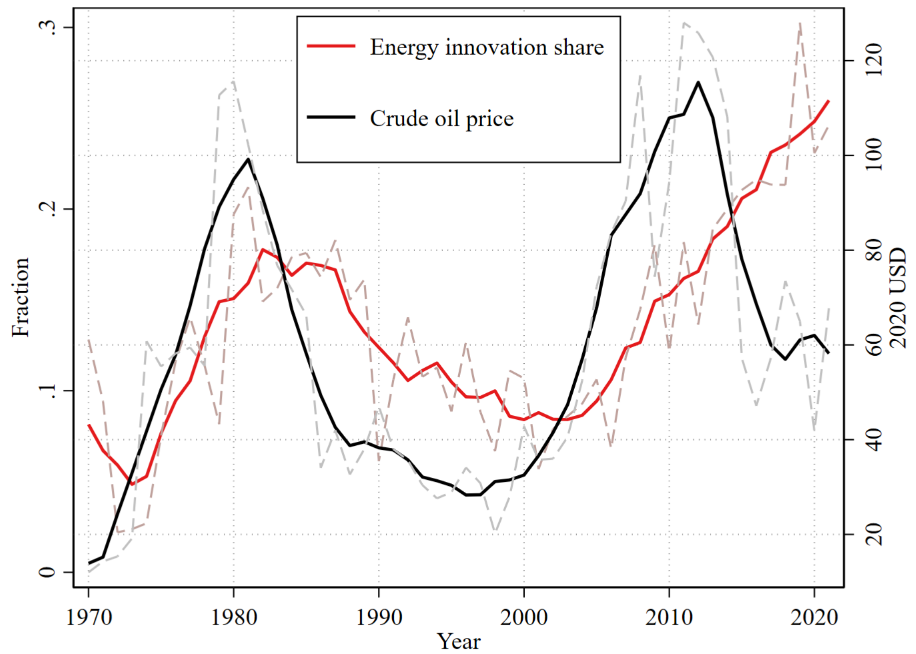
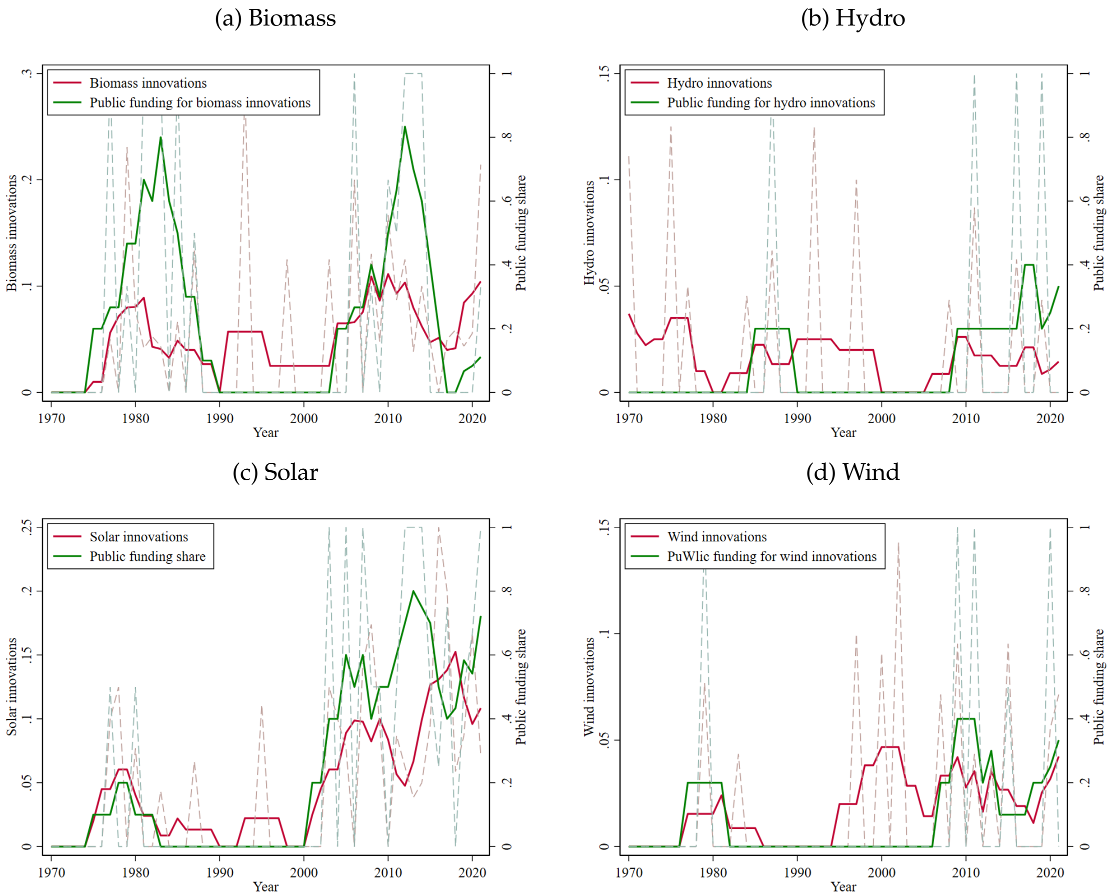
Additional figures and tables

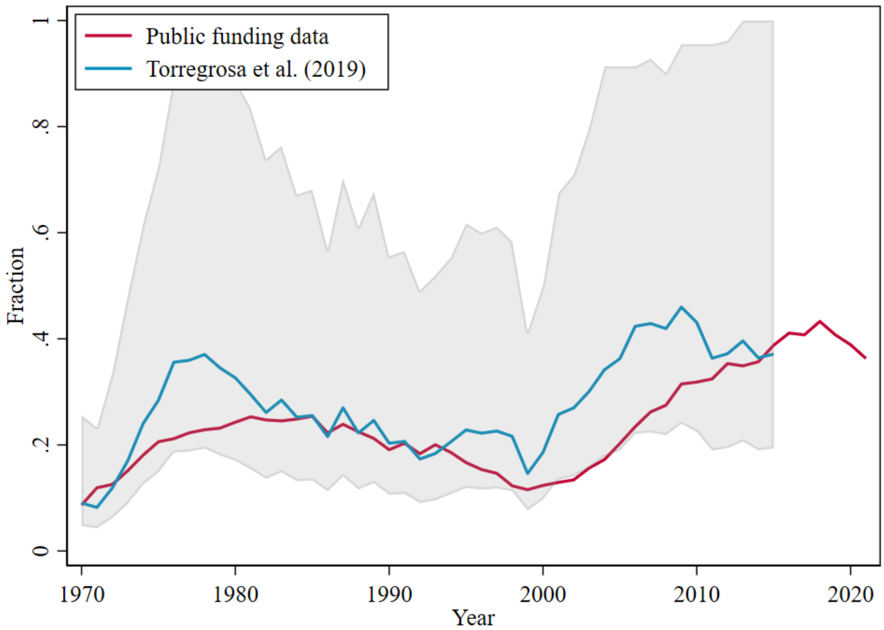
Supplementary Figure 1: Share of energy innovations vs. Crude oil price, 1970-2021



Supplementary Figure 2: Share in total innovations and public funding propensity for energy innovations, 1970-2021



Supplementary Figure 3: Comparison of public funding share across different samples of breakthrough innovations from three sources



Supplementary Table 1: Regressions with alternative definition of significance

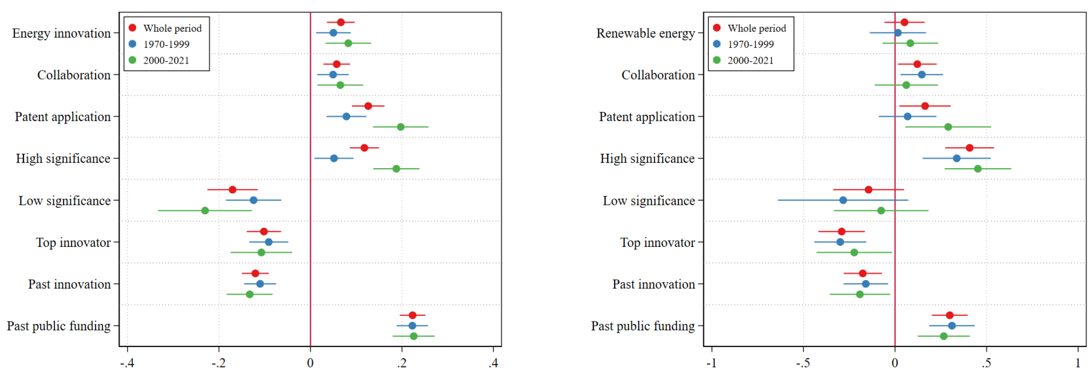
	All innovations			Energy innovations		
	1970-2021	1970-1999	2000-2021	1970-2021	1970-1999	2000-2021
Energy	1.517***	1.444**	1.558**			
	(0.000)	(0.009)	(0.001)			
Renewable				1.280	1.103	1.418
				(0.357)	(0.841)	(0.281)
Collaboration	1.432***	1.436**	1.419*	1.789*	2.486*	1.293
	(0.000)	(0.005)	(0.011)	(0.024)	(0.014)	(0.485)
Patent application	2.204***	1.777***	2.878***	2.187*	1.533	3.372*
	(0.000)	(0.000)	(0.000)	(0.022)	(0.392)	(0.015)
High significance	2.092***	1.457*	2.734***	7.006***	8.121***	6.633***
	(0.000)	(0.019)	(0.000)	(0.000)	(0.000)	(0.000)
Low significance	0.344***	0.403***	0.291***	0.502	0.172	0.728
	(0.000)	(0.000)	(0.000)	(0.145)	(0.131)	(0.566)
Top innovator	0.529***	0.513***	0.563**	0.249***	0.156***	0.394*
	(0.000)	(0.000)	(0.002)	(0.000)	(0.000)	(0.034)
Past innovation	0.470***	0.447***	0.491***	0.431***	0.371*	0.448*
	(0.000)	(0.000)	(0.000)	(0.001)	(0.010)	(0.023)
Past funding	4.046***	5.103***	3.351***	4.167***	6.906***	3.041***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Constant	0.058***	0.063***	0.041***	0.107***	0.099***	0.038***
	(0.000)	(0.000)	(0.000)	(0.001)	(0.001)	(0.000)
Time FE	Yes	Yes	Yes	Yes	Yes	Yes
Observations	4,853	2,681	2,172	706	358	348
R^2	0.147	0.121	0.162	0.149	0.144	0.153

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Supplementary Figure 4: Marginal effects of binary variables - based on externally validated significance, 1970-2021

(a) All innovations

(b) Energy innovations



Supplementary Table 2: Regressions based only on public funding database

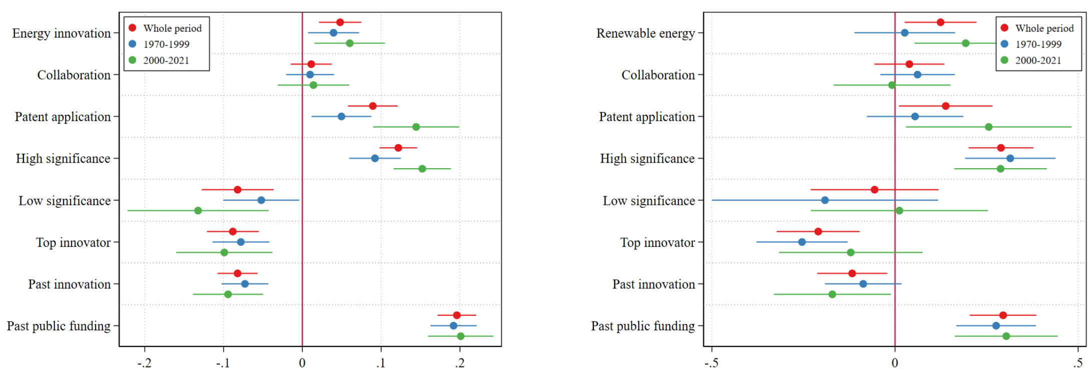
	All innovations			Energy innovations		
	1970-2021	1970-1999	2000-2021	1970-2021	1970-1999	2000-2021
Energy	1.469***	1.465*	1.492**			
	(0.000)	(0.017)	(0.008)			
Renewable				2.060*	1.241	2.559**
				(0.013)	(0.704)	(0.007)
Collaboration	1.095	1.099	1.098	1.255	1.647	0.961
	(0.396)	(0.527)	(0.542)	(0.423)	(0.237)	(0.920)
Patent application	2.050***	1.613*	2.612***	2.237*	1.558	3.478*
	(0.000)	(0.010)	(0.000)	(0.034)	(0.415)	(0.027)
High significance	2.657***	2.433***	2.752***	5.374***	12.846***	4.070***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Low significance	0.517***	0.605*	0.415**	0.723	0.212	1.060
	(0.000)	(0.035)	(0.004)	(0.532)	(0.241)	(0.923)
Top innovator	0.493***	0.471***	0.518**	0.295***	0.128***	0.555
	(0.000)	(0.000)	(0.001)	(0.000)	(0.000)	(0.226)
Past innovation	0.517***	0.496***	0.534***	0.507*	0.495	0.434*
	(0.000)	(0.000)	(0.000)	(0.017)	(0.102)	(0.037)
Past funding	4.820***	6.361***	3.806***	5.560***	9.382***	4.391***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Constant	0.059***	0.059***	0.028***	0.082***	0.069***	0.019***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.001)	(0.001)
Time FE	Yes	Yes	Yes	Yes	Yes	Yes
Observations	4,549	2,540	2,009	627	319	308
R^2	0.129	0.158	0.134	0.170	0.287	0.213

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Supplementary Figure 5: Marginal effects of binary variables - based on public funding database only, 1970-2021

(a) All innovations

(b) Energy innovations



Supplementary Table 3: Overview over Swedish Public funding bodies

Swedish name	Acronym	Start	End	Information	Source
Hjärt-lungfonden		1904		Founded as Swedish National Anti-tuberculosis association. Today general research in the field of cardiovascular diseases	Hjärt-Lungfonden (2023)
Statens kommitté för byggnadsforskning		1942	1953	Building sector	Riksarkivet (2024)
Statens tekniska forskningsråd		1942	1968	Technichal research finance, no support for applied research	Riksarkivet (2024)
Statens Geotekniska Institut	SIG	1944		Promote geotechnical research in Sweden. Its research is of special importance for the construction sector.	SGI (2023)
Medicinska forskningsrådet	MFR	1945	2000	General and militaric medical research	Riksarkivet (2024)
Skogs- och jordbruksforskningsrådet	SJFR	1945	2000	Research in agriculture and forestry	Riksarkivet (2024), Nationalencyklopedin (2023)
Statens naturvetenskapliga forskningsråd		1946	1976	Support scientific publications	Riksarkivet (2024)
Statens råd för samhällsforskning		1947	1976	Social science research	Riksarkivet (2024)
Svensk uppfinnarkontoret		1947	1968	General support for inventors, check inventions, informations on patenting	Riksarkivet (2024)
Statens råd för atomforskning		1950	1976	Nuclear research	Riksarkivet (2024)
1953 års fond		1953	1964	Support of poor students at Lund and Malmö univeristy	Riksarkivet (2024)

Statens nämnd för byggnadsforskning		1953	1960	Building sector	Riksarkivet (2024)
Statens humanistisk forskningsråd		1959	1976	Humanistic research	Riksarkivet (2024)
Byggforskningsrådet	BFR	1960	2000	Promote reasearch in community planning and the building sector	Byggforskningsrådet (2016), Riksarkivet (2024)
Ragnars Södergbergs Stiftelse		1960		Early career support for scientists in economics, medicine, and law	Ragnar Södergbergs Stiftelse (2023)
Malmfonden		1961	1971	Support research and development in the scientific and technical sector with industrial connections; Projects were transfered to the STU after its establishment in 1968	Riksarkivet (2024)
Stiftelsen för exploatering av forskningsresultat	Efor	1963	1968	Mediation of research results	Riksarkivet (2024)
Institutet för nyttiggörande av forskningsresultat	INFOR	1964	1968	Further development of research findings and inventions for industrial use	Riksarkivet (2024)
Stiftelsen Riksbankens Jubileumsfond	RJ	1964		Promotion and support of humanistic and social science research; Increasing focus on supporting of long term projects and international collaborations	Rikbankens Jubileumsfond (2017)
Forskningsbiblioteksrådet	FBR	1965	1979	Provide information for research and development	Riksarkivet (2024), Nationalencyklopedin (2023)

Kungliga biblioteket		1968		Preservation and digitization of information in written, audio, and virtual form; Partially responsible for DFIs operations since 1988	Nationalencyklopedin (2023)
Statens råd för vetenskaplig information och dokumentation	SINFDOK	1968	1979	Provide information for research and development	Nationalencyklopedin (2023), Riksarkivet (2024)
Styrelsen för Teknisk Utveckling	STU	1968	1991	Promotion of collaboration between academia and industries; focus on "economic areas of special interest", new focus on applied research	Perez Vico and Hallonsten (2019), Åström et al. (2011)
Värmeforsk		1968	2015	Finance and direct research in the fields of combustion, heat and environmental technology	Nationalencyklopedin (2023)
Fond för skeppsteknisk forskning		1970	1978	Marine technology	Riksarkivet (2024)
Delegation for rymdverksamheten	SBSA	1972	1992	Space research and space applications	Wormbs and Källstrand (2007)
Statens Industriverket	SIND	1973	1991	Promote industrial development and finance regionalpolitical development	Nationalencyklopedin (2023)
Biblioteks- och dokumentationssamverkanskommittén	BIDOK	1975	1979	Provide information for research and development	Riksarkivet (2024), Nationalencyklopedin (2023)

Humanistisk-samhällsvetenskapliga forskningsrådet	HSFR	1976	2000	Promote and initiate research in social science, humanities, law, and religious studies	Nationalencyklopedin (2023), Vetenskapsrådet (2022b)
Naturvetenskapliga forskningsrådet	NFR	1976	2000	Natural science and mathematic basic research	Nationalencyklopedin (2023), Vetenskapsrådet (2022b)
Forskningsrådsnämnden	FRN	1977	2001	Support research and information on research; promote collaboration between research institutions	Nationalencyklopedin (2023)
Delegationen för vetenskaplig och teknisk informationsförsörjning	DFI	1979	1988	Provide information for research and development	Riksarkivet (2024), Nationalencyklopedin (2023)
Energiforskningsnämnden	EFN	1982	1990	Long-term energy related research; function taken over by Statens energiverk in 1990	Nationalencyklopedin (2023)
Statens Energiverket	STEV	1983	1991	Administration of Swedish energy policy	Nationalencyklopedin (2023)
Svenskt Gastekniskt Center	SGC	1990	2015	Promote research on renewable gas from decomposition and gasification	SGC (2023)
Teknikvetenskapliga forskningsrådet	TFR	1990	2000	Technologic base research and research training; preference for projects promoting international collaboration	Riksarkivet (2024)

Närings- och teknikutveck-lingsverket	NUTEK	1991	2000	Fusion of STU, Industriver-ket, and Statensenergiverket; ontribute to long-term devel-opment of the industrial and energy secotr	Perez Vico and Hal-lonsten (2019), Åström et al. (2011), Rik-sarkivet (2024)
Rymdstyrelsen	SNSB	1992		Space research and space ap-plications	Wormbs and Käll-strand (2007)
Elforsk		1993	2015	Research and development company of Swedish electri-cal companies	Energiforsk (2023)
Östersjöstiftelsen		1994		Development in Eastern Eu-rope and the Baltic region	Östersjöstiftelsen (2023)
Institutet för arbetsmarknads- och utbild-ningspolitisk utvärdering	IFAU	1997		Research on labor market and education policy, annual bud-get of 6 million SEK	IFAU (2023)
Energimyndigheten		1998		Promote transitions towards a sustainable energy system, research in fuel, renewable energy sources, green technol-ogy and international climate collaboration	Energimyndigheten (2023)
Forskningsrådet för hälsa, arbetsliv och välfärd	FORTE	2000		Research on health, worklife and welfare, annual budget of 800 million SEK	FORTE (2023)

Vetenskapsrådet	VR	2000		Largest governmental research funding body in Sweden with a budget of almost 8 billion, promotion of research in all scientific areas	Vetenskapsrådet (2022b), Sveriges Riksdag (2000), Nationalencyklopedin (2023)
Sveriges innovationsmyndighet	Vinnova	2001		Promotion of sustainable development through the provision of innovation finance	VINNOVA (2022), Sveriges Riksdag (2009)
Fjärrsyn		2006	2015	Research on district heating	Energiforsk (2023)
Statligt forskningsråd för hållbar utveckling	FORMAS	2009		Research and innovation funding in environmental, agricultural science, spatial planning; Aiding Sweden in its effort to achieve the environmental targets	FORMAS (2023), Regeringskansliet (2009)
Energiforsk		2015		Coordination and promotion of energy research	Energiforsk (2023)

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