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Which start-ups win public procurement tenders?

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DISCUSSION PAPER

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// BASTIAN KRIEGER, LENA FÜNER,
AND MALTE PRÜFER

Which Start-Ups Win Public Procurement Tenders?

Which start-ups win public procurement tenders?

Bastian Krieger^a, Lena Füner^b, and Malte Prüfer^c

This version: November 2024

Abstract

We explore which start-ups win in public procurement. Most notably, our analysis presents significant differences between firms applying for tenders with and without functional criteria. First, we use representative telephone survey data to estimate public procurement applicant and winner shares for the population of German start-ups. We find in total eleven percent of start-up firms applied for public tenders since their foundation, and 65 percent of them won at least one tender. Additionally, younger and more innovative firms tend to apply for and win tenders with functional criteria, while older and less innovative firms tend to apply for and win tenders without functional criteria. Second, we employ non-linear estimation methods to identify firm and founder characteristics predicting to win public tenders within the group of applicants. Start-ups applying for functional tenders profit from smaller foundation teams, younger founders, more industry experience, and higher innovation capacities, while start-ups applying for tenders without functional criteria, profit from larger foundation teams, older founders, more industry experience, and the absence of founding experience.

Keywords Public procurement – Start-up firms – Innovation

JEL-Code H57 – L26 – O38

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1. Introduction

Public procurement has the potential to foster innovation, entrepreneurship, and growth (Zabala-Iturriagagiotia, 2022). It has gained increasing attention as a demand-side innovation policy during the last decades (e.g., Czarnitzki et al., 2020; Edler and Georghiou, 2007) and accounted for around 16 percent of the European Union's gross domestic product in 2017 (Becker et al., 2019). Moreover, it has the potential to promote start-ups through three different channels: i) Publishing public procurement tenders informs potential founders and start-ups about existing market opportunities (Edler and Georghiou, 2007), ii) winning public procurement tenders provides start-up firms with an initial level of demand and allows early economies of scale (Hvide and Meling, 2023), and iii) winning public procurement tenders provides a quality certification to further potential customers of start-up firms (Dai et al., 2021).

As a result, the role of public procurement for start-up firms has garnered increasing scientific (e.g., Bentancor, 2019; De Coninck et al., 2018; Dai et al., 2021; Pickernell et al., 2013; Preuss, 2011; Talebi et al., 2022a/b; Zabala-Iturriagagiotia, 2022) and political attention (European Commission, 2023; Kister and Theurer, 2022). For instance, the German Federal Ministry for Economic Affairs and Climate Action recently released a draft of its procurement transformation package, which prioritizes support for start-ups (BMWK, 2024). Despite this growing interest, quantitative empirical evidence on the significance of public procurement for start-ups remains limited, primarily to the studies by Hvide and Meling (2023) and Dai et al. (2021). Hvide and Meling (2023) investigate the tenders of Public Roads, a Norwegian government agency responsible for building and maintaining the country's road infrastructure. They find that start-up firms benefit from winning public tenders in terms of increased employment, sales, and profits both in the short and long term. In contrast, Dai et al. (2021) analyze the demand and certification effects of public procurement for young versus established firms in China, revealing that both effects are significant, with the certification effect being more pronounced for younger firms.

The literature considering the relevance of public procurement for small and medium-sized enterprises (SMEs), and its effects on them has recently grown significantly, too. First, Stake (2017), Hoekman and Taş (2020), and Nemec (2024) investigated the participation of SMEs in European public tenders, finding that policies fostering SME participation in public procurement are successful. Also, Tukamuhabwa and Namagembe (2023) examined the relevance of different firm strategies for the participation of women-owned SMEs in public procurement. Then, Schäfer et al. (2023), and Kinyua et al (2024) analyzed the effects of public procurement and find winning public tenders decreases SMEs' financial obstacles.

The literature on public procurement as innovation policy and the innovation activities of firms is more mature (e.g., for reviews, see Appelt and Galindo-Rueda, 2016; Mowery and Rosenberg, 1979; Obwegeser and Müller, 2018). In recent years, it focused on the impact of innovative public procurement (e.g., Czarnitzki et al., 2020; Stojčić et al., 2020; Guerzoni and Raiteri, 2015; Ghisetti, 2017; Caravella and Crespi, 2020), which is particularly relevant for start-up firms as they are in many cases founded for the introduction of innovative products, services, or business models. In contrast to regular public procurement, which only considers the price of an existing tendered product or service as a selection criterion, innovative public procurement requires innovative solutions and not yet developed technologies as part of its tenders. In summary, the literature finds a positive effect of innovative public procurement on the innovation activities of firms, whereas the significance and effect size depends on the used identification strategy and sample.

Our study contributes to the described literature streams about public procurement, start-ups, SMEs and innovation in three ways:

We provide first evidence on the aggregate relevance of public procurement tenders for start-up firms. Whereas Hvide and Meling (2023) and Dai et al. (2021) analyzed the effects of public procurement on start-up firms, they did not demonstrate its aggregate relevance. Thus, we largely follow Stake (2017), Hoekman and Taş (2020), and Nemec (2024), whereas we do not concentrate on the participation of SMEs in public procurement, but start-ups firms. More precisely, we utilize representative telephone survey data for German start-ups to learn about the share of start-ups participating and winning in public procurement. The analysis combines the survey responses of 5,060 start-up firms with population weights stratified according to firms' foundation years and industries. Most importantly, we find eleven percent of start-ups in Germany applied for a public procurement tenders since their foundation, whereas 65 percent of them won at least one tender. However, the participation and success of start-up firms in public procurement significantly differs with regard to the type of procurement, as well as the industry, and age of a firm.

Second, we are the first to explore the relevance of a large number of start-up firm and founder characteristics for winning different kinds of public procurement tenders by comparing applying start-up firms within cross-sectional probit estimations. The predictors of winning public tenders for start-up firms were not investigated at this point. Moreover, similar large-scale studies for non-start-up firms had no information on non-winning applicants (e.g., Blind et al., 2020). Thus, their results have a remaining risks of being driven by structural differences between firms applying for, and firms not applying for public procurement tenders. Our results indicate that the determinants of winning public

procurement differ significantly between firms applying for tenders with and without functional criteria. Most notably, we observe several founder characteristics demonstrating an opposing relationship depending on the type of applicant.

Third, we examine if start-up firms strategically introduced market novelties before winning public procurement tenders to increase their chances of winning them. Thus, we investigate the mechanisms of public procurement in more detail than previous studies on the innovation effects of public procurement. Previous studies focused on award winning-firms. They did not consider the difference between introducing innovation to win or as a result of winning a tender. As a consequence, they did not consider the possibility of public procurement tenders triggering innovations in non-winning firms (e.g.; Czarnitzki et al., 2020; Stojčić et al., 2020). We find introducing market novelties targeted at increasing the chances to win a public tenders are commonly used: 40 percent of start-up firms applying for functional tenders, and 16 percent of start-up firms applying for product tenders implemented them. Moreover, they are statistically significantly associated with a higher probability to win public tenders with and without additional criteria. Thus, previously estimated effects of public procurement on firm innovations are likely to be underestimated.

2. Economic framework

A substantial body of literature analyzes which determinants make some start-ups successful and others not (e.g. Reid and Smith, 2000; Cressy, 2006; Santarelli and Vivarelli, 2007; Hyytinen et al., 2017). In this section, we theoretically examine determinants which make start-ups participating and winning in public procurement. Further, we describe mechanisms through which a public procurement contract can promote start-ups. While some of these channels can also apply for more mature firms, we focus on those channels which we expect to be particularly relevant specifically for start-ups. Additionally, we distinguish between two different forms of public procurement - product and functional procurement - and investigate different incentives for start-ups to participate in both forms of procurement.

Public procurement provides an initial demand to start-ups

Demand is a major driver for new businesses and start-up success (Hvide and Meling, 2023). However, start-ups in their initial starting face usually face no or only little demand due to informational, reputational or other frictions (Foster et al., 2016). This hampers them from building up production capacities and from establishing efficient supply-chains and logistical networks (Freeman et al., 1983). Thus, production processes of start-ups can induce high marginal costs, making the start-up less competitive in comparison to older, established firms (Gimenez-Fernandez et al., 2020).

Winning a public procurement contract changes this situation for the start-up: With the public sector as a customer, the start-up can predict and quantify the demand. It faces a guaranteed minimum market-size and thus, risks for the enterprise to invest in a market are mitigated (Edler and Georghiou, 2007; Dai et al., 2021). Accordingly, start-ups can build up and align its production capabilities (Edler and Georghiou, 2007). In addition, the public sector as a customer typically demands a big quantity of a product or a service. Start-ups crucially depend on achieving a critical mass in their development, based on which they can grow without depending on additional investments and a public procurement contract can help achieving this critical size early-on (Fonseca et al., 2021). Furthermore, the size of the procurement contract allows start-ups to realize early economies of scale, for example by negotiating discounts with suppliers (Edler and Georghiou, 2007). In addition, the public sector is not only a big, but also a reliable customer and thus the expressed demand is relatively certain. A major barrier for start-ups to be successful is that they face a low number of customers, and thus the risk of a customer falling out due to bankruptcy or other unforeseen circumstances is little diversified. In contrast, with the public sector as a customer, the drop-out risk is little and thus gives long-term planning certainty to the start-up. Taking these factors together, a public procurement contract induces a big and certain demand to the start up, and thus can realize substantial efficiency gains, lowering marginal costs and increasing profitability.

Public procurement signals reliability and quality to investors and private customers

Investing into production and technological capacities requires access to financial resources. However, start-ups suffer from financial constraints and lack access to capital markets and external financial means (e.g. Stucki, 2014; Ferrucci and Guida, 2020). This is due to information asymmetries between the start-up and potential investors: The investor can only oversee the start-up's performance and potential to a limited extent, and therefore might be hesitant to invest its money to the start-up, as it has not sufficiently proven its long-term profitability and success. Instead, it has to rely on own internal resources (e.g. Holmstrom, 1989; Amit et al., 1998; Czarnitzki and Hottenrott, 2007). Especially for start-ups availability of internal financial means is usually limited or even non-existent.

Again, winning a public procurement contract changes this situation for the start-up, as the public procurement can be perceived as a signal of the start-up about its reliability, quality and prospects to external investors. Firms which win a public procurement contract go through a careful screening process, in which the public procurer evaluates the start-up and ensures it fulfils certain standards and requirements (Dai et al., 2021). Thus, start-ups relax their financial constraints by winning public procurement contracts, easing their access to external financial resources. In addition, winning a public procurement contract is not only a signal towards external investors, but also towards other private customers. Private customers might be hesitant to adapt the potentially new product or technology of

the start-up as it has not been proven yet on the market. The government as a public procurer can close this gap by acting as a lead-user of the start-up's product, potentially bearing the costs of learning and improving the product (Edler and Georghiou, 2007; Dai et al, 2021; Zabala-Iturragoitia, 2022). The public procurement contract increases the start-ups visibility in a market, signals functionality and awareness, increases the start up's credibility and therefore lowers the adaption costs of private customers for the product (Edler and Georghiou, 2007; Dai et al., 2021).

Public procurement reduces information asymmetries between demand and supply

Furthermore, public procurement tenders can mediate between both market sides: Start-ups often lack awareness of what the actual market needs are and which products and solutions are demanded by market actors. Simultaneously, procurers do not know which products are available on the market and which potential solutions start-ups could be able to provide. Public procurement tenders mitigate this information asymmetry between supplier and purchaser and provide a platform for both market sides to communicate about needs and solutions (Edler and Georghiou, 2007). This does not only benefit winning firms, but also non-winning firms which get an idea of what potential issues and challenges the market is facing, which technologies and solutions the market is searching for and what potential market opportunities are. This allows start-ups to redirect their inventive efforts closer to actual market needs.

Barriers for start-ups to participate in public procurement

Despite strong incentives for start-ups to participate in public procurement, they also face significant barriers to do so. From the start-up's perspective, the public procurement procedure is a highly bureaucratic process (Decarolis et al., 2020). Thus, start-ups have to commit dedicated human and financial resources to steer through this bureaucratic process (Talebi et al., 2022b; Loader, 2015), which due to their limited resources and experience with administrative processes imposes high entry costs and makes them less competitive in comparison to more established firms (Talebi et al., 2022a; Nemec, 2024).

From the procurer's perspective, start-ups are more agile and flexible compared to established firms, and they have more up to date skills and technological know-how (e.g.; Ouimet and Zarutskie, 2014; Dorner, et al., 2017; Talebi et al., 2022a). Also, start-ups provide an opportunity to local governments to support their local economic development (Talebi et al., 2022a). However, public procurers are risk-averse and less willing to choose innovative products in comparison to established solutions (Georghiou et al., 2014). Products and technologies from start-ups are usually not proven on the market yet, and thus public procurers face a higher risk of purchasing an inferior solution compared to an established solution from a more mature firm. In addition to these barriers for both parties, public

procurers and start-ups, there are also cultural differences between both sides, for instance due to asymmetries in terms of power, structure and organizational size or with respect to the norms, habits and mindsets (Laursen and Salter, 2006; Baum Calabrese and Silverman, 2000; Talebi et al, 2022a). Taking these factors together, participating in public procurement is not trivial for start-ups and depends on various factors and circumstances.

Functional vs. product procurement

Public procurement contracts consist of multiple components and thus each public procurement contract is different and can individually affect a start-up's decision to participate or not to participate in a public procurement contract. We follow Edquist and Zabala-Ittariguigotta (2020) and differentiate between functional procurement - procurement contracts which formulate functional requirements, i.e. problems to be solved or functions/needs to be fulfilled in the procurement description - and product procurement - procurement contracts which describe the specific product to be bought. Both forms of procurement contracts are prevalent in the European economy and both impose different incentives to start-ups to participate and win in either functional or product procurement. We describe these incentives from a theoretical point of view in the following.

In product procurement, procuring agencies purchase a pre-defined product from the supplier with the lowest bid. Thus, participating firms only compete with respect to the price. More established firms are usually bigger than start-ups, have established logistical networks and supply chains, higher production capacities and more experience. In contrast, young start-ups first have to build up the corresponding infrastructure and capabilities to produce the product and continuously refine their methods by learning-by-doing. Thus, older and more established firms can exploit more economies of scale and scope, carry lower production costs and thus are more likely to be able to supply the product for a lower price to the procuring agency than a start-up. This, in turn, disincentivizes start-ups to participate in product procurement contracts.

In functional procurement also other criteria beyond the price are considered, and suppliers can offer their individual solution to a certain problem. Thus, public procurers do not simply pick the supplier of the cheapest, but the supplier of the solution which best meets the functional requirements of the procurement contract. This opens up opportunities for start-ups to propose and implement their innovative ideas and products and therefore incentivizes participation of start-ups in functional procurement. However, while functional procurement contracts are more accessible for technologically-advanced start-ups with innovative ideas, functional procurement also comes up with additional administrative and technical requirements. This makes functional procurement contracts more complex than product procurement contracts. In product procurement contracts, suppliers know

exactly which product to offer to the procurer. In functional procurement, however, firms face uncertainty if their proposed solution actually fits the need of the procurement contract, if it can be provided in a sufficient quantity for the big demand of the procurer and if the proposed solution is technologically reliable and sufficiently proven in the market and/or comparable market situations. Thus, start-ups have a disadvantage in comparison to established firms, as the latter might have already proven the functionality of their products in other private or public procurement processes. Taking the aforementioned risk-aversity of public procurers into account, this might discourage start-ups to propose their innovative, but not yet fully market-proven solution to a functional procurement contract and thus disincentivizes their participation in a functional procurement contract. Thus, the incentives for start-ups to participate in functional procurement are ambiguous.

3. Database

For our empirical analysis, we use the IAB/ZEW Start-Up Panel. The IAB/ZEW Start-Up Panel is a representative yearly telephone survey providing information on business start-ups in Germany since 2007. The data serve as a suitable basis for describing and analyzing the structure and development of start-up firms. Covering 5,000 to 6,000 start-up firms in its telephone survey on administrative, financial, innovation, and founder characteristics, the panel is unique in its sample size and topic range. Our analysis builds on its wave of 2022, which covered additional questions focused on public procurement designed by us. The database is described in more detail in Fryges et al. (2010).

All additional questions on public procurement translated from German into English are listed in Appendix A. Table 1 shows the translated public procurement questions utilized for this paper. The public procurement questions were tested by three external scientific partners, whereas all partners are experts within the field of innovative public procurement based on their publication record. Furthermore, within the selection of the 2022 special questions of the IAB/ZEW Start-Up Panel, all public procurement questions were discussed by the IAB/ZEW Start-Up Panel organization board. As the telephone survey space is limited, the selection is highly competitive and special topics necessarily need i) to meet a high quality standard, and ii) have to be of high scientific and political interest.

The IAB/ZEW Start-Up Panel's public procurement questions significantly differ from existing studies using survey data on firms' participation in public procurement:

First, in contrast to our Question (A), none of the previous studies using survey data covered firms' application for public procurement tenders. Therefore, we are able to compare winning firms to non-winning firms within the group of appliers. As a result, our findings to identify the predictors of winning public procurement tenders are unlikely to result from pre-existing differences between appliers and non-appliers. On top of that, we are able to examine the relevance of public procurement

for start-up firms in more detail in our population descriptive statistics, as applying for public procurement poses a relevance for non-winning start-ups due to their investments in preparing their tender applications, too.

Second, existing studies on the impact of innovative public procurement on firms' innovation activities define their variables of interest, "winning innovative public procurement," typically based on the firm's viewpoint (e.g., Czarnitzki et al., 2020; Stojčić et al., 2020). The Community Innovation Survey in 2013 asks, for example, "Did your enterprise undertake any innovation activities as part of a public procurement contract?" in combination with the three answers i) "Yes, innovation activities were required as part of the contract," ii) "Yes, but innovation activities were not explicitly required by the contract," and iii) "No." Thus, the question does not identify if the public procurement contract required innovative solutions but if the firm was required to engage in innovation activities. However, this required engagement in innovation activities by the firm can also be triggered by a description of an already existing product or service in the tender, which is not yet within the portfolio of the firm. Thus, it is necessary to consider the existence of additional requirements within public procurement tenders to accurately evaluate the effect of innovative public procurement. However, even if the exact requirements of a public procurement contract are known, the clear identification of innovative public procurement is difficult, as it would require knowledge about the entire existing market supply of products and services related to the tender. Thus, identifying public procurement tenders with the potential to be innovative based on their tender requirements, as described in the conceptual paper by Edquist and Zabala-Iturriagiotia (2020), is the best alternative.

Edquist and Zabala-Iturriagiotia (2020) distinguish between two kinds of public procurement within the current framework of the EU procurement directives: i) product procurement and ii) functional procurement. As previously mentioned, in product procurement, public authorities describe existing products and services in their tenders. Hence, it does not foster the introduction of new or significantly improved products or services to the market. On the contrary, public authorities procure the described products or services, even though they might already be obsolete. In functional procurement, public authorities specify the functionalities in their tenders. They describe problems/functions/needs to be solved/fulfilled/met through the procurement of products or services. Thus, it is open to introducing new products and services and has the potential to foster the introduction of new and significantly improved products to the market. We aim at identifying functional public procurement tenders with our Question (B).

Third, we consider if start-up firms introduced market novelties as a result of winning public procurement tenders and adhering to their requirements - Question (E) - or before winning a public procurement tenders to increase their chances of winning them - Question (C). Thus, we are able to

investigate the existence of a potential underestimation of the innovation effects of public procurement due to missing out its pre-winning effects.

Fourth, we investigate start-up firms aged between one and four. Thus, we deviate from the often used “three-year period questions/variables” (e.g., Caravella and Crespi, 2020; Krieger and Zipperer, 2022) and asks for firms’ application for public procurement tenders, as well as firms’ winning of public procurement tenders since their foundation in Question (A) and Question (D). Thus, we avoid asking younger start-up firms about their pre-foundation years.

Finally, we are aware of a number of limitations of our questions. Most importantly, we are not able distinguish between firms i) solely applying for functional public procurement tenders, and firms applying for functional and product procurement tenders, as well as ii) firms solely winning functional public procurement tenders, and firms winning functional and product procurement tenders. This differentiation would have needed additional questions within the telephone survey, whereas survey space was too scarce to include them. The same reasoning holds for not including further questions, such as, the number and value of applications and won tenders.

Table 1: Utilized IAB/ZEW Start-Up Panel questions on public procurement

ID	Filter	Telephone survey questions	Yes	No
A	-	Has your company applied for tenders for public procurement contracts since its establishment?	1	0
B	if A = 1	In addition to a low price, were there any other functional requirements in the invitations to tender? These are, for example, requirements regarding the quality of the product to be procured, environmental protection or social concerns.	1	0
C	if A = 1	Have any market novelties been introduced in your company to increase your chances of being selected for the procurement contracts your firm applied for?	1	0
D	if A = 1	Has your company received any public procurement contracts since its foundation?	1	0
E	if D = 1	Have any market novelties been introduced in your company to meet the functional requirements of the won procurement contracts?	1	0

Note: The question listed above were part of the IAB/ZEW Start-Up Panel telephone survey from 2022. Market novelties are previously defined as products or services new to a firm's market. In addition, the phone interviewer received extra information for potential questions of interviewees as listed in Appendix A.

4. Participation of start-up firms in public procurement

In total, 5,060 start-up firms with a maximum age of four years answered the public procurement questions in the IAB/ZEW Start-Up Panel telephone survey of 2022. These firms represent 550,702 start-up firms in Germany. The weighting procedure for the 2022 survey wave is described in detail by Egelin et al. (2023), and as the procedure has changed minimally over time, it is also appropriately explained in English by Fryges et al. (2010).¹ Based on our weighted sample, eleven percent of the population of German start-up firms applied for public procurement tenders since their foundation, whereas 65 percent of them won at least one public procurement tender. Thus, even though a significant share of start-ups win public tenders, the average firms in Germany has a significantly higher probability to have won public tenders. Start-up firms with a maximum age of four years have an average probability of seven percent to have won public tenders, whereas the average probability of

¹ We use the standard population weights calculating the average number of up to four year old firm of a given industry and founding year the firm in the Start-Up Panel stands for.

a firm in the German business sector has a probability of 16 percent to have won public tenders within the last three years (Aschoff et al., 2014).²

In the following, we distinguish between firms applying for functional tenders, and firms solely applying for product tenders. Their distributions by age and industries differ significantly, demonstrating their varying relevance for different types of start-up firms. As a result, the aggregate distributions for public procurement can hardly be interpreted. Thus, we abstain from discussing them.

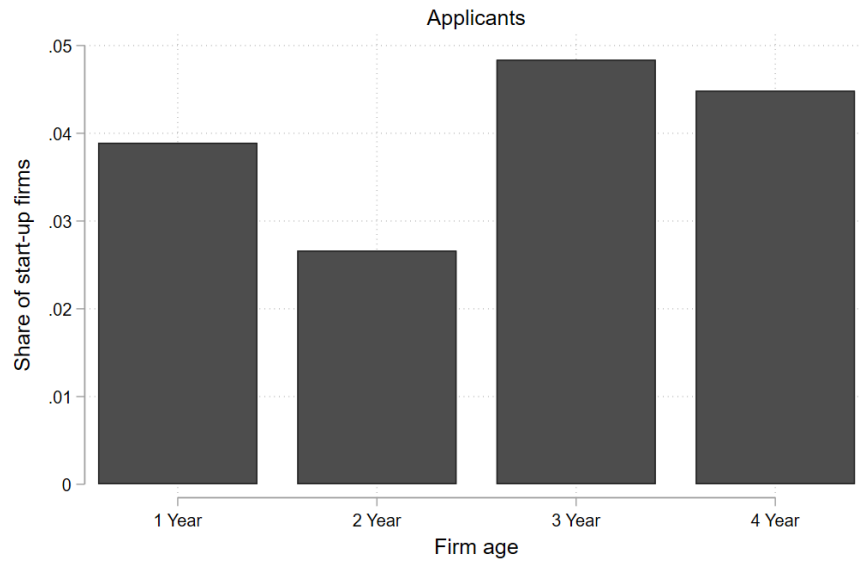
4.1. Participation of start-up firms in functional procurement

Total - Focusing at functional procurement shows that four percent of start-up firms in Germany applied for public procurement tenders with additional functional criteria, representing around 34 percent of all start-ups applying for public tenders. Of these, 60 percent won at least one tender, a five percentage points lower success rate compared to public procurement in general. Even though not directly comparable, this indicates that potentially innovative criteria play a relatively larger role for German start-up firms, than for the entire German business sector. In the German business sector only eleven percent of tender winning firms won tenders requiring innovation (Aschoff et al., 2014), whereas 31 percent of tender winning start-up firms won tenders with functional - potentially innovative - criteria.

Age - Figure 1.a and Figure 1.b demonstrates no definite trend in the distribution of applying and winning firms across firm age for the population of start-ups in Germany. However, three year old firms are the most likely to have applied for a functional tenders since their foundation followed by four year old firms, whereas this results is at least in parts driven by their longer existence in the market. Moreover, we only see one percentage point less applicants within the group of one year old firms. Furthermore, according to Figure 1.c younger firms seem more successful in winning functional tenders: one-year-old firms have a 71 percent “success rate,” two-year-olds 60 percent, three-year-olds 49 percent, and four-year-old firms 61 percent.³

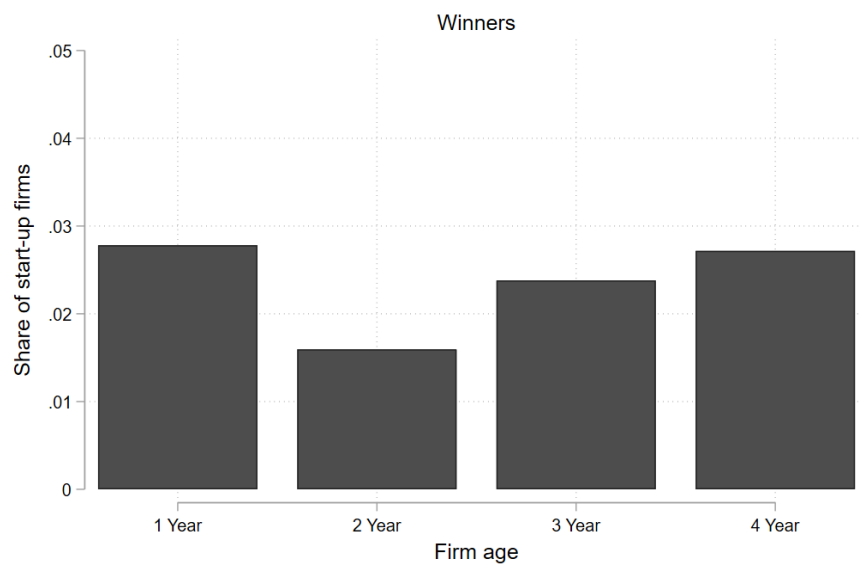
² We compare values from different time period. The IAB/ZEW Start-Up Panel wave covered the years 2018 to 2021. The innovation survey covered the years 2010 to 2012. However, as the volume of public procurement in Germany increased over time, the estimated difference rather presents a conservative estimate.

³ The success rate is defined at the level of the firm as “number of firms having won tenders since their foundation” over “number of firms having applied for tenders since their foundation.” We are not able to estimate a success rate at the level of the tender.



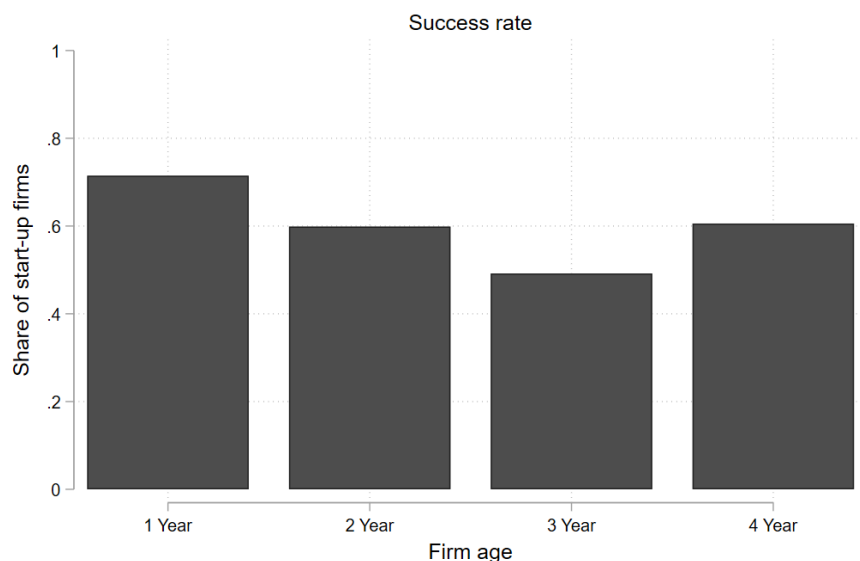
Note: Figure 1.a displays the share of start-up firms applying for functional public procurement tenders by firm age.

Figure 1.a: Share of start-ups applying functional tenders by age



Note: Figure 1.b displays the share of start-up firms winning functional public procurement tenders by firm age.

Figure 1.b: Share of start-ups winning functional tenders by age

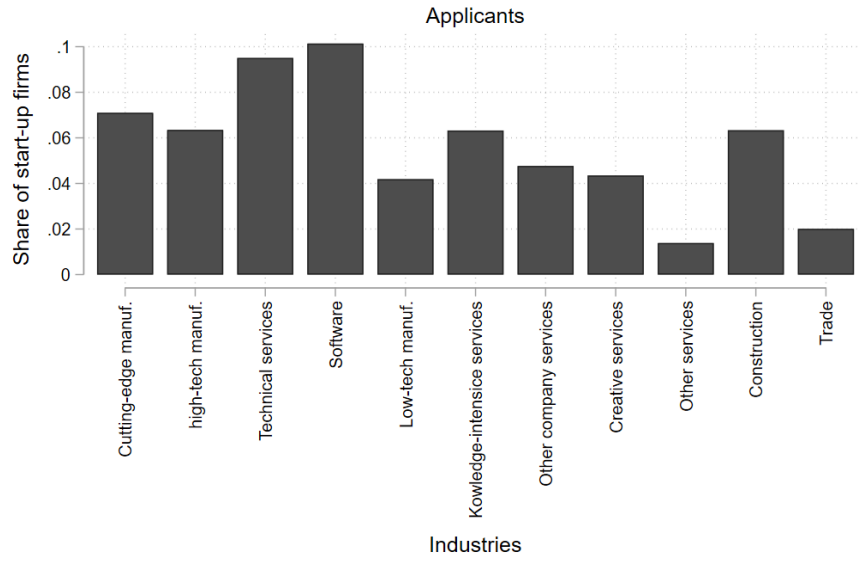


Note: Figure 1.c displays the share of start-up firms winning functional public procurement tenders among applicants by firm age.

Figure 1.c: Success rate of start-ups applying for functional tenders by age

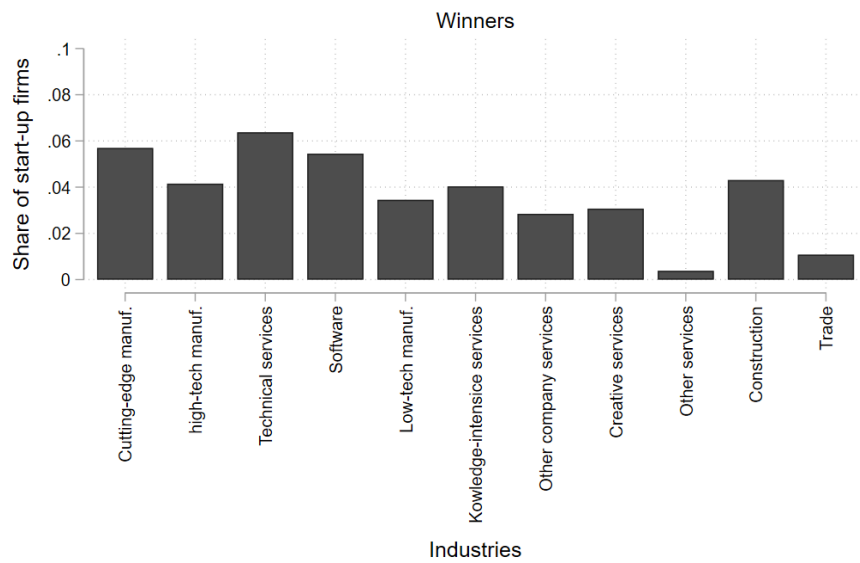
Industry - As shown in Figure 2.a, two industries stand out as the most relevant, each with an applicant share of approximately ten percent: i) software and ii) technical services. They are followed by cutting-edge technology manufacturing at seven percent, and high-tech manufacturing, knowledge-intensive services, and construction, each with about six percent. Furthermore, other company services, creative services, and low-tech manufacturing have relatively high shares, ranging from four to five percent, while all remaining industries have an applicant share of less than two percent.

Among high-tech manufacturing, technical services, knowledge-intensive services, other company services, creative services, and construction, success rates are relatively similar, averaging around 60 to 70 percent, as demonstrated in Figure 2.c. The trade and software industries also show close success rates, with each at 54 percent. However, there are significant disparities in success rates across industries, too. Low-tech manufacturing applicants achieve a success rate of 82 percent, while cutting-edge manufacturing applicants succeed in 80 percent of their applications. In contrast, only 27 percent of start-up firms from the other service industry win public procurement tenders.



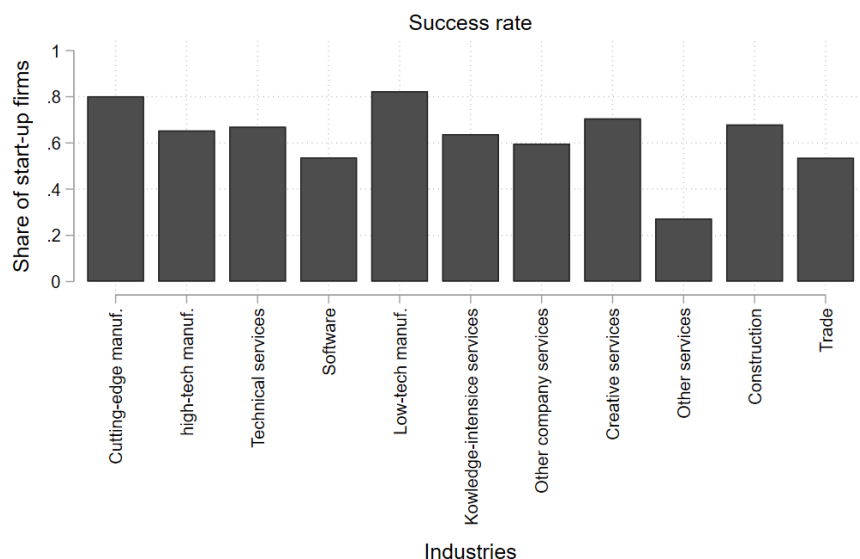
Note: Figure 2.a displays the share of start-up firms applying for functional public procurement tenders by industry.

Figure 2.a: Share of start-ups applying functional tenders by industry



Note: Figure 2.b displays the share of start-up firms winning functional public procurement tenders by industry.

Figure 2.b: Share of start-ups winning functional tenders by industry



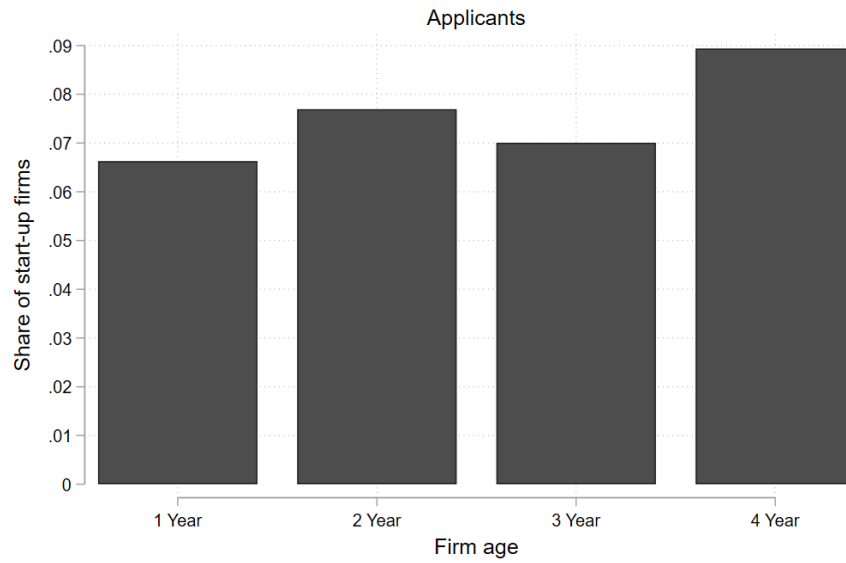
Note: Figure 2.c displays the share of start-up firms winning functional public procurement tenders among applicants by industry.

Figure 2.c: Success rate of start-ups applying for functional tenders by industry

4.2. Participation of start-up firms in product procurement

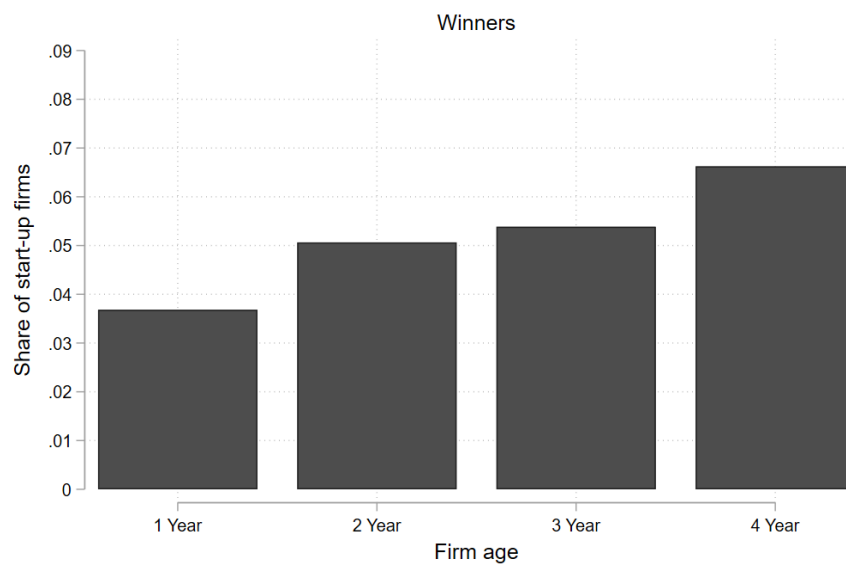
Total - Concentrating on the participation in product procurement shows that eight percent of start-up firms in Germany solely applied for public procurement tenders without additional functional criteria; representing around 66 percent of all start-ups firms applying for public tenders in general. Moreover, a 69 percent share of start-ups firms in this group won at least one public tender, a percentage close to the success rate of public procurement in general.

Age - The likelihood of applying for and winning product procurement tenders clearly increases with the age of start-up firms, as shown in Figure 3.a and Figure 3.b. Younger start-ups, particularly those in their first year, have a lower probability of having applied for tenders (seven percent) and winning them (four percent). Older start-ups have higher probabilities, with eight percent for two-year-old, seven percent for three-year-old and nine percent for four-year-old firms having applied for and with five, five, and seven percent of firms having won product tenders. This results in a success rate of 56 percent for younger start-ups and success rates between 66 and 77 percent for older ones as shown in Figure 3.c. Thus, indicating that, unlike functional tenders, the success rate for product tenders seems to increase with age.



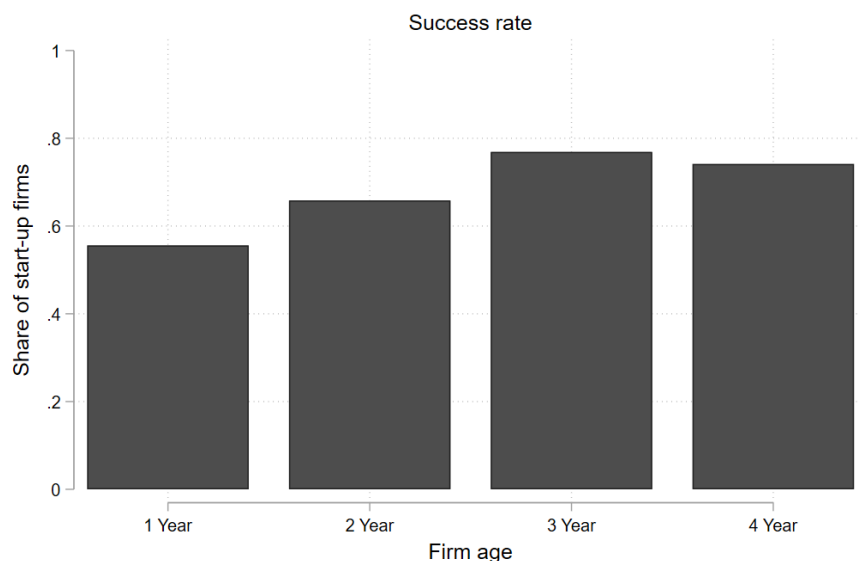
Note: Figure 3.a displays the share of start-up firms applying only for product public procurement tenders by firm age.

Figure 3.a: Share of start-ups applying for product tenders by age



Note: Figure 3.b displays the share of start-up firms winning only product public procurement tenders by firm age.

Figure 3.b: Share of start-ups winning product tenders by age

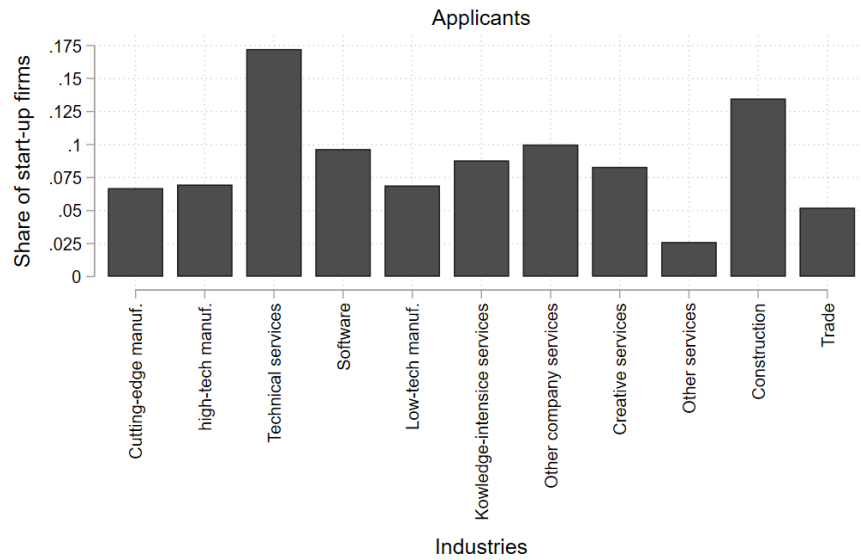


Note: Figure 3.c displays the share of start-up firms winning only product public procurement tenders among applicants by firm age.

Figure 3.c: Success rate of start-ups applying for product tenders by age

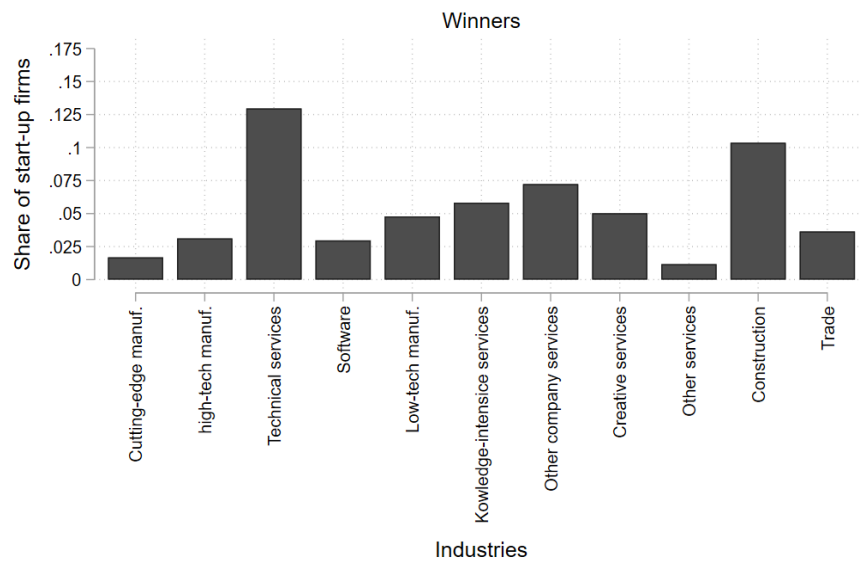
Industries - Taking a look at the importance of product tenders in different industries, Figure 4.a and Figure 4.b present product procurement being the most relevant for technical services. In total 17 percent of all technical services start-ups applied for product procurement tenders, and 13 percent won public tenders since their foundation. The Construction industry follows with the second largest share of start-up firms with a 13 percent share of applicants, and a ten percent share of winners. In the trade and other services industry, the relevance of product tenders is the lowest with five and three percent of start-up firms in these industries applying solely for them.

Like Figure 2.c, Figure 4.c reveals notable variation in success rates across industries. Industries with success rates exceeding 70 percent include technical services, other company services, and construction. In the next tier, success rates between 60 and 70 percent are found in low-tech manufacturing, knowledge-intensive services, and creative services. By contrast, high-tech manufacturing and other services exhibit lower success rates, around the 45 percent mark. Finally, the software and cutting-edge manufacturing industries have the lowest rates at 31 and 25 percent, respectively.



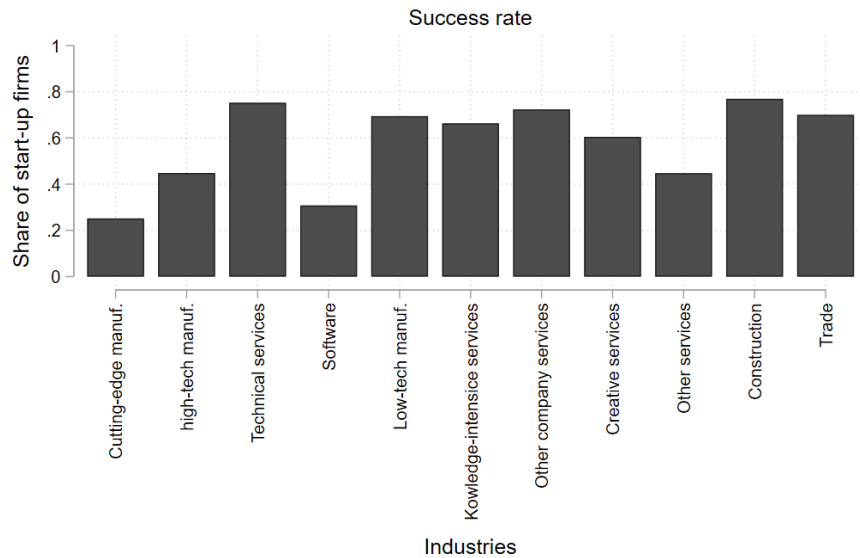
Note: Figure 4.a displays the share of start-up firms applying only for product public procurement tenders by industry.

Figure 4.a: Share of start-ups applying for product tenders by industry



Note: Figure 4.b displays the share of start-up firms winning only product public procurement tenders by industry.

Figure 4.b: Share of start-ups winning product tenders by industry



Note: Figure 4.c displays the share of start-up firms winning only product public procurement tenders among applicants by industry.

Figure 4.c: Success rate of start-ups applying for product tenders by industry

4.3. Comparing the participation of start-up firms in functional and product procurement

The overall participation rate for functional tenders stands at four percent, significantly lower than the eight percent observed for product tenders. This disparity indicates that while a substantial number of start-ups engage with public procurement, the additional requirements of functional tenders may act as a deterrent for many firms. Moreover, for functional tenders, the success rate across start-ups is 60 percent, nine percent lower than the 69 percent observed in product public procurement. This lower success rate may reflect i) a heightened competition, and/or ii) stringent requirements of functional tenders.

When examining participation by age, older start-ups demonstrate a higher participation, and success rate in product tenders. Conversely, the participation by age for functional tenders paints no clear picture, whereas its success rate suggests a decrease in success with a higher age. This suggests that older firms, with their accumulated experience and established processes, might be more successful in securing product, but not necessarily functional tenders.

Industry-specific participation also highlights notable differences. Start-up firms in industries associated with higher technological demands, such as software, high-tech manufacturing, and cutting-edge technology manufacturing, show a higher participation and success in functional than in product tenders. These industries seem to i) leverage their innovative capabilities to meet the demands of functional tenders, and/or ii) face a more innovative demand requiring functional criteria more frequently. In comparison, the relevance of product tenders is most pronounced in the technical

services, construction, and other company services industries, whereas more innovative industries play a less important role.

In sum, these findings hint at various implications. First, they demonstrate start-up firms are on average less likely to win public tenders than the average firm (16 percent of German business sector firms vs. seven percent of German start-up firms), suggesting that they face significant obstacles in meeting the requirements of public procurers due to their young age. Moreover, they indicate that product tenders, with their focus on existing products, are particularly relevant for older start-ups. On the contrary, success in functional tenders with a higher innovation potential is more pronounced for younger start-up firms. Thus, even though older start-up firms remain young compared to the population of all firms, it is already possible to observe younger firms focusing more strongly on innovative public demand. Finally, industries such as other company services and construction align more strongly with product tenders, while more innovative industries, such as software and cutting-edge manufacturing, align more frequently with functional tenders, highlighting their individual tendencies toward less and more innovative procurement opportunities.

5. Determinants of winning public procurement tenders for start-up firms

We established a significant share of start-up firms in Germany participate in public procurement. Thus, demonstrating the economic relevance of public procurement for start-up firms. Moreover, we show start-up firms are on average less likely to win public tenders than established firms; posing the question about the determinants of start-up firms' success in securing public tenders.

5.1. Estimation strategy

To quantitatively explore the determinants of winning public procurement tenders by start-up firms, with a particular focus on the role of founder and firm characteristics, we employ the following probit model:

$$P(PP_i = 1) = \Phi(\alpha + Founder_i\beta + Firm_i\gamma + Industry_i\delta + \epsilon_i),$$

where $P(PP_i = 1)$ is the probability of firm i to have won public procurement tenders since its foundation. $Founder_i$ is a vector covering the characteristics of firm i 's founders at the point of its foundation. The vector $Firm_i$ represents contemporary characteristics of start-up firm i , and $Industry_i$ is a vector of eleven industry dummy variables. Finally, Φ represents the cumulative distribution function of the standard normal distribution, and ϵ_i is the error term. We use maximum

likelihood to estimate the parameters of the probit model.⁴ Moreover, we choose standard errors robust to heteroscedasticity, and all coefficients are presented as average marginal effects.

5.2. Subsample selection

To remove differences emerging from the differences between firms applying for public procurement tenders, and firms not applying for public procurement tenders, we reduce our estimation to firms applying for public procurement tenders. Moreover, to take the particularities of public procurement tenders with and without additional functional criteria into account, we further divide this sample into three different subsamples.

Subsample (1): All firm that answered “yes” to Question (A)⁵ - applied for public tenders.

Subsample (2): All firm that answered “yes” to Question (A) - applied for public tenders - and Question (B)⁶ - applied for tenders with criteria.

Subsample (3): All firm that answered “yes” to Question (A) - applied for public tenders - and “no” to Question (B) - applied for tenders without criteria.

5.3. Determinants of success in public procurement

We explore the importance of the following *founder characteristics* for winning public procurement tenders:

Team size: The number of people within the founding team of the start-up firm. A larger team size may provide a broader range of skills, greater capacity to accomplish tasks, more knowledge, and wider networks (Jin et al., 2016). This, in turn, can enhance the firm’s ability to understand and meet the requirements of public procurement tenders, as the diverse expertise within a larger team can contribute to more innovative solutions.

Founder age: The current age of the youngest person in the founding team. Research has shown that, compared to younger founders, older founders are more likely to establish firms that introduce new services and products to the market. Murmann et al. (2023) demonstrate that, on average, an additional ten years of age increases a founder's probability of introducing a market novelty by 19 to 30 percent. Thus, younger founders may lack market experience, which can be a disadvantage in navigating complex procurement processes.

⁴ The results are robust to using a logit model.

⁵ Has your company applied for tenders for public procurement contracts since its establishment?

⁶ Has your company received any public procurement contracts since its foundation?

Female founder: A dummy variable for a woman being part of the foundation team. The presence of a woman in the founding team is relevant as research shows that women-led firms are less likely to win government contracts than those led by men, even when similar in size and sector (Bates, 2000). Moreover, women's greater risk aversion (Jianakoplos and Bernasek, 1998) and stronger focus on social impact (Guzman et al., 2020) may influence decisions to apply for public tenders. Additionally, gender diversity can enhance problem-solving and competitiveness, and some procurement policies may favor women-owned businesses, making gender a key factor in success.

Founder nationality: A dummy variable for a German being part of the founding team. Minority founders often face racial biases (e.g., Fairlie et al., 2022). Additionally, local founders may have a better understanding of market conditions, regulatory environments, and public procurement processes, which can be advantageous when applying for local tenders. Familiarity with local norms and practices can streamline the application process and improve compliance with tender requirements.

Industry experience: The highest amount of relevant industry experience, measured in years, of a founding team member. Firms founded by employees from a focal industry have been shown to build their new business on knowledge gathered at their previous employer (e.g., Shane, 2000). This experience can provide insights into market needs and the technical requirements of tenders. It also suggests a deeper understanding of industry standards and practices, which can be crucial for meeting procurement specifications and demonstrating credibility to evaluators.

Higher education: A dummy variable equal to one if a founding team member has a higher-education degree. Higher educational attainment is often used as a proxy for ability in various studies (e.g., Astebro et al., 2012). Additionally, it may correlate with advanced technical knowledge and problem-solving skills, which are valuable for addressing complex procurement criteria. Education can also improve the team's capacity to develop and effectively articulate innovative solutions.

Doctoral degree: A dummy variable equal to one if a founding team member holds a doctorate. Academic entrepreneurship is often driven by early-stage product innovations developed by the founding researchers, with the firm serving as a vehicle to further advance the technology. Since academic entrepreneurs leverage their specialized research knowledge, they differ significantly from those who start businesses through general employment (Agarwal and Shane, 2014). Thus, a doctoral degree reflects a high level of expertise, which can be especially valuable for tenders requiring cutting-edge or specialized solutions.

Public sector: A dummy variable indicating whether a founding team member was employed in the public sector before establishing the start-up. Based on semi-structured interviews with government procurement executives, Preuss (2011) develops a theoretical framework for entrepreneurship policy, emphasizing the relationships between procurers and suppliers. Prior public sector experience increases the likelihood of having established connections, which can enhance awareness of public procurement opportunities and improve the chances of submitting a successful tender application.

Private sector: A dummy variable indicating whether a founding team member was employed in the private sector before establishing the start-up. Private sector experience can provide valuable insights into market dynamics, customer needs, and competitive strategies, helping the firm develop commercially viable solutions that align with public procurement requirements. Additionally, in combination with the previous public sector variable, this variable distinguishes entrepreneurship driven by prior employment from necessity-based entrepreneurship arising from unemployment, which involves different strategic entry decisions (Bock et al., 2015).

Previous foundation: A dummy variable indicating whether members of the founding team have prior experience in establishing firms. Research shows that experience in founding previous companies is associated with a greater ability to identify market opportunities (McGrath and MacMillan, 2000; Baron and Ensley, 2006), as well as a higher likelihood of recognizing more profitable opportunities (Ucbasaran et al., 2009; Gruber et al., 2015). This expertise can also enhance the team's ability to navigate public procurement processes, as tenders offer valuable insights into government demand and opportunities.

Moreover, we examine the relevance of the following ***firm characteristics*** for winning public tenders:

Firm size: The number of employees working for the start-up firm in 2022. Numerous studies demonstrate that the size of SMEs is positively related to their participation in public procurement (e.g., Karjalainen and Kemppainen, 2008; Flynn et al., 2015). Larger firms typically have greater resources and capabilities to dedicate to the complex task of preparing and submitting tenders. They are also better positioned to meet substantial contract requirements and manage multiple projects simultaneously, which increases their attractiveness to public procurers. Additionally, Hoekman and Tas (2022) find that larger firms are generally better equipped to navigate open tendering processes. Conversely, SMEs appear to benefit from more transparent regulations, which can enhance their success in public procurement.

Export status: A dummy variable indicates whether a firm generates export revenues. Firms with export revenues have proven their ability to compete internationally. This experience can be

advantageous in public procurement, where firms need to certify their experience (Dai et al., 2021) and potentially manage cross-border supply chains.

Market novelty: A dummy for having implemented new or significantly improved products or services not yet existing in the market of the start-up firm. Implementing innovation demonstrates a firm's ability to lead in innovation and bring solutions to the market. Such firms are often well-positioned to fulfill the advanced and specific needs of public procurement tenders that seek novel solutions (Blind et al. 2020).

Targeted market novelty: A dummy for having implemented market novelty to increase the chances of winning public procurement tenders and fulfilling their functional requirements. Firms that strategically introduce market novelties to win tenders show a proactive approach to meeting procurement demands. This targeted innovation increases their likelihood of success in tenders that require tailored solutions.

R&D intensity: Research and development expenditures over revenues. Following the innovation literature (e.g., Aschoff and Sofka, 2009), we use R&D intensity as a proxy for the absorptive capacity of a start-up firm (Cohen and Levinthal, 1990). High R&D intensity indicates a strong commitment to research and development, suggesting that the firm is continually working on new and improved products, services, and processes. This dedication to innovation can make the firm more competitive in tenders that require advanced technological solutions and/or innovative production processes.

Public support: A dummy variable for receiving public subsidies. Receiving public subsidies can significantly enhance a firm's credibility and financial stability. The certification that comes from public funding reduces barriers to accessing external financing sources (Bellucci et al., 2023). This factor is particularly important in public procurement, as agencies likely prefer to collaborate with firms that have already been vetted and supported by public funds.

Foundation year: The foundation year of the start-up firm. The foundation year allows for an understanding of the firm's maturity and experience in the market. Older firms may have more established processes and a proven track record, which can be advantageous in winning public procurement tenders. However, newer firms might bring fresh, innovative approaches that are also highly valued. In addition, older firms had more time to apply for a public tenders since their foundation than younger firms.

5.4. Regression sample statistics

Within our sample of 5,060 answering start-up firms in the 2022 survey wave of the IAB/ZEW Start-Up Panel, 746 start-up firms applied for public procurement tenders since their foundation between 2018 and 2021. Moreover, 279 applied for tenders with functional criteria, and 467 solely for tenders without functional criteria. As described previously, we focus on these samples of different applicants for our analysis.

Table 2 shows the descriptive statistics of the subsamples for i) start-up firms applying for functional tenders and ii) start-up firms applying for product tenders. For both samples, the number of observations decreases as we restrict them to those without missing values in our selection of potential predictors and exclude observations from the top one-percent percentile of R&D intensity.⁷ We see no larger differences to the descriptive statistics provided in previous studies using the IAB/ZEW Start-Up Panel, in particular with regard to the minimum and maximum values of each variable (e.g., Gottschalk and Müller, 2022; Berger and Hottenrott, 2021; Hottenrott and Richtstein, 2020).⁸ However, there are statistically significant differences between the samples, highlighting the importance of their separate examination.⁹

Firm characteristics - Firms applying for function tenders are eight percent more likely to have won tenders since their foundation. In addition, they are significantly more innovative. First, they are more likely to introduce market novelties in general, and targeted to win public tenders. This frequent use of targeted innovations, implies a potential underestimation of the innovation effects of public procurement in the previous literature. Secondly, they have a significantly higher R&D intensity, and probability for export revenues.

Founder characteristics - Adding to this trend, the founder teams of firms applying for functional tenders are nine percent more likely to include a person with a doctoral degree. Additionally, they have larger founding teams and are more likely to have founders with prior founding and industry experience, as well as a higher average age. Lastly, firms applying for functional tenders are less likely to have founders with previous employment in the private sector.

Table 2: Descriptive sample statistics

⁷ The R&D intensity values of the top one-percent percentile range from 1.54 to 44.44, with a mean of 4.78.

⁸ For this comparison to previous studies, minimum and maximum values are the most important. They demonstrate, our variables being within the same boundaries as in previous studies. Comparing mean values is less suitable to test the reliability of our variable generation, as start-up firms applying for functional/product tenders are likely to differ from the mean characteristics of non-applying start-up firms.

⁹ We could divide the descriptive statistics of both samples with regard to tender winning and non-winning firms. However, even though our analysis represents rather correlative than causal relationships, we concentrate on presenting the conditional correlations in our estimation strategy, and refrain from presenting differences in means to identify the determinants of winning public tenders.

	Applying for functional tenders Obs. 216				Applying for product tenders Obs. 357				Mean differences
	Mean	S.d.	Max.	Min.	Mean	S.d.	Max.	Min.	T-test
Winning tender	0.67	0.47	1.00	0.00	0.59	0.49	1.00	0.00	*0.08
Founder characteristics									
Team size	1.90	1.27	10.00	1.00	1.66	0.91	8.00	1.00	**0.24
Female founder	0.15	0.36	1.00	0.00	0.18	0.39	1.00	0.00	-0.03
Founder age	40.60	11.00	82.00	20.00	38.90	10.20	67.00	20.00	*1.70
Founder nationality	0.90	0.30	1.00	0.00	0.91	0.29	1.00	0.00	-0.01
Industry experience	16.80	10.90	60.00	1.00	15.10	10.20	48.00	1.00	*1.70
Higher education	0.61	0.49	1.00	0.00	0.57	0.50	1.00	0.00	0.04
Doctoral degree	0.15	0.36	1.00	0.00	0.06	0.25	1.00	0.00	***0.09
Public sector	0.11	0.31	1.00	0.00	0.07	0.26	1.00	0.00	0.03
Private sector	0.61	0.49	1.00	0.00	0.71	0.46	1.00	0.00	** -0.10
Previous foundation	0.59	0.49	1.00	0.00	0.44	0.50	1.00	0.00	***0.15
Firm characteristics									
Firm size	5.28	4.46	24.50	1.00	4.97	5.11	31.00	0.50	0.31
Export status	0.18	0.38	1.00	0.00	0.10	0.30	1.00	0.00	**0.08
Market novelty	0.50	0.50	1.00	0.00	0.19	0.40	1.00	0.00	***0.30
Targeted market novelty	0.38	0.49	1.00	0.00	0.14	0.35	1.00	0.00	***0.24
R&D intensity	0.20	0.36	1.50	0.00	0.06	0.21	1.50	0.00	***0.14
Public support	0.36	0.48	1.00	0.00	0.31	0.46	1.00	0.00	0.05
Foundation year	2020.00	1.05	2021.00	2018.00	2020.00	1.03	2021.00	2018.00	0.00

Note: T-tests assume an unequal variance. P-values are defined as *p < 0.10, **p < 0.05, ***p < 0.01.

5.5. Regression results

Table 3 presents the estimation results for our three subsamples. Column (1) includes all start-up firms applying for public tenders, Column (2) focuses on start-ups applying for functional tenders, and Column (3) comprises start-ups applying solely for product tenders.

In Column (1), four predictors of winning public tenders since a start-up's founding show statistical significance. First, each additional year of founders' industry experience increases the probability of winning a public procurement tender by approximately one percentage point. This finding suggests that founders with more industry experience are better equipped to navigate the requirements of public procurement tenders. Second, start-ups that introduced a market novelty to enhance their chances of winning are associated with a 23 percentage point increase in the probability of securing any tender. This implies that innovation strategically aimed at improving public procurement success is at least partially effective. Third, supporting a positive influence of innovation in general, a start-up's R&D intensity is positively associated with tender wins. Fourth, firms founded more recently are less likely to have won a tender since their foundation, with each additional year since founding increasing the probability of a successful tender by four percentage points.

In the second column, which examines start-ups applying for functional tenders, more predictors demonstrate statistical significance for winning public tenders. The results indicate that an increase of

one team member is associated with an approximately 13 percentage point decrease in the probability of winning, suggesting that larger teams may encounter coordination challenges when responding to more functional tenders. Also, an increase of one year in the age of the youngest founder is associated with a decrease of approximately one percentage point in winning probability, hinting that younger founders might be more successful in securing innovative contracts. As before, each additional year of founders' industry experience is associated with an approximate one percentage point increase in the probability of winning any public procurement tender. On top of that, the presence of a founder with a doctoral degree increases the probability of winning by about 35 percentage points, underscoring the significant role of advanced scientific qualifications in addressing the demands of functional tenders, too. Finally, following the results of Column (1), firms that introduced market novelties with the intent of increasing their tender success show an additional 24 percentage points in the probability of winning tenders, further illustrating the effectiveness of targeted innovation strategies, and the R&D intensity remains positively related to tender success, with even greater statistical significance and magnitude, underscoring its importance for firms targeting functional tenders.

Table 3: Determinants of winning public tenders since start-up firm foundation

	all tender applicants	functional tender applicants	product tender applicants
<i>Founder characteristics</i>			
Team size	-0.03 (0.02)	-0.13*** (0.0306)	0.07** (0.03)
Female founder	0.05 (0.06)	0.16 (0.11)	-0.03 (0.07)
Founder age	-0.00 (0.00)	-0.01*** (0.00)	0.01*** (0.00)
Founder nationality	0.01 (0.07)	0.06 (0.11)	-0.00 (0.08)
Industry experience	0.01*** (0.00)	0.01*** (0.00)	0.01* (0.00)
Higher education	0.06 (0.05)	0.07 (0.08)	0.04 (0.06)
Doctoral degree	0.116 (0.08)	0.35*** (0.11)	-0.15 (0.11)
Public sector	0.03 (0.07)	-0.11 (0.10)	-0.02 (0.09)
Private sector	0.06 (0.04)	0.05 (0.07)	0.05 (0.06)
Previous foundation	-0.03 (0.04)	0.08 (0.06)	-0.11** (0.0524)
<i>Firm characteristics</i>			
Firm size	0.00 (0.00)	0.01 (0.01)	-0.00 (0.00)
Export status	-0.05 (0.06)	-0.09 (0.08)	-0.03 (0.09)
Market novelty	-0.12 (0.08)	-0.10 (0.10)	-0.14 (0.13)
Targeted market novelty	0.23*** (0.08)	0.24** (0.11)	0.25* (0.13)
R&D intensity	0.14* (0.08)	0.22** (0.10)	-0.00 (0.14)
Public support	-0.03 (0.04)	-0.02 (0.06)	-0.04 (0.05)
Foundation year	-0.04** (0.02)	0.00 (0.03)	-0.06** (0.02)
Observations	573	216	357

Note: Dependent variable is a dummy variable indicating if a start-up firm has won a public tenders since its foundation (0=No, 1=Yes). All estimates are based on a probit model. Eleven industry dummies are included in all estimations. Standard errors are robust to heteroscedasticity and displayed in parentheses. Significance levels are robust to using a logit model as alternative estimation method. Column names indicate the used subsample for our estimations. P-values correspond to *p < 0.10, **p < 0.05, ***p < 0.01.

The third column, which focuses on firms only applying for public procurement tenders without additional criteria, reveals further heterogeneity in the results. An additional founding team member is associated with a seven percentage point increase in the probability of winning product procurement tenders, potentially due to larger capacities, knowledge, and/or networks. Additionally, each additional year in the age of the youngest founder is linked to a one percentage point increase in the likelihood of winning; this could reflect a stronger focus on less risky, already established products, and services the older founders' business models. Thus, Column (3) presents results directly opposing those of Column (2). Moreover, in contrast to Column (2), prior founding experience exhibits a negative association with the probability of winning public tenders without specific criteria. Thus, prior founders do not benefit from their experience, but are potentially penalized by procurers for their previous (failed) business. Also, the findings from Column (1) regarding firms founded more recently are particularly pronounced in this subsample, where firms are less likely to have won a tender; each additional year since founding increases the probability of a successful tender by six percentage points. Finally, the positive and statistically significant relationship between founders' industry experience and tender success remains consistent across the analyses. Similarly, even in the absence of functional tender criteria, firms that introduce market novelties to enhance their chances experience a 25 percentage point increase in the probability of winning a tender.

6. Conclusion

6.1. Start-up firm participation in public procurement

This study investigates the participation of start-up firms in public procurement, distinguishing between those applying for functional tenders and those applying solely for product tenders. The results indicate significant differences in the population shares and success rates.

The overall participation rate for functional tenders was four percent, significantly lower than the eight percent observed for product tenders. This disparity suggests that while a substantial number of start-ups engage with public procurement, the additional requirements of functional tenders may act as a deterrent for a selection of firms. Moreover, the success rate for functional tenders across start-ups is 60 percent, lower than the 65 percent observed in general public procurement and 69 percent for product tenders. This lower success rate for functional tenders may reflect the requirements they entail, too.

When examining participation by age, older start-ups demonstrate a higher success rate in product tenders. One-year-old firms have a 56 percent success rate, which increases with age to up to 77 percent for three-year-olds. In contrast, the success rate for functional tenders seems to decrease with age. Thus, younger firms, possibly due to higher innovation capabilities, might be better suited to meet

the criteria of functional tenders, whereas older firms could be more successful in product procurement due to their experience.

Industry-specific participation also highlights notable differences. Start-ups in industries associated with higher technological demands, such as software, high-tech manufacturing, and cutting-edge technology manufacturing, show a relatively higher participation in functional tenders. These industries, on the one hand, might leverage their innovative capabilities to meet the demands of functional tenders. On the other hand, they might face a more innovative demand requiring functional tenders more frequently. In contrast, the relevance of product tenders is more pronounced in less innovative industries, such as technical services and construction.

Finally, when the success of German start-up firms in winning public procurement (seven percent) is compared to the success of the German enterprise sector as a whole (16 percent), it is indicated that start-ups face particular challenges in securing public tenders. In addition, even though not directly comparable, in the German business sector, only eleven percent of tender-winning firms won tenders requiring innovation (Aschoff et al., 2014), whereas 31 percent of tender-winning start-up firms won tenders with functional - potentially innovative – criteria. Thus, potentially innovative criteria seem to play a larger role for German start-up firms.

6.2. Determinants of winning public procurement

The study highlights the importance of founder and firm characteristics in determining the success of start-up firms in different types of public procurement.

For functional tender applicants, having a doctoral degree among the founders is positively related to the probability of winning, underscoring the important role of scientific expertise in meeting functional tender requirements. Moreover, further highlighting the significance of innovation capacities, strategically introducing market novelties to win public tenders, and a higher R&D intensity is generally accompanied by a higher likelihood to win public tenders. Larger team size is negatively correlated with the probability of winning functional tenders, possibly due to coordination challenges in responding to functional tenders. Also, older founder teams have a lower likelihood of winning functional tenders, potentially as a result of focusing more strongly on less risky, already established products, and services in their start-up firms' business models. In contrast, the industry experience of founders is positively associated with success in functional tenders, demonstrating the benefits of knowledge gathered at previous employers that can provide insights into market needs and the technical requirements of tenders.

For product tender applicants, innovation capacities are less important. The strategic introduction of market novelties to win public tenders is the only innovation-related predictor with statistical

significance. Furthermore, in direct contrast to the results for functional tender applicants, i) larger founder teams are positively associated with the probability of winning, indicating that team capacity might be advantageous for winning less innovative tenders, and ii) older founder teams have a higher likelihood of winning product tenders, again, potentially resulting from a less risky business model choice focused on established products and services. Consistent with functional tender applicants, however, industry experience among founders is positively associated with a start-up's success in winning public tenders. Predictors unique to product tender applicants include founders' previous entrepreneurial experience and the age of the start-up itself—both of which are negatively related to tender success. The negative association with prior entrepreneurial experience may reflect a penalty by public procurers due to past business failures, while the negative relationship with start-up age likely arises naturally, as older firms have had more opportunities to secure public tenders over time.

6.3. Targeted market novelties to win public tenders

As demonstrated, introducing market novelties to win public tenders has a positive and statistically significant association with success in both types of public tenders. Firms that introduced market novelties to increase their chances of winning tenders have a higher probability of success in both functional and product tenders, emphasizing the competitive advantage provided by targeted innovation. However, beyond being an important determinant of tender success, these results suggest an underestimation of the innovative effects of public procurement in previous literature, which has primarily investigated the effects of winning public tenders on firms' innovation and performance, thus, at least in part, overlooking the innovations introduced before tender placement.

6.4. Managerial implications

For start-up founders, the insights from this study can inform strategic decisions regarding public procurement participation. For example, understanding the different success rates associated with functional and product tenders based on the firm's age, industry, and innovation capacity can be helpful. Younger, technologically adept firms may find greater opportunities in functional tenders, leveraging their innovative capabilities. Conversely, more established firms with more experience and established processes may be better positioned to secure product tenders.

Moreover, start-up firms can recognize the determinants of success in different public tenders - such as i) the value of doctoral education within the foundation team, ii) the potential penalty for previous foundation experience, and iii) the higher probability to win accompanied by targeted market novelties - and leverage these findings to improve their tender applications.

6.5. Policy implications

For policymakers, the study underscores the potential of supporting start-up firms in their public procurement engagement. Most notably, as established firms are more than twice as likely to win public tenders (16 percent), compared to start-up firms (seven percent). Targeted measures, potentially similar to those successful in increasing the participation of SMEs, might be a first step. Examples are dividing tenders into smaller lots, and awarding a tender based on functional criteria to increase the winning probability of younger and smaller firms (Nemec, 2024). However, even though increasing the probability of winning, these measures did not increase participation rates (Nemec, 2024; Hoekman and Taş, 2020). To increase participation, the results of Hoekman and Taş (2020) suggest that facilitating participation in general, for example through simplifications of procedures, and bid eligibility requirements that are feasible, can be successful.

Moreover, policy makers might foster the success of start-up firms in public procurement indirectly by supporting the determinants of winning public tenders. For example, policies aimed at promoting doctoral education within entrepreneurial teams could enhance their success in securing functional tenders. Also, they could take the distinct industry dynamics of different types of public procurement into account. Industries with high technological demands, such as software and high-tech manufacturing, show higher engagement in functional tenders, whereas construction and other company services demonstrate larger applicant shares for product tenders. This suggests a need for industry-specific support measures, such as industry-tailored advisory, to better equip these firms to meet the public demand directed towards their industry.

6.6. Limitations and future research

Even though we provide insights into the participation of start-up firms in public procurement and the determinants of their success, our analysis has several limitations.

First, the study is ***explorative and establishes correlations rather than causal relationships***. Although estimations focused on comparing start-up firms within the groups of applicants, causality cannot be definitively determined from the available data.

Second, more research on the mechanisms behind our predictors of public procurement success is strongly needed. In total, we find various statistically significant predictors. However, even though the ***predictors hint at the mechanism described by us, further research is necessary to verify them***.

Third, the analysis is based on ***start-up firms in Germany, limiting the generalizability of the findings*** to other countries with different public procurement frameworks and entrepreneurial ecosystems. Future research should test the external validity of these findings in other national contexts.

Fourth, the study differentiates between functional and product tenders but ***does not capture other dimensions of public procurement***, such as the value and number of tenders applied for and won. Additional detailed information - in particular on the level of individual tenders - could provide a more nuanced understanding of the effects of public procurement on start-up firms.

Fifth, while the study focuses on the participation and success of start-ups in public procurement, it ***does not investigate the short- or long-term effects*** of applying for or winning tenders on the performance of these firms. Developing identification strategies to estimate these causal effects, is left for current (Hvide and Meling, 2023), and future research.

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Appendix A. IAB/ZEW Start-Up Panel Telephone Survey Questions

The following block of questions deals with the significance of public procurement contracts for your company.

Public procurement contracts are contracts awarded by the public administration and by publicly operated institutions such as universities, schools, hospitals and utilities companies. Examples include tenders for the construction of streetlights, office equipment for city and municipal facilities, X-ray equipment for hospitals, or cleaning services for schools.

1. publ_proc

Did tenders for public procurement contracts help you to assess market opportunities or sales possibilities before you started your business?

- 1: Yes
- 2: No
- X: Don't know / No answer

2. pp_mneu, if publ_proc = 1

Have these tenders shown your company a demand for market novelties?

- 1: Yes
- 2: No
- X: Don't know / No answer

3. pp_ori, if pp_mneu = 1

Does your company's product or service portfolio align with this identified demand?

- 1: Yes
- 2: No
- X: Don't know / No answer

4. pp_antrag

Has your company applied for tenders for public procurement contracts since its establishment?

- 1: Yes
- 2: No
- X: Don't know / No answer

5. pp_gruend, if pp_antrag = 1

Was your company founded to apply for these tenders?

- 1: Yes
- 2: No
- X: Don't know / No answer

6. pp_funktion, if pp_antrag = 1

In addition to a low price, were there any other functional requirements in the invitations to tender? These are, for example, requirements regarding the quality of the product to be procured, environmental protection or social concerns.

INTERN [start]:

Functional requirements are:

Environmental attributes refer, for example, to the energy consumption or emissions of a product, the use of renewable energy by their company, the sustainability of the raw materials used or noise pollution.

Social issues refer to, for example, promoting employment opportunities for the long-term unemployed, older workers and people with disabilities. They also include compliance with labor and social regulations and the promotion of social inclusion, equal opportunities, accessibility and fair trade.

Economic attributes refers in particular to the quality, cost-efficiency, aesthetics or functionality of a product or service. However, criteria may also be applied in relation to delivery periods and distances, as well as to the company's customer service and technical support.

INTERN [end]

1: Yes

2: No

X: Don't know / No answer

7. pp_chance, if pp_antrag = 1

Have any market novelties been introduced in your company to increase your chances of being selected for the procurement contracts your firm applied for?

1: Yes

2: No

X: Don't know / No answer

8. pp_auftrag, if pp_antrag = 1

Has your company received any public procurement contracts since its foundation?

1: Yes

2: No

X: Don't know / No answer

9. pp_mneu_grund, if pp_auftrag = 1 and pp_funktion

Have any market novelties been introduced in your company to meet the functional requirements of the won procurement contracts?

1: Yes

2: No

X: Don't know / No answer



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