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The participation of young firms in public procurement

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DISCUSSION PAPER

// BASTIAN KRIEGER, LENA FÜNER, AND MALTE PRÜFER

The Participation of Young Firms in Public Procurement

Leibniz Association

ZEW

The participation of young firms in public procurement

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Abstract

Public procurement offers sizable market opportunities for young firms. We investigate the firm- and founder-level characteristics determining young firms' decision to apply for public tenders, as well as the procurers' selection of an awardee. We distinguish between observable and unobservable characteristics as well as price-based tenders (tenders awarded solely on the price criterion) and criteria-based tenders (tenders awarded based on additional criteria next to the price). Using representative survey data for 4,314 young firms in Germany, we estimate a multinomial two-stage selection model. In the first stage, firms decide to "not apply," to "apply for price-based tenders," or to "apply for criteria-based tenders." In the second stage, procurers choose the awardee among the applicants of each tender type. We find the firm and founder determinants largely differ with regard to the first and second stage, as well as price- and criteria-based tenders.

Plain English Summary

Public procurement makes up 16 percent of GDP in the EU and provides sizeable market opportunities for young firms. But what drives them to apply – and what makes them win? It depends on whether tenders solely focus on the price as criterion, or not. We use data from over 4,000 young German firms to see which ones apply for government contracts and which ones actually win. We find that larger firms generally have an easier time bidding successfully, while more verifiably innovative firms and founder teams do better in tenders that reward quality criteria. Thus, young firms should tailor their strategy depending on whether they are pursuing a contract that mainly cares about the lowest price or about other factors like quality or innovation.

Keywords Public procurement – Young firms
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, young firms have the potential to particularly profit from public procurement. First, winning public procurement tenders provides young firms with a secure initial level of demand and allows early economies of scale (Hvide and Meling, 2023). Second, winning public procurement tenders provides a quality certification to potential customers and financiers of young firms (Dai et al., 2021).

As a result, the role of public procurement for young firms has recently received increasing scientific (e.g., Talebi et al., 2022a/b; Zabala-Iturriagagiotia, 2022; De Coninck et al., 2018; Dai et al., 2021; Pickernell et al., 2013; Preuss, 2011) and political attention (BMWK, 2024; European Commission, 2023; Kister and Theurer, 2022). However, despite this growing interest, quantitative research analyzing young firms' remains scarce, focusing solely on the effects of winning tenders on firm performance (Hvide and Meling, 2023; Dai et al., 2021), instead of the determinants of young firms' participation and success in public procurement.

In contrast, quantitative research on small and medium-sized enterprises grew significantly within the last decade. Moreover, it primarily examined the participation and success of small and medium-sized enterprises in public procurement, with only recent studies investigating the effects of winning tenders on their performance (Schäfer et al., 2024; Kinyua et al., 2024, Krieger and Zipperer, 2022). Most prominently, the design of public tenders was analyzed, demonstrating that subdividing contracts into smaller lots positively influence small and medium-sized enterprises' participation and success (Nemec, 2024; Hoekman and Taş, 2022), and providing mixed evidence on the effectiveness of additional award criteria (Deschamps, 2025; Nemec, 2024; Hoekman and Taş, 2022; Stake, 2017; Flynn et al., 2015). In addition, firm-level characteristics – such as innovation capacity, firm size, and tendering experience – were explored as predictors of procurement success (Blind et al., 2020; Flynn et al., 2015), while only Di Mauro et al. (2020), and Flynn and Davis (2017) considered firm and tender characteristics.

The literature on public procurement as innovation policy is more mature and has been widely reviewed (Chiappinelli et al., 2025; Obwegeser and Müller, 2018; Appelt and Galindo-Rueda, 2016; Mowery and Rosenberg, 1979). In recent years, it has increasingly examined the effects of innovative public procurement (e.g., Caravella and Crespi, 2020; Czarnitzki et al., 2020; Stojčić et al., 2020; Ghisetti, 2017; Guerzoni and Raiteri, 2015), which is particularly relevant for young firms as they are in many cases founded for the introduction of innovative products, services, or business models. In contrast to price-based tenders, which *hinder innovation* by procuring existing products for the lowest price, and criteria-based tenders, which *reward innovation* by incorporating additional award criteria beyond the price, innovative tenders explicitly *require the development of novel solutions or not-yet-existing technologies* as part of the tender (Krieger et al., 2024). In sum, the literature consistently reports positive effects of innovative public procurement on firms' innovation activities, although the magnitude and significance of these effects depend on the applied identification strategy and sample context.

In this paper, we examine the firm- and founder-level characteristics that influence the participation and success of young firms – defined as those no older than seven years – in public procurement. Drawing on representative telephone survey data from 4,314 young firms in Germany, we distinguish between price-based (innovation-hampering) and criteria-based (innovation-rewarding) tenders to explore how both observable and unobservable attributes affect the decision to apply and the eventual selection of an awardee. We employ a multinomial two-stage model, enabling us to capture differences between non-applicants, applicants, and successful applicants in a unified framework. Through this approach, we extend prior work on young firms in procurement by highlighting the critical role of founder characteristics, in addition to firm attributes, and by explicitly contrasting tender types with and without additional award criteria. More precisely, our study contributes theoretically and empirically to the described literature streams about public procurement, young firms, and small and medium-sized firms as follows:

Theoretical contributions – First, we distinguish two stages in the procurement process: firms' self-selection into applying and procurers' selection of winning firms. Previous studies largely emphasize on determinants of procurement success from the perspective of the firm (Blind et al., 2020). By comparison, our study clarifies determinants influencing both stages separately, and highlights the heterogeneous importance of characteristics which are observable and

unobservable by procurers within both stages. In addition, prior research has predominantly concentrated on the performance of firms after securing public contracts (e.g., Hvide and Meling, 2023; Dai et al., 2021), largely abstracting from the process of application decision and winner selection.

Second, the sole studies theoretically concentrating on application and winning are Di Mauro et al. (2020) and Flynn and Davis (2017) in their analysis of small and medium-sized firms. They concentrate on the importance of a diverse set of firm and tender characteristics. In contrast, we focus on young firms with a limited market history as unit of analysis, as well as the importance of founder-level characteristics alongside firm-level attributes within our discussion; emphasizing founders' role in strategic decisions, especially within young firms.

Finally, our study contributes to the debate on additional award criteria (e.g., Krieger et al., 2024; Nemec, 2024; Stake, 2017). We argue that firm- and founder-level characteristics influence participation and success in public procurement distinctly across price-based (innovation-hampering) and criteria-based (innovation-rewarding) tenders, emphasizing their structural differences and the accommodating varying relevance of specific firm and founder attributes.

Empirical contribution – Empirically, our study contributes by leveraging a unique dataset that i) captures both firms applying for public procurement tenders and those ultimately winning them, and ii) founder- and firm-level characteristics. This allows us to overcome limitations in existing research, which i) either focuses exclusively on successful bidders (e.g., Blind et al., 2020) or relies on aggregated bidding data without firm-level detail (e.g., Hoekman and Taş, 2022), and ii) considers firm or tender characteristics (e.g., Di Mauro et al., 2020), while abstracting from founder attributes.

First, we identify novel determinants shaping firms' decisions to apply for public tenders as well as their success upon applying. By distinguishing between applicants and non-applicants, our analysis uncovers participation dynamics that remain unobserved in most prior studies – an exception being Di Mauro et al. (2020) and Flynn and Davis (2017), which, however, focus on small and medium-sized firms and do not integrate founder attributes.

Second, we jointly model the determinants of tender application and success using a multinomial two-stage framework, explicitly accounting for distinct effects of firm- and founder-level characteristics across price-based and criteria-based tenders. In doing so, we extend the empirical work of Di Mauro et al. (2020) and Flynn and Davis (2017), who acknowledge the relevance of additional award criteria but do not explore them as a source of effect heterogeneity. More broadly, our design addresses sample selection bias and thus enhances the internal validity of our findings compared to studies analyzing only winning firms (e.g., Flynn et al. , 2015) or employing binary selection models (Di Mauro et al., 2020).

Finally, we differentiate between founder-level and firm-level characteristics and employ residualization as a pre-estimation variable correction technique. This methodology enables us to disentangle "total" and "inherent" effects of each characteristic on procurement participation and success, thereby offering deeper insights into how founder-specific and firm-specific factors collectively shape procurement outcomes.

The findings of our analysis reveal distinct determinants of young firms' participation and success across procurement types. Firm size consistently predicts both application and winning probabilities. Founder characteristics significantly influence firms' application decisions, particularly public-sector experience, educational background, and team size. Importantly, we find pronounced differences between price-based and criteria-based tenders: while price-based tender success hinges on firm size and founder experience, criteria-based tender success is associated strongly with realized innovation, founders' doctoral qualifications, and team diversity. These findings emphasize that effective managerial and policy interventions must align specifically with tender type.

The remainder of the paper is structured as follows. Section 2 provides the theoretical background, emphasizing the relevance of public procurement for young firms and distinguishing between different tender types and decision stages. Section 3 describes the data, construction of variables, and key descriptive statistics. Section 4 details the empirical strategy, including the two-stage estimation framework and the residualization approach. Section 5 presents the main empirical findings. Section 6 discusses these results and outlines their implications for both managers and policymakers. Section 7 concludes.

2. Theoretical Background

2.1. Benefits of public procurement for young firms

Public procurement is the procedure through which public authorities, such as government departments and local authorities, acquire goods or services. It corresponds to 17 percent of European and 15 percent of German gross domestic product; therefore constituting significant market opportunities for private firms (Flammer, 2018).

The public procurement process consists of multiple stages. First, the procuring agency identifies a need for the purchase of a good, or service. Second, it issues a call for tender, in which it describes the requirements of the procured good, or service. Third, the procuring agency invites bids from potential suppliers. Fourth, it reviews the submitted bids and assigns scores based on the pre-established award criteria. Finally, the procuring agency grants the tender to the supplier that best fulfills the specified requirements.

Whereas all firms can profit from public procurement, young firms have a particularly high potential:

First, young firms in their founding phase face no or only little demand, preventing them from building up production capacities and supply chains. Winning a public procurement contract changes this situation, since with the public sector as a customer, young firms now can predict and quantify a certain and guaranteed demand, allowing them to scale-up their capacities (Hvide and Meling, 2023; Edler and Georghiou, 2007). This holds in particular since the government is not only a large, but also a reliable customer and thus the expressed demand is relatively certain, with little fallout risk.

Second, young firms are particularly affected by information asymmetries (Hall and Lerner, 2010). Unlike established firms with a proven market history, young firms often lack a history of customer relationships or an established network that can signal their reliability and growth potential. This lack of observable information makes it difficult for external parties – such as investors or customers – to assess the firms' true quality. Winning a public procurement contract changes this situation, providing a certification mechanism that signals credibility to external stakeholders. Recipients of a public procurement contract go through an extensive and rigorous selection procedure during the tender period. During this period, the public authority carefully considers the eligibility of a firm to sufficiently fulfill the contract

requirements. Thus, if a firm succeeds in a public procurement tender, this is a strong signal for high quality and reliability of the firm. This, in turn, eases firms' access to external financial means and allows them to build up relationships with customers (Dai et al., 2021).

Thus, in total, young firms benefit from public procurement in two key ways: i) the contract provides a guaranteed demand, allowing firms to expand production capacities and exploit economies of scale, and ii) it serves as a signal, reducing information asymmetries between the firm and potential customers or investors.

2.2. Differences between price- and criteria-based public tenders

As argued, public procurement provides significant market opportunities for private firms, in particular younger ones. However, there are significant differences between public procurement tenders. In particular, former research demonstrated the importance of additional award criteria next to the price within public tenders, such as environmental (e.g., Chiappinelli et al., 2025; Schäfer et al., 2024; Krieger and Zipperer, 2022), quality (e.g., Krieger et al., 2024), or innovation requirements (e.g., Czarnitzki et al., 2020, Stojčić et al., 2020).

We built on Krieger et al. (2024), who highlight the difference between tenders with and without additional award criteria next to the price. Extending the work of Edquist and Zabala-Iturriagagoitia (2020), they introduce the concept of price-based public procurement – public procurement tenders with no additional award criteria beyond the price – as opposed to criteria-based public procurement – public procurement tenders with additional award criteria beyond the price.

Award criteria are a major component within public procurement procedures and the European public procurement directives specifically encourage procurement agencies to include them in the selection process. They have the option to establish award criteria including qualitative, environmental, social, or innovative aspects when determining their awardee. As a result, the range of award criteria is broad and can also include more implementation-driven aspects, such as "wheelchair-user friendly ergonomics" in the context of a printer procurement by the European Commission[1], the "delivery time" and "service and maintenance provision" in the context of the procurement of trash cars by a German

[1] See https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:52021XC0706(03)&rid=6, last retrieved on 18/03/2025.

municipality[2], or more transformation-oriented motivated criteria such as "a 15-20% improvement in energy efficiency" to reduce carbon emissions in the context of the procurement of an electrical car ferry by the Norwegian Ministry of Transport (Baron, 2016). Firms that demonstrate better performance in the established criteria within their offers receive an increased likelihood of winning the tender (Krieger and Zipperer, 2022). Therefore, such tenders *reward innovation* within the dimensions of their award criteria. Krieger et al. (2024) refer to them as criteria-based tenders.

However, evaluating tenders with additional award criteria involves substantial time, expertise, and effort from the procurer. In comparison, price-based evaluations are more straightforward and quicker to execute (Sigma, 2016). Consequently, a large number of public procurement tenders focus exclusively on price, without considering other factors (Krieger et al., 2024). As a result, these tenders are typically awarded to the firm offering the lowest price for a clearly specified, and likely already existing product. Going beyond the description of the tenders within an offer is not rewarded, but increases the likelihood of a rejection. As such, tenders without additional criteria largely *hinder innovation*. Krieger et al. (2024) refer to these tenders as price-based tenders.

2.3. Procurers' awardee selection and firms' application decision

Thus, while public procurement offers opportunities for young firms to develop, not all procurement tenders are equally suitable for young firms, and not all young firms are equally participating in public procurement. First, firms with different capabilities and resources may be more or less suited to fulfill the requirements of price- or criteria-based tenders, affecting their preferences in applying and influencing their chances of winning either tender type. Second, the role of founders stands out, as they typically lead decision-making in young firms. Thus, their choices play a relevant role in shaping the founded firms (Chapman and Hottenrott, 2022; Dencker and Gruber, 2015), and make them highly relevant drivers in recognizing business opportunities (Unger et al., 2011), such as public procurement.

To understand the factors that enable young firms to participate and succeed in public procurement, we explore a variety of firm- and founder-level determinants. We conceptually differentiate between i) firm- and founder level characteristics which public procurers use to

[2] See https://ted.europa.eu/en/notice/-/detail/669923-2021, last retrieved on 18/03/2025.

identify a reliable winning firm out of the pool of applicants and ii) those firm- and founder-level characteristics which drive a firm's decision to apply for a public procurement award. A differentiation between both stages – winning procurement tenders and applying for them – is important, as there are two distinct selection mechanisms at play. Firms get selected out of the pool of applicants by public procurers based upon observable determinants (e.g., Szucs, 2024; Baltrunaite et al., 2021). In contrast, firms which apply for public procurement tenders self-select themselves into the procurement process based on internal decision-making (Di Mauro et al., 2020).

Picking the winner – From the procurer's perspective, public agencies have to carefully select an awardee based upon observable characteristics. However, a fundamental challenge in this process arises from information asymmetries between the procurer and potential suppliers. While firms possess private information about their true capabilities, costs, and innovation potential, the public agency must rely on observable characteristics and past performance as imperfect proxies for these attributes (e.g., Uyarra et al., 2014; Edler and Georghiou, 2007). While the public agency has some freedom in choosing the winning candidate out of the pool of applicants by specifying award criteria in the tender specifications, they are legally obliged to transparently pick a winning firm which qualifies to fulfil the contractual obligations of the procurement contract in a reliable and concise manner.[3] In order to do so, public agencies have to rely on observable firm-level and founder-level characteristics, which serve as a signal for public agencies about the potential future performance of a firm.

Exemplarily, consider a public agency which aims to procure a standardized good for the cheapest price in a price-based procurement tender. In that scenario, it might prefer an older and larger firm, which has established logistical networks and supply chains, higher production capacities and can exploit its economies of scale to submit a very competitive bid. Simultaneously, a smaller and younger firm might lack the necessary infrastructure, and has to build up production capacities first (Helfat and Peteraf, 2003), to refine them over time by learning-by-doing (Herriott et al., 1984). This makes selecting a smaller and younger firm for a price-based tender – in which procurers often aim to find a cheap, reliable, uncomplicated

[3] See European Public Procurement Directive 2014/24/EU.

and quick solution – more risky and in turn also more costly for the risk-averse public procurer (Georghiou et al., 2014).

In contrast, if an agency seeks out for an innovative solution for a problem it is facing, and also other criteria beyond the price are considered, this opens up opportunities for younger and smaller firms to propose and implement their innovative ideas and products (Talebi et al., 2022a; Dorner, et al., 2017; Coad et al., 2016; Arora and Cohen, 2015; Ouimet and Zarutskie, 2014; Cohen and Klepper, 1996). In criteria-based procurement, public procurers do not simply pick the cheapest offer, but the supplier of the solution which best meets the different requirements of the procurement contract. Therefore, in this case, the procurer more likely prefers a firm with a portfolio of innovative products (García-Quevedo et al., 2014). Thus, a broad range of at least partly different firm-level characteristics – such as firm size, age, and innovation performance – are observable for the public agency and relevant determinants in picking an awardee.

Additionally, public procurers may go beyond firm-level characteristics and consider tender-relevant attributes of the founding team when selecting a winner. As for firm characteristics, they are likely to select firms with different founder characteristics for either price-based or criteria-based procurement. Exemplarily, founder teams with high educational attainment might rather be picked for criteria-based procurement contracts, in which they can excel with technologically advanced, innovative ideas and products (Agarwal and Shane, 2014; Åstebro et al., 2012). In contrast, experienced founders might draw on their successfully completed projects to strengthen their bids in price-based tenders (Dencker and Gruber, 2014; Shane, 2000), thereby increasing their chances of being selected as awardee.

Deciding to apply – From the firm's perspective, the public procurement procedure is a highly bureaucratic process (Decarolis et al., 2020). Thus, in particular younger firms have to dedicate human and financial resources to steer through this bureaucratic process (Talebi et al., 2022b; Loader, 2016), which due to their limited resources and experience with administrative processes imposes high entry costs (Nemec, 2024; Talebi et al., 2022a). Therefore, the decision to apply for a procurement tender depends on a firm's evaluation whether they can meet the specified criteria, if the duration of the contract is long, and its size large enough to competitively price an offer, and on the perceived execution risk associated with the tender (Uyarra et al., 2014). In sum, the potential benefits have to outweigh the costs of preparing and

submitting a bid for a young firm to participate in public procurement (e.g., Kostamis et al., 2009). Thus, firms' decisions to apply for criteria-based or price-based procurement contracts are shaped by a set of internal, and often unobservable, strategic considerations. Accordingly, distinct types of firms may perceive the benefits and costs of a tender differently, leading to different decisions on whether to participate in public procurement, or not.

Exemplarily, larger and older firms with more established production capacities and supply-chains may be drawn to price-based procurement tenders to exploit economies of scale (Hoekman and Taş, 2022), whereas smaller and younger firms face relatively higher costs and thus may be less drawn to compete (Audretsch, 1999). Simultaneously, smaller and younger firms specializing in innovation may find criteria-based procurement attractive, as it allows them to differentiate themselves through quality, technological expertise, or unique solutions (e.g., Schneider and Veugelers, 2010). This holds in particular for firms with higher R&D capacities (Blind et al., 2020), as criteria-based public procurement allows these firms to apply their knowledge acquired during their R&D processes in a real-world environment.

Moreover, a firm's founding team and its composition, likely impact the application decision. Literature has repeatedly emphasized the role of sociodemographic founder characteristics, such as gender, age, nationality, or human capital attributes of the founder, such as education, or experience on the founders' risk preferences (e.g., Tang and Li, 2016; Faccio et al., 2016), their innovation capabilities (e.g., Fonseca et al., 2019; Faems and Subramanian, 2013; Cohen and Levinthal, 1990;) and their access to a network and resources to work with private firms or public institutions (e.g., Calvo et al., 2019; Dencker and Gruber, 2015).

For example, while larger teams might possess a broader range of skills, they are also less agile and flexible (Stieglitz et al., 2015), making it difficult to coordinate on potential solutions for technically more demanding criteria-based procurement contracts. In price-based procurement contracts, larger founding teams can benefit from their extensive network (Raz and Gloor, 2007), allowing them to build up efficient supply-chains and optimize their cost structures. A broader span of ages can be advantageous for both, criteria- and price-based procurement tenders: Whereas younger founders are found to be more open-minded towards innovation (Acemoglu et al., 2022), older founders might provide the team with more experience in navigating the complex procurement procedures (Murmann et al., 2023; Shane, 2000). In addition, more gender diverse founding teams have been shown to perform better

with respect to innovation (Dai et al., 2019), and thus might be more inclined towards criteria-based procurement.

In sum, Section 2 offers a theoretical background for an explorative examination of how young firms engage with public procurement – a market that promises both a reliable source of demand and a certification effect. By distinguishing between price-based and criteria-based tenders, we underscore how tender processes, alongside firm- and founder-level characteristics, guide both firms' strategic decision to apply and public agencies' choice of awardees.

3. Data preparation

3.1. 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 young firms in Germany with a maximum age of seven since 2007. The data serve as a suitable basis for describing and analyzing the structure and development of young firms. Covering 5,000 to 6,000 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).

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), most previous studies using survey data abstracted from firms' application for public procurement tenders. Therefore, we are able to compare winning firms to non-winnings firms within the group of appliers as part of a multi-step selection model. As a result, our findings on the predictors of success in public procurement are unlikely to result from pre-existing differences between appliers and non-appliers.

Second, existing studies on the impact of 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 first described in the conceptual paper by Edquist and Zabala-Iturriagagiotia (2020), and later extended with a focus on award criteria by Krieger et al. (2024), is the best alternative.

Krieger et al. (2024) distinguish between two kinds of public procurement: i) price-based procurement and ii) criteria-based procurement. As previously mentioned, in price-based procurement, public authorities largely describe existing products and services in their tenders, while using the price as sole award criterion. 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 criteria-based procurement, public authorities specify further criteria in their

tenders, such as environmental, quality, or social criteria. 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 criteria-based public procurement tenders with our Question (B).

Third, we investigate young firms aged between one and seven. Thus, we deviate from the often used "three-year period variables" (e.g., Krieger and Zipperer, 2022; Caravella and Crespi, 2020) 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 (C). Thus, we avoid asking younger firms about their pre-foundation years.

Finally, we are aware of a number of *limitations of our survey 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 to scare to include them. The same reasoning holds for not including further questions on tender characteristics, such as, the value of won or applied for 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	Has your company received any public procurement contracts since its foundation?	1	0

Note: The question listed above were part of the IAB/ZEW Start-Up Panel telephone survey from 2022.

3.2. Variable construction

We explore the relevance of various founder and firm characteristics in determining firms' application decision, and procurers' winner selection as highlighted in Section 2. At the founder level, we concentrate on determinants related to founder team size, diversity, and history. At the firm level, we focus on determinants related to firm size, history, innovativeness, and performance.

Founder characteristics

- *Team size* – The number of persons within the founding team of the firm.
- *Age* – We estimate the age of the founder team as the median of the founders' ages.[4]
- *Age diversity* – We estimate age diversity as the standard deviation of the founders' ages.[5]
- *Female share* – The share of female founders in the foundation team.
- *Gender diversity* – We measure gender diversity as continuous linear variable being equal to one for a maximum diversity (a ratio of 50/50), and a value of zero for a minimum diversity (a ratio of 100/0).[6]
- *Nationality* – A dummy variable for a German being part of the founding team.
- *Higher education degree* – A dummy variable equal to one if a founding team member has a higher-education degree.[7]
- *Doctoral degree* – A dummy variable equal to one if a founding team member holds a doctorate.
- *Public sector* – A dummy variable indicating whether a founding team member was previously employed in the public sector.
- *Private sector* – A dummy variable indicating whether a founding team member was previously employed in the private sector.

[4] Our result stay robust to using the mean of founders' age.
[5] Our result stay robust to using the IQR or the difference between the maximum and minimum age.
[6] Our results stay robust using a squared term of the "female share" instead of a diversity index.
[7] Our results stay robust to excluding the "Doctoral degree" from the "Higher education degree" variable.

Firm characteristics

- *Firm size* – The number of employees working for the young firm.
- *Export status* – A dummy variable indicates whether a firm generates export revenues.
- *Market novelty* – A dummy for having implemented new or significantly improved products or services not yet existing.
- *R&D intensity* – Research and development expenditures over employees.[8]
- *Public support* – A dummy variable for receiving public subsidies.
- *Firm age* – The age of the young firm in years.

3.3. Sample statistics

This section presents descriptive statistics for young firms based on their participation in public procurement tenders. We differentiate between non-applicants, unsuccessful applicants, and successful applicants, separately addressing the statistics related to price-based (Table 2.A) and criteria-based (Table 2.B) tenders. The total sample comprises 4,314 firms, including 3,586 non-applicants and 458 applicants for price-based tenders, and 270 applicants for criteria-based tenders. Descriptive statistics for our total sample are provided in Table A.1 in Appendix A. Among applicants, the share of firms applying for price-based tenders (11.3%) is higher than the share applying for criteria-based tenders (7.0%). However, the success rate – measured as the share of applicants winning at least one tender since foundation – is higher among criteria-based applicants (69.3%) compared to price-based applicants (62.0%).

Table 2.A provides descriptive statistics related to price-based procurement tenders for 4,044 young firms. Out of these, 3,586 firms did not apply for tenders, while 458 firms applied, with 284 successful in obtaining at least one contract. Applicants for price-based tenders differ significantly from non-applicants in several aspects. Specifically, applicant firms have larger founder teams, higher educational attainment among founders, larger employment sizes, and longer firm histories. However, these firms have slightly lower representation of female founders and fewer introductions of market novelties compared to non-applicants, although these differences are only marginally significant. Among price-based applicants, successful

[8] Our results stay robust to defining R&D intensity as "research and development expenditures over revenues."

firms are notably characterized by older founder teams, slightly higher educational attainment among founders, and greater firm age compared to unsuccessful applicants.

Table 2.B presents statistics for criteria-based procurement tenders based on 3,856 observations, including 3,586 non-applicants and 270 applicants, of whom 187 successfully secured contracts. Applicants for criteria-based tenders significantly differ from non-applicants. These applicants generally exhibit larger founder teams, older founder age, and greater educational attainment, including higher proportions of doctoral degrees. Criteria-based applicants also tend to have larger firm sizes, longer firm existence, higher export orientation, greater R&D intensity, and a slightly higher likelihood of having introduced market novelties. Within the group of applicants, successful firms have significantly more employees, marginally higher proportions of doctoral degrees among founders, and greater firm age compared to unsuccessful applicants.

4. Empirical Strategy

To investigate how firm- and founder characteristics shape young firms' participation in public procurement, we adopt a multi-step approach that addresses their total, and inherent effects.[9] Specifically, we analyze both the decision to apply for public tenders and the likelihood of securing them, while addressing potential sample selection bias arising from observing only applicants in the winning stage. Moreover, we employ a residualization procedure to separate the components of firm-level variables that are driven by founder characteristics, thereby enabling a clearer estimation of the inherent influences of founder and firm-specific factors on public procurement participation.

[9] Although we use the term "effect" when identifying separate founder and firm influences through our residualization strategy, the results should be understood as correlational rather than causal in nature.

Table 2.A – Descriptive statistics of non-applicants, applicants, and winners of price-based tenders

T-tests for differences in means focused on **price-based** public procurement tenders	Means		Difference	Means		Difference
	Non-applicants	Applicants	(2)-(1)	Unsuccessful applicants	Successful applicants	(5)-(4)
	(1)	(2)	(3)	(4)	(5)	(6)
Number of founders	1.443	1.587	**0.144****	1.494	1.644	0.150
Median age of founders	42.359	42.148	-0.210	40.109	43.398	**3.289****
Share of female founders	0.146	0.116	**-0.030***	0.122	0.112	-0.010
Gender diversity (0-1)	0.085	0.110	0.024	0.082	0.127	0.045
German founder (0/1)	0.892	0.919	**0.027***	0.902	0.930	0.027
Higher education degree (0/1)	0.504	0.607	**0.103*****	0.546	0.644	**0.098***
Doctoral degree (0/1)	0.054	0.076	0.022	0.075	0.077	0.003
Previous employment in public sector (0/1)	0.059	0.061	0.002	0.052	0.067	0.015
Previous employment in private sector (0/1)	0.644	0.668	0.024	0.655	0.676	0.021
Number of employees	4.013	5.440	**1.427*****	4.987	5.717	0.730
Firm age in years	2.555	3.162	**0.607*****	2.851	3.352	**0.502****
Export revenues (0/1)	0.137	0.118	-0.019	0.126	0.113	-0.014
Public support (0/1)	0.300	0.310	0.010	0.339	0.292	-0.047
R&D intensity	3.444	3.172	-0.272	4.381	2.431	-1.950
Market novelty (0/1)	0.038	0.022	**-0.016***	0.029	0.018	-0.011
Observations	3,586	458	-	174	284	-

* p < 0.10, ** p < 0.05, *** p < 0.01

Table 2.B – Descriptive statistics of non-applicants, applicants, and winners of criteria-based tenders

T-tests for differences in means focused on **criteria-based** public procurement tenders	Means		Difference	Means		Difference
	Non-applicants	Applicants	(2)-(1)	Unsuccessful applicants	Winners	(5)-(4)
	(1)	(2)	(3)	(4)	(5)	(6)
Number of founders	1.443	1.841	**0.398*****	1.976	1.781	-0.195
Median age of founders	42.359	43.750	**1.391***	42.988	44.088	1.100
Share of female founders	0.146	0.101	**-0.045****	0.070	0.115	0.045
Gender diversity (0-1)	0.085	0.104	0.019	0.071	0.119	0.047
German founder (0/1)	0.892	0.926	**0.034***	0.916	0.930	0.015
Higher education degree (0/1)	0.504	0.700	**0.196*****	0.651	0.722	0.071
Doctoral degree (0/1)	0.054	0.148	**0.094*****	0.084	0.176	**0.092***
Previous employment in public sector (0/1)	0.059	0.119	**0.059****	0.108	0.123	0.015
Previous employment in private sector (0/1)	0.644	0.589	-0.055	0.530	0.615	0.085
Number of employees	4.013	6.204	**2.191*****	4.940	6.765	**1.825****
Firm age in years	2.555	3.163	**0.608*****	2.663	3.385	**0.722****
Export revenues (0/1)	0.137	0.189	**0.052***	0.205	0.182	-0.023
Public support (0/1)	0.300	0.341	0.041	0.301	0.358	0.057
R&D intensity	3.444	6.759	**3.316*****	7.091	6.612	-0.479
Market novelty (0/1)	0.038	0.074	**0.036***	0.036	0.091	0.055
Observations	3,586	270	-	83	187	-

* p < 0.10, ** p < 0.05, *** p < 0.01

Probability of applying – We model whether firms i) do not apply, ii) apply for price-based tenders, or iii) apply for criteria-based tenders.[10] As such, we estimate a multinomial probit model:

$$P(apply_i = j) = \Phi(X_i \beta_j + Z_i \gamma_j + \varepsilon_i), \qquad for\ j \in \{0,1,2\}$$

where $P(apply_i = j)$ is the probability that firm i selects outcome j. X_i contains firm and founder characteristics, while Z_i denotes two instrumental variables. The error term ε_i follows a multivariate normal distribution, allowing correlation across choices.

Instrumental variables – To correct for the non-random selection of firms into applying for public procurement, we use two region-level instrumental variables aiming at exogenous differences in local procurement patterns. One instrumental variable captures the share of sample firms in a given labor market region that apply for criteria-based tenders, while the other captures the share applying for price-based tenders.[11]

Inverse Mills Ratios – After estimating the multinomial probit, we derive Inverse Mills Ratios for applying for price- or criteria-based tenders. Specifically, we compute separate ratios for firms that opt for price-based versus criteria-based tenders. These ratios capture the probability of a firm self-selecting into each respective tender type and serve as correction terms in the second stage (e.g., Certo et al., 2016; Heckman et al. 2008). The Inverse Mills Ratio for an individual firm i and outcome j is computed as:

$$IMR_{ij} = \varphi(\hat{x}_{ij}) / \Phi(\hat{x}_{ij}),$$

where $\varphi(\cdot)$ is the standard normal density function and $\Phi(\cdot)$ is the standard normal cumulative distribution function. The term $\hat{x}_{ij} = (X_i \beta_j + Z_i \gamma_j)$ represents the estimated index from the first-stage multinomial probit for outcome j. Intuitively, IMR_{ij} captures how the unobserved factors that drive the application decision also influence the likelihood of winning, correcting for self-selection.

[10] Multi-outcome selection models are frequently applied in management research. For example - focusing on the analysis of public procurement - Nemec (2024) used a multinomial logit model to investigate the participation of small and medium sized enterprises in winning public procurement tenders.

[11] Green (2006) discusses the approach to incorporating sample selectivity in a model in general, as well as the binary, count, and multinomial case.

Probability of winning – Conditional on application, we model each firm's likelihood of winning via probit estimations:

$$P(win_i \,|apply_i = j) = \Phi(W_i\,\theta + \lambda_j\, IMR_i + \eta_i)$$

where W_i includes firm and founder characteristics, IMR_i is the selection correction for the relevant tender type, and η_i is an error term. The parameter λ_j indicates how the selection process influences winning probabilities for price-based ($j = 1$) or criteria-based ($j = 2$) tenders.[12]

Assumptions – By incorporating IMR_i, we aim to account for unobserved factors jointly determining the application decision and the likelihood of winning. However, the effectiveness of this correction relies on several key assumptions (e.g.; Heckman et al. 2008, Acemoglu and Johnson, 2005):

i. *Relevance* – The instrumental variables must strongly correlate with application decisions but not directly influence winning.
ii. *Exclusion restriction* – The instrumental variables affect tender outcomes only through the firm's decision to apply, not via other channels.
iii. *Instrument specificity* – Each instrumental variable predominantly affects one type of application choice – price-based or criteria-based – to avoid conflating correlations with both outcomes.

Model specifications – We employ three distinct specifications to parse the respective contributions of founder- and firm characteristics to procurement outcomes. By systematically varying which variables are included and how they are treated, we can distinguish between "total," and "inherent" effects of founder and firm characteristics.

Founder only (A) – In this specification, we include only founder-level characteristics. Because founder attributes may indirectly shape firm-level factors, their coefficients in this model capture both the direct effects of founders and any indirect influence that occurs via firm-level channels. Thus, the estimated coefficients represent the *total* effect of founder characteristics with procurement outcomes.

[12] Adams and Cuecuecha (2010) represent an example of a multinomial two-stage selection model.

Firm only (B) – Here, we include only firm-level characteristics. However, because these firm-level factors may themselves be driven by founders' attributes, the coefficients also reflect founder-induced influences. Therefore, this specification yields a *total* effect – this time, of firm characteristics – without disentangling the founder's role in shaping those variables.

Residualized (C) – In this specification, we jointly include founder- and firm-level characteristics. However, we implement a pre-estimation residualization procedure to isolate the purely firm-specific component of each firm-level variable from any founder-driven influence. By including these residualized firm variables and the original founder characteristics together, we estimate the *inherent* contribution of firm characteristics independent of founder traits. This aims to secure firm-level effects reflecting those aspects intrinsic to the firm, rather than the imprint of its founders, and vice versa.

Residualization – Estimating founder and firm variables directly in a single equation can conflate overlapping sources of variation (Wooldridge, 2010).[13] By contrast, in Specification (C), each firm-level variable is first regressed on the full set of founder characteristics using ordinary least squares, and only the resulting residuals – that is, the variation not explained by those founder characteristics – are included in the main equation of our first and second stage estimations.[14] Consequently, the coefficients on these residualized firm variables reflect only the impact of the portion that does not overlap with founder influences. In other words, any direct founder imprint on the firm variable is stripped out and now appears exclusively in the founder coefficients.

Effect heterogeneity – In order to capture potential non-linear relations, we include squared terms for all continuous variables in all our estimations. Then, for each individual estimation, we evaluate whether each squared term and its corresponding linear term are statistically significant. Specifically, if not both are statistically significant, we remove the squared term and retain only the linear term. With this, we aim to account for meaningful non-linearities in

[13] Wooldridge points out that when researchers include variables measured at different levels (for example, founder-level and firm-level characteristics) in a single regression equation, they risk attributing the same underlying variation to multiple sources. In other words, correlated factors at the founder level and firm level can make it difficult to isolate the separate explanatory effects of each set of variables. This conflation can leads to biased or misleading coefficient estimates because what appears to be the effect of a founder-level variable may partly reflect unmeasured firm-level phenomena, and vice versa.

[14] Demerjian et al. (2010) similarly parse out firm-specific and management-specific determinants of firm efficiency.

founder- and firm-level characteristics without overburdening the model with higher-order terms that do not contribute to explaining procurement outcomes.

Estimation – We report all results as Average Marginal Effects to facilitate interpretation of changes in the predicted probability of each outcome. To mitigate multicollinearity between linear and squared terms, we center all continuous variables. We use robust standard errors to accommodate heteroscedasticity.

Empirical limitations – Despite these methodological refinements, several limitations must be acknowledged:

Data constraints – As outlined in Section 3, we are unable to separately identify firms that apply to both types of tenders, nor can we distinguish between those that apply exclusively to criteria-based tenders and those that apply to both price- and criteria-based tenders. Consequently, we must treat all such firms as a single group in our analysis, which may limit our ability to capture more nuanced bidding behaviors across different tender types. As a result, important distinctions in how firms engage with price- versus criteria-based tenders may be overlooked. Furthermore, beyond the presence of additional criteria, no detailed information on the tenders themselves – such as their value or administrative complexity – is available. Therefore, our analysis reflects average outcomes for the tenders young firms apply for or win within the identified tender groups, while potential heterogeneities resulting from other tender demands remain unobserved (e.g., Di Mauro et al., 2020; Flynn and Davis, 2017).

Instrument validity – Our selection-correction hinges on region-level shares of firms applying for price-based or criteria-based tenders serving as valid instruments. While it is unlikely that these region-level tendencies directly affect winning – which primarily reflect firm-specific bids – unobserved local factors could, in principle, violate the exclusion restriction. Nevertheless, awarding agencies are legally obligated to decide based on each firm's proposal rather than broader regional application rates, reinforcing the plausibility that these instruments shape application choices without directly influencing individual firms' winning probability.

Founder–firm interactions – Given the large number of variables, we do not estimate interaction terms between founder and firm characteristics. As a result, paths – where certain founder traits amplify or moderate firm-level effects – remain unobserved.

External validity – Our empirical analysis focuses on young firms in Germany, which was an early adopter of key EU public procurement reforms – such as allowing innovative procurement and mandating the subdivision of tenders into smaller lots. Consequently, Germany's legal framework offers a valuable benchmark for other EU member states that have implemented or plan to implement similar measures. Moreover, Germany is one of Europe's largest economies, alongside France and the United Kingdom, and it exhibits relatively stable rates of new firm formation despite offering comparatively limited fiscal support for entrepreneurship. While these contextual distinctions exist, previous firm-level research on public procurement (e.g., Caravella and Crespi, 2020; Stojčić et al., 2020) suggests broadly similar results across different European settings. Thus, our findings likely extend to other jurisdictions that operate under comparable procurement regulations or exhibit parallel entrepreneurial dynamics. For a more comprehensive account of the German environment, see Appendix B.

Overall, while our multi-step estimation strategy and residualization procedure represent an improvement over simpler methods, these limitations underscore the need for cautious interpretation of the findings.

5. Results

Tables 3.A and 3.B present the results of the first-stage multinomial probit estimations, examining how founder and firm characteristics influence young firms' decisions to apply for price-based or criteria-based public procurement tenders. Specification (A) captures total founder effects, Specification (B) total firm effects, and Specification (C) inherent effects of both groups.

Table 3.A – For price-based tender applications, the regional share of price-based applicants is significantly associated with application likelihood, supporting the relevance of this instrument. Conversely, the regional share of criteria-based applicants shows no significant association, supporting instrument specificity. Founder characteristics, including the number of founders and prior public sector employment, show marginal significance in Specifications (A) and (C). Moreover, the similarity of their coefficients suggests a possible inherent association for both. Founders' higher education degrees are weakly significant in Specification (A), then decrease in magnitude and significance in Specification (C), pointing to

the absence of an inherent association but the presence of a total association that may be mediated by firm characteristics. Finally, firm size is consistently associated with higher application likelihood in Specifications (B) and (C), indicating a stable inherent pattern.

Table 3.B – For criteria-based tender applications, the regional share of criteria-based applicants is significantly associated with application likelihood, supporting instrument relevance, whereas the share of price-based applicants is not, reinforcing instrument specificity. Founder characteristics—including the number of founders, higher education degrees, and doctoral degrees—are significantly associated with application probabilities in Specifications (A) and (C), suggesting notable inherent associations. Prior public sector employment shows a similar, though weaker, pattern given its lower statistical significance. Firm size and R&D intensity are significantly associated with increased application likelihood at a diminishing rate in Specifications (B) and (C), indicating consistent inherent patterns.

Table 3.A – Determinants of applying for price-based tenders

Dependent variable:	Price-based tender applicant (0/1)		
Specification:	(A)	(B)	(C)
Founder Characteristics			
Centered number of founders	**0.011***		**0.011***
	(0.006)		(0.006)
Median age of founders	-0.000		-0.001
	(0.000)		(0.000)
Standard deviation of age	-0.001		-0.001
	(0.001)		(0.001)
Share of female founders	-0.013		-0.010
	(0.018)		(0.018)
Gender diversity (0-1)	0.011		0.010
	(0.018)		(0.018)
German founder (0/1)	0.006		0.011
	(0.016)		(0.016)
Higher education degree (0/1)	**0.020***		0.016
	(0.010)		(0.010)
Doctoral degree (0/1)	0.012		0.013
	(0.018)		(0.018)
Previous employment in public sector (0/1)	**0.011***		**0.011***
	(0.006)		(0.006)
Previous employment in private sector (0/1)	-0.000		-0.001
	(0.000)		(0.000)
Firm characteristics			
Centered number of employees		**0.012*****	**0.011*****
		(0.001)	(0.001)
Centered number of employees²		**-0.000*****	**-0.000*****
		(0.000)	(0.000)
Firm age in years		-0.000	0.000
		(0.000)	(0.001)
Export revenues (0/1)		-0.017	-0.019
		(0.014)	(0.014)
Public support (0/1)		-0.001	-0.001
		(0.010)	(0.010)
Centered R&D intensity		-0.001	-0.001
		(0.001)	(0.001)
Centered R&D intensity²		0.000	0.000
		(0.000)	(0.000)
Market novelty (0/1)		-0.042	-0.041
		(0.028)	(0.028)
Instrument variables			
Regional criteria-based applicant share	-0.013	-0.049	-0.054
	(0.115)	(0.114)	(0.116)
Regional price-based applicant share	**0.916*****	**0.893*****	**0.888*****
	(0.074)	(0.073)	(0.073)

Note: Table 3.A and 3.B. are jointly estimated using a multinomial probit model. The number of observations equals 4,314. Standard errors are in parentheses and robust to heteroscedasticity. Dummies for industries are included. Estimates are presented as average marginal effects. Specifications (A) to (C) represent the specifications as introduced in Section 4. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table 3.B – Determinants of applying for criteria-based tenders

Dependent variable:	Criteria-based tender applicant (0/1)		
Specification:	(A)	(B)	(C)
Founder characteristics			
Centered number of founders	**0.016*****		**0.018*****
	(0.004)		(0.004)
Median age of founders	0.001		0.001
	(0.000)		(0.000)
Standard deviation of age	0.000		0.000
	(0.001)		(0.001)
Share of female founders	-0.015		-0.016
	(0.014)		(0.014)
Gender diversity (0-1)	-0.011		-0.013
	(0.014)		(0.014)
German founder (0/1)	-0.004		-0.003
	(0.013)		(0.012)
Higher education degree (0/1)	**0.018****		**0.017****
	(0.008)		(0.008)
Doctoral degree (0/1)	**0.020***		**0.023****
	(0.012)		(0.012)
Previous employment in public sector (0/1)	**0.025***		**0.021***
	(0.013)		(0.013)
Previous employment in private sector (0/1)	-0.004		-0.005
	(0.007)		(0.007)
Firm characteristics			
Centered number of employees		**0.006*****	**0.005*****
		(0.001)	(0.001)
Centered number of employees²		**-0.000*****	**-0.000****
		(0.000)	(0.000)
Firm age in years		0.000	0.000
		(0.000)	(0.000)
Export revenues (0/1)		0.009	0.008
		(0.010)	(0.010)
Public support (0/1)		-0.001	-0.001
		(0.008)	(0.008)
Centered R&D intensity		**0.002*****	**0.001****
		(0.001)	(0.001)
Centered R&D intensity²		**-0.000****	**-0.000***
		(0.000)	(0.000)
Market novelty (0/1)		0.011	0.007
		(0.016)	(0.016)
Instrument variables			
Regional criteria-based applicant share	**0.745*****	**0.741*****	**0.723*****
	(0.090)	(0.089)	(0.087)
Regional price-based applicant share	0.013	0.016	0.002
	(0.060)	(0.059)	(0.059)

Note: Table 3.A and 3.B. are jointly estimated using a multinomial probit model. The number of observations equals 4,314. Standard errors are in parentheses and robust to heteroscedasticity. Dummies for industries are included. Estimates are presented as average marginal effects. Specifications (A) to (C) represent the specifications as introduced in Section 4. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Tables 4.A and 4.B report the second-stage probit estimations, analyzing the determinants of winning price-based and criteria-based public procurement tenders, conditional on applying. Both present Specifications (A) to (C), as Table 3.A. and 3.B previously.

Table 4.A – For winning price-based tenders, the Inverse Mills Ratio is weakly significant only in Specification (B), indicating moderate selection bias correction primarily when founder characteristics are not included. Founder characteristics show that median age is significantly associated with higher winning probabilities across Specifications (A) and (C), suggesting a potential inherent association. The number of founders shows a weakly significant positive association only in Specification (C), providing no consistent pattern across specifications. Regarding firm characteristics, larger firm size is significantly associated with higher winning likelihood in both Specifications (B) and (C), with a diminishing rate, indicating a stable inherent pattern. Firm age is significantly associated with winning only in Specification (B), suggesting that its observed total association may be influenced by founder-level characteristics.

Table 4.B – For winning criteria-based tenders, the Inverse Mills Ratio is marginally significant in Specification (B), again indicating limited selection bias correction when founder characteristics are excluded. Founder characteristics – specifically age diversity and holding a doctoral degree – are significantly and consistently associated with higher winning probabilities across Specifications (A) and (C), suggesting possible inherent associations. Conversely, the number of founders is consistently negatively associated with winning likelihood, indicating potential disadvantages of larger founder teams in securing criteria-based tenders. Firm characteristics, such as larger firm size and the introduction of market novelties, are significantly associated with increased winning probabilities in Specifications (B) and (C), pointing to strong inherent patterns. Firm age is only significantly associated in Specification (B), suggesting that its total association may be primarily driven by founder-level characteristics.

Table 4.A – Determinants of winning price-based tenders

Dependent variable:	Price-based tender winner (0/1)		
Specification:	(A)	(B)	(C)
Founder characteristics			
Centered number of founders	0.043		**0.054***
	(0.031)		(0.030)
Median age of founders	**0.007*****		**0.006*****
	(0.002)		(0.002)
Standard deviation of age	-0.006		-0.006
	(0.006)		(0.006)
Share of female founders	-0.110		-0.075
	(0.091)		(0.087)
Gender diversity (0-1)	0.076		0.046
	(0.090)		(0.086)
German founder (0/1)	0.034		0.082
	(0.082)		(0.082)
Higher education degree (0/1)	0.040		0.006
	(0.057)		(0.055)
Doctoral degree (0/1)	-0.090		-0.087
	(0.089)		(0.085)
Previous employment in public sector (0/1)	0.072		0.056
	(0.093)		(0.091)
Previous employment in private sector (0/1)	0.028		0.032
	(0.050)		(0.050)
Firm characteristics			
Centered number of employees		**0.027*****	**0.028*****
		(0.010)	(0.010)
Centered number of employees²		**-0.002*****	**-0.002*****
		(0.001)	(0.001)
Firm age in years		**0.006*****	0.003
		(0.002)	(0.003)
Export revenues (0/1)		-0.036	-0.044
		(0.072)	(0.072)
Public support (0/1)		-0.018	-0.001
		(0.048)	(0.047)
Centered R&D intensity		-0.004	-0.006
		(0.004)	(0.005)
Centered R&D intensity²		0.000	0.000
		(0.000)	(0.000)
Market novelty (0/1)		0.057	0.091
		(0.153)	(0.155)
Inverse Mills Ratio			
IMR_{i1}	0.098	**0.317***	0.285
	(0.183)	(0.183)	(0.188)

Note: Table 4.A. is estimated using a probit model. The number of observations equals 458. Standard errors are in parentheses and robust to heteroscedasticity. Dummies for industries are included. Estimates are presented as average marginal effects. Specifications (A) to (C) represent the specifications as introduced in Section 4. * p < 0.10, ** p < 0.05, *** p < 0.01

Table 4.B – Determinants of winning criteria-based tenders

Dependent variable:	Criteria-based tender winner (0/1)		
Specification:	(A)	(B)	(C)
Founder characteristics			
Centered number of founders	**-0.080*****		**-0.070****
	(0.030)		(0.030)
Median age of founders	-0.001		-0.001
	(0.003)		(0.003)
Standard deviation of age	**0.016****		**0.016****
	(0.007)		(0.007)
Share of female founders	0.127		0.121
	(0.128)		(0.123)
Gender diversity (0-1)	0.137		0.084
	(0.122)		(0.120)
German founder (0/1)	0.007		-0.019
	(0.106)		(0.103)
Higher education degree (0/1)	0.058		0.071
	(0.076)		(0.074)
Doctoral degree (0/1)	**0.229****		**0.246*****
	(0.092)		(0.091)
Previous employment in public sector (0/1)	-0.025		-0.042
	(0.096)		(0.093)
Previous employment in private sector (0/1)	0.063		0.033
	(0.057)		(0.056)
Firm characteristics			
Centered number of employees		**0.019****	**0.015****
		(0.007)	(0.006)
Firm age in years		**0.005****	**0.008****
		(0.003)	(0.003)
Export revenues (0/1)		-0.076	-0.088
		(0.072)	(0.069)
Public support (0/1)		0.056	0.045
		(0.058)	(0.058)
Centered R&D intensity		-0.001	-0.001
		(0.002)	(0.002)
Market novelty (0/1)		**0.237****	**0.219****
		(0.115)	(0.110)
Inverse Mills Ratio			
IMR_{i2}	-0.086	**-0.404***	-0.224
	(0.239)	(0.209)	(0.209)

Note: Table 4.B. is estimated using a probit model. The number of observations equals 270. Standard errors are in parentheses and robust to heteroscedasticity. Dummies for industries are included. Estimates are presented as average marginal effects. Specifications (A) to (C) represent the specifications as introduced in Section 4. * p < 0.10, ** p < 0.05, *** p < 0.01

6. Discussion

6.1. Young firms' application decision and procurers' awardee selection

Young firms' application decision – Our first-stage results identify both joint and distinct determinants of young firms' decision to apply for public procurement tenders, differentiated by tender type. Most founder- and firm-level characteristics exert inherent relationships, as indicated by their continued significance after residualization, highlighting the importance of taking both levels of characteristics into account.

Joint founder-level determinants include the number of founders and prior public sector employment, both positively associated with application likelihood across price-based and criteria-based tenders. Similarly, firm size is a robust joint firm-level determinant, though the diminishing average marginal effect suggests decreasing returns. These patterns suggest that teams with more capacity and public sector familiarity are better positioned to overcome the administrative burden of application, regardless of tender type.

Distinct founder- and firm-level patterns appear for criteria-based tenders. Higher education and doctoral degrees among founders, as well as R&D intensity at the firm level, are significantly associated with a higher probability of application, but show no association for price-based tenders. These findings highlight the relevance of founder human capital and innovation-related capabilities primarily in tenders that include additional award criteria related to quality and innovation.

Procurers' awardee selection – In the second-stage probit models, the selection correction is only significant when omitting founder characteristics, confirming their importance in the application stage. This implies that founder-level characteristics explain parts of the selection into application, reducing sample selection bias once included.

For price-based tenders, a higher median founder age consistently predicts success, indicating that more experienced teams may be better equipped to secure contracts. This suggests they can more effectively demonstrate tender-specific expertise or leverage their larger experience to submit more competitive bids. Firm size is also a robust predictor, suggesting procurers value organizational capacity. In contrast, firm age loses significance when founder characteristics are included, indicating founder-driven effects. There are no further statistically

significant determinants. Therefore, these results point to procurers favoring signals of reliability and delivery capacity in price-based tenders, where technical or innovative merit seems to plays a limited role.

For criteria-based tenders, founder doctoral degrees and founder age diversity are significantly and consistently associated with a higher probability of winning, pointing to the relevance of team qualifications and diversity. In contrast, larger founding teams are negatively associated with winning likelihood, possibly reflecting internal complexity. At the firm level, both firm age and size, as well as the introduction of market novelties, are positively associated with success. This suggests that the capacity and reliability of young firms may be particularly relevant in criteria-based tenders. Moreover, as market novelties are associated with success while R&D intensity is not, procurers seem to place greater emphasis on realized innovation than on input efforts.

Aligning with Di Mauro et al. (2020) and Flynn and Davis (2017), firm size emerges as the only firm-level determinant consistently influencing both the decision to apply and the likelihood of winning tenders across price-based and criteria-based procedures. This finding indicates, first, that public procurers place a premium on execution capacity, and second, that larger firms are generally better equipped to navigate the application process – regardless of tender design. However, our remaining findings on the determinants of applying and being selected for price-based versus criteria-based tenders — which differ strongly between the two tender types – highlight the necessity of allowing their drivers to vary in future analyses.[15]

Finally, our theoretical arguments on how procurers select awardees based on observable characteristics are largely supported, particularly by the heterogeneous effects of innovation inputs and outputs at the application and selection stages. Standing in contrast, however, are our findings on the importance of relatively unobservable, non-tender-specific founder characteristics — namely high age diversity and small founding teams – in the selection stage. Since public procurers cannot use these attributes as formal selection criteria, their positive effects likely stem from such firms' ability to submit more competitive offers, whereas we do not observe the individual offers.

[15] Di Mauro et al. (2020) find that both firms' quality advantage and age are positively associated with winning public tenders. However, our results suggest that, without accounting for distinct determinants across price-based and criteria-based tenders, these relationships are likely primarily driven by criteria-based tenders.

6.2. Managerial implications

The analysis of award decisions yields several actionable implications for managers of young firms, depending on their strategic goals and the type of public procurement tender they are targeting.

First, if the goal is to increase the likelihood of success in either price-based or criteria-based tenders, then building organizational capacity should be a priority. Firm size is the only consistent and significant predictor of winning across both tender types, indicating that public procurers place a universal premium on execution ability and delivery reliability. Smaller firms may therefore benefit from scaling strategies, subcontracting relationships, or consortia participation to enhance their competitive standing.

Second, if managers aim to compete in criteria-based tenders, then demonstrating innovation outcomes and leveraging team-level expertise becomes essential. Realized innovation – rather than R&D intensity – significantly increases winning probabilities, indicating that procurers reward tangible results over internal efforts. Moreover, doctoral-level qualifications and age diversity among founders are positively associated with success, suggesting a premium on cognitive diversity and deep expertise when tenders emphasize quality. However, larger founding teams reduce the likelihood of success, persumably due to coordination complexity. Thus, managers should emphasize outcome-based innovation, delegate proposal responsibilities clearly, and ensure strategic coherence within the bid process.

Third, if managers intend to compete in price-based tenders, they should de-emphasize innovation in favor of signaling organizational capacity. In these tenders, neither innovation inputs nor outputs are linked to success. Instead, winning is primarily associated with firm size and founder experience, pointing to the value of scale and maturity. Accordingly, when targeting price-based tenders, young firms should focus on highlighting logistical competence, delivery certainty, and lean execution, rather than differentiating through innovation or quality.

Taken together, these findings suggest that procurement strategies should be tailored to tender type and firm capabilities — emphasizing execution in price-based tenders, and leveraging innovation outcomes, expertise, and team composition in criteria-based tenders.

6.3. Policy implications

The analysis of application decisions yields several differentiated implications for policymakers, depending on the specific policy objective pursued within the procurement system.

First, if the goal is to expand the overall participation of young firms in public procurement, then structural entry barriers must be addressed. Firm size is a consistent and significant predictor of application across both tender types, suggesting that smaller firms face disproportionate burdens. Simplifying administrative procedures, capping pre-qualification requirements proportionally to contract value, and encouraging lot subdivision can lower entry thresholds and help broaden participation across the young firm landscape (Hoekman and Taş, 2022).

Second, if the aim is to engage founders without prior public sector exposure, then targeted capacity-building measures are needed. Prior public employment significantly increases application likelihood across both price-based and criteria-based tenders, implying informational or procedural familiarity advantages. To mitigate this imbalance, public agencies should invest in outreach formats, founder-oriented training, and advisory services that lower procedural uncertainty for firms lacking institutional procurement experience.

Third, if policymakers seek to attract innovation-driven and highly qualified young firms to criteria-based tenders, the current system appears to be working. Application is significantly driven by innovation intensity and doctoral-level qualifications among founders, indicating that such firms are responsive to tenders with innovation or quality criteria. Maintaining or expanding these criteria – while ensuring their transparency and interpretability – can further support the development of innovative young firms through innovation-led procurement.

In total, these findings suggest that policy interventions should be clearly aligned with the intended goal – whether it is to increase general participation, reduce access asymmetries, or target innovation. A one-size-fits-all policy is unlikely to be effective; instead, differentiated strategies are needed to foster both inclusive access and high-quality engagement by young firms in public procurement.

7. Conclusion

The analysis conceptualized public procurement in two key dimensions – firms' internal decision to apply and procurers' subsequent award choice – while distinguishing between price-based (innovation-hampering) and criteria-based (innovation-rewarding) tenders. Our theoretical background highlighted the importance of both firm- and founder-level attributes, particularly for young firms with limited market histories. Empirically, the findings broadly confirm these theoretical considerations and reveal significant differences across i) the two selection stages (application vs. award), ii) price- vs. criteria-based tenders, and iii) founder- vs. firm-level drivers.

Whereas firm-level variables show that firm size is positively associated with both application and winning across both tender types, innovation-related measures appear only relevant in criteria-based procurement. Specifically, firm innovation output is positively linked to being selected as an awardee, while innovation input correlates with a higher likelihood of applying. Firm age also exhibits a positive relationship with winning criteria-based tenders.

At the founder level, larger founder teams and prior public-sector experience correlate with higher application probabilities for both tender types. Meanwhile, doctoral degrees and higher education within the founding team are linked to increased application rates – and, for doctoral degrees, also higher winning rates – in criteria-based contests. Additionally, smaller team size and greater age diversity further correlates with winning criteria-based tenders, whereas a higher median founder age is the only founder-level factor positively associated with winning price-based tenders.

As a result, we contribute to the literature by bridging the gap between previous research focusing on small and medium-sized enterprises (Di Mauro et al., 2020; Flynn and Davis, 2017) and studies assessing only the performance effects of winning tenders among young firms (Hvide and Meling, 2023; Dai et al., 2021). Specifically, we offer the first examination of how young firms' application and success are determined within a two-stage framework that distinguishes price-based (innovation-hampering) from criteria-based (innovation-rewarding) procurements (Krieger et al., 2024). Through this analysis, we clarify how tender structure intersects with firm- and founder-level attributes to shape the procurement participation of young firms.

From both managerial and policy perspectives, our findings yield a range of implications that depend on the underlying objectives of the respective stakeholders. Our discussion emphasizes that our heterogeneous results on the determinants of applying for and winning price- versus criteria-based tenders imply that optimal strategies may vary substantially. For instance, managers aiming for success in public procurement may need to develop distinct strategies tailored to each specific tender type. Similarly, policy implications can diverge considerably, for instance, the interventions required to foster overall participation of young firms in public procurement significantly differs from those aimed at rewarding innovative young firms through targeted awards.

Our analysis provides novel insights but is subject to several limitations that present avenues for future research:

First, despite employing a multi-stage selection model to address sample selection bias, our findings remain rather correlational than causal. While the assumptions underlying our instruments appear plausible, the validity of these assumptions cannot be verified. On top of that, they tackle selection into application, but not alternative sources of endogeneity, such as reverse causality. Future research should consider alternative identification strategies, for instance based on panel data.

Second, our empirical design does not explicitly account for potential interactions between founder- and firm-level characteristics. As a result, we might overlook complementarities between these factors. Extending the analysis by modeling such interactions would deepen the understanding of how firm- and founder-level attributes jointly influence procurement participation and success.

Third, we have limited to no information regarding specific tender, offer, and procurer characteristics. Consequently, unobserved heterogeneity along these dimensions remains, potentially affecting firms' application decisions and procurement success. Future studies could enrich our findings by incorporating detailed tender-level and procurer-level data to reveal additional sources of heterogeneity.

Fourth, our empirical context is limited to Germany, and thus the external validity of our results relies on comparable environments for young firms. Although prior public procurement research has generally reported consistent firm-level effects across various

European contexts, confirming these our findings in other countries would further validate the analysis.

Fifth, our data's cross-sectional nature prevents an investigation of path dependencies in firms' procurement activities. Future studies could utilize panel datasets to explore how past procurement experiences influence future application behaviors, tender outcomes, and dynamics in young firms' performance.

Finally, although we conceptually outline the relevance of specific firm- and founder-level determinants, our analysis remains largely explorative, relying on illustrative examples rather than systematically derived hypotheses for each variable. Future research could address this limitation by developing and testing explicit theoretical predictions, ideally paired with appropriately tailored identification strategies for each.

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Appendix A

Table A.1 – Descriptive statistics of total sample

	Mean	S.d.	Median	Min.	Max.
Number of founders	1.483	0.841	1.000	1.000	11.000
Median age of founders	42.423	10.863	41.000	19.000	86.000
Share of female founders	0.140	0.313	0.000	0.000	1.000
Gender diversity (0-1)	0.089	0.279	0.000	0.000	1.000
German founder (0/1)	0.897	0.304	1.000	0.000	1.000
Higher education degree (0/1)	0.527	0.499	1.000	0.000	1.000
Doctoral degree (0/1)	0.063	0.242	0.000	0.000	1.000
Previous employment in public sector (0/1)	0.063	0.243	0.000	0.000	1.000
Previous employment in private sector (0/1)	0.643	0.479	1.000	0.000	1.000
Number of employees	4.302	5.863	2.500	0.250	101.000
Firm age in years	2.657	1.798	2.000	1.000	7.000
Export revenues (0/1)	0.138	0.345	0.000	0.000	1.000
Public support (0/1)	0.304	0.460	0.000	0.000	1.000
R&D intensity	3.622	11.365	0.000	0.000	100.000
Market novelty (0/1)	0.039	0.193	0.000	0.000	1.000
Observations	4,314				

Appendix B –Public procurement and young firms in Germany

Entrepreneurship and the promotion of young firms are central to stimulating regional growth, competitiveness (Acs and Audretsch, 1988; Audretsch and Pena-Legazkue, 2012), and broader economic prosperity (Delfmann et al., 2014; Sternberg, 2009). Among European nations, Germany ranks high in its absolute budget for early-stage financing – alongside France and the UK (Bai et al., 2021). However, when looking at expenditures relative to GDP (0.2%–0.4%), Germany falls into a third-tier group, positioned behind Austria, Estonia, France, and the UK (up to 0.6%) as well as the Netherlands, Finland, and Portugal (0.6%–1.3%). Consequently, while Germany's nominal investment is significant, other countries make relatively larger commitments. Despite these financing efforts, Europe continues to witness fragile startup rates and skewed growth distributions among young firms (EFI, 2017; Haltiwanger, 2022; OECD, 2017). Germany's own formation rates have been relatively stable overall, even though they recorded a notable decrease from 2021 to 2022 (Gottschalk and Hantzsch, 2025).

Germany was an early mover in embedding innovation incentives into public procurement. As of 2009, it incorporated innovation considerations into the national legal framework (§ 97 Abs. 4 GWB), aligning them with social and environmental standards from EU Directive 2004/18/EG. Below the EU's procurement thresholds, analogous provisions were introduced through the Verdingungsordnungen für Leistungen (VOB/A, VOL/A) (Falck and Wiederhold, 2013). While the 2014 EU Directive 2014/24/EU codified similar requirements at the European level, some member states delayed implementation for up to four years (European Court of Auditors, 2023). Despite Germany's comparatively early integration of such incentives, there is no evidence for significantly higher levels of innovative public procurement in Germany (Rossel, 2021).

In 2009, Germany enacted a parallel landmark reform (§ 97 Abs. 3 GWB) requiring tendering authorities to break contracts into multiple lots "where economically reasonable," thus reducing entry barriers for small and medium-sized businesses. This provision is especially crucial for young firms, which often face more pronounced resource constraints than established competitors. Although this lot-division practice was discussed and endorsed at the European level (Falck and Wiederhold, 2013) as a way to promote participation among smaller

enterprises, its implementation largely remains at each member state's discretion. Germany's explicit legal mandate reflects a firm commitment to leveling the playing field for newly founded businesses, a stance further reinforced by the country's recent start-up strategy (BMWK, 2022), which underscores the importance of public procurement as a catalyst for entrepreneurial growth.

In addition to legislative measures, Germany established the Competence Centre for Innovative Procurement (KOINNO) in 2013 to raise awareness of public procurement opportunities among businesses. Similar institutions also exist elsewhere in Europe – PIANOo in the Netherlands, IÖB-Servicestelle in Austria, and Motiva in Finland – all dedicated to enhancing the capabilities of public procurers and their suppliers. KOINNO advises procuring agencies, organizes seminars, supports applications for European research funding (European Commission, 2019), and hosts networking events (BMWI, 2017; BMWK, 2023). Finally, following Germany's 2022 start-up strategy, KOINNO intensified its focus on start-ups, recognizing their unique constraints and innovation potential (BMWK, 2023).

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