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Firms in (Green) Public Procurement: Financial strength indicators' impact on contract awards and its repercussion on financial strength[§*]

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Abstract

We examine whether the financial strength of companies, in particular, small and medium-sized enterprises (SMEs) is causally linked to the award of a public procurement contract (PP), especially in the environmentally friendly "green" area (GPP). For this purpose, we build a combined procurement company data set from the Tenders Electronic Daily (TED) and the SME database AMADEUS, which includes ten European countries. First, we apply probit models to investigate whether the probability of winning the public tender depends on the company's financial strength. We then use the Flexpanel DiD approach to investigate the question of whether the award has an impact on the future financial strength of the successful company. On the one hand, we find that a lower equity ratio and a higher short-term debt ratio increase the probability of being successful in a public tender. On the other hand, the success means that the companies can continue to work after the award with a lower equity ratio than comparable companies without an award, regardless of whether the company was successful in a traditional or a "green" public tender. We conclude from this that the success in a PP is a substitute for one's own financial strength and thus facilitates access to external financing. The estimation results differ depending on whether public procurement in general or the sub-group of "green" public procurement is examined.

Keywords: Sustainable Finance, Public Procurement, Green Public Procurement, Small and Medium-sized Companies, Innovation, Financial constraints
JEL: G30, Q56, Q01, O16

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Introduction

From 2015 to 2017 numerous EU public authorities spent approximately 2 trillion Euros annually, around 14 % of GDP, on the purchase of services, works and supplies (European Commission 2019). Although Green Public Procurement (GPP) has been a small share of this total expenditure, it is expected to grow considerably in the coming years. According to the EU Commission, Green Public Procurement is "a process whereby public authorities seek to procure goods, services and works with a reduced environmental impact throughout their life cycle when compared to goods, services and works with the same primary function that would otherwise be procured" (COM 2008, p. 400 "Public procurement for a better environment"). By launching so-called green tenders and awarding offers for goods, services, and works that protect the environment more effectively than conventional variants, public authorities' purchasing power contributes to the Great Green Transition (Kemfert, Schäfer and Semmler 2020). Firms that compete for the green procurement contracts and financial institutions that fund the applicants are the mediators in this process.

In this paper, we shed new light on how public procurement (PP) in general and GPP in particular are linked to the applicants' financial strength. Specifically, we use the Tenders Electronic Daily (TED) database of the European Union to identify those firms that were successful in receiving PPs and GPPs. Using TED and the AMADEUS firm database we build a dataset of successful procurement firms and peers that qualify as suitable control group. First, we apply a Probit panel data model to investigate how the firm's financial strength affects the likelihood of winning a public procurement tender. Second, we capture the causal effect of the Green Public Procurement success on financial strength by employing the flexpanel DiD approach (Dettmann, Giebler and Weyh 2020).

We establish two main results. On the one hand, we find that a lower equity ratio and a higher ratio of short-term credits increase the likelihood of being successful in a public tender, be the tender of a general or "green" nature. On the other hand, we find that the successful companies can continue to work after the success with a lower equity ratio than comparable companies without such a success.

Our research is closely related to the literature exploring the impact of public procurement on firms' financial barriers and on innovation. However, we note that there is a blind spot in research regarding traditional public procurements and there is literally no research considering the link between green public procurement and a firm's financial strength neither for firms in general nor for SMEs in particular. To the best of our knowledge we are the first to address these issues.

The rest of the paper proceeds as follows. Section 2 gives an overview of the related research. Section 3 describes the dataset. Section 4 presents the empirical approach and the estimation results. Section 5 concludes.

Previous Research

Investment in technologies to achieve a low carbon economy produces positive externalities in both innovation and diffusion stages. This causes market failure and underinvestment, as the private returns from those investments are lower than the social returns (Rennings 2000, Kemp and Oltra 2011, De Marchi 2012). The discrepancy between private and social returns justifies policy intervention. Public procurement is a particular type of public intervention. It is considered to be a key policy instrument, not only to incentivize private actors to broaden the application of existing Renewables Energy Supply (RES) technologies, but also to develop innovative RES products and solutions. Public Procurement is not direct public funding, but rather an instrument to allocate and distribute public funds in return for societal benefits.

The issue of funding innovations in renewable energy supply (RES) is of growing interest both for firms and policy makers, as RES innovations pave the way to a low carbon economy. Currently, little is known about how SMEs finance the purchase of new clean energy and technologies necessary to make production processes and distribution channels climate-friendly, and what restrictions SMEs face vìs-à-vìs large firms in financing RES innovations. In general, the funding possibilities of RES innovators, be they on the forefront in applying innovative RES technologies or in creating new climate-tech solutions, are constrained. Environmental innovation projects are long-term commitments often associated with immature and complex technology (Olmos, Ruester and Liong 2012). The long payback period reinforces the perceived risk of such investments (Ghisetti, Mancinelli, Mazzanti and Zoli 2017). In addition, innovative firms often own large stocks of intangible assets that cannot be pledged as collateral (Brown, Martinsson and Petersen 2012, Cosci, Meliciani and Sabato 2016, Hall, Moncada-Paternò-Castello, Montresor and Vezzani 2016).

Although opaqueness and information asymmetry between borrowers and investors are particularly problematic for SMEs, those obstacles are even more pervasive for environmental innovation projects (Cecere, Corrocher, Gossart and Ozman 2014a, Jensen, Schäfer and Stephan 2019). Accordingly, immaturity of some RES markets, a greater perceived risk of the investment in environmental innovations (Aghion, Veugelers and Hemous 2009, Ghisetti et al. 2017), fierce competition from fossil-fuel-affine incumbents and an insufficient recognition of climate risks in rating models, including the banks' own internal models, work in favor of funding constraints and often induce financial institutions to shy away from supplying the required funds (Hottenrott and Peters 2012, Schäfer, Stephan and Mosquera 2017).

Public procurement has the potential to stimulate firms' innovation (Appelt and Galindo-Rueda 2016, Aschhoff and Sofka 2009, Czarnitzki, Hünermund and Moshgbar 2018). Success in public

procurement tenders also has a crucial role in improving innovation success, measured in terms of turnover achieved with new products (Ghisetti 2017). Czarnitzki et al. (2018) study the effect of changes in innovation policy enforced in 2009 on turnover changes in three years after 2009. They find that turnover with new products and services benefits from public procurement of innovations. In a study of US firms, the effect on stock returns of awarding a tender was positive (Larson and Picou 2002).

Cheng, Appolloni, D'Amato and Zhu (2018) study Green Public Procurement (GPP). They see the main benefits of GPP as its ability to be a demand-pull factor and "market trigger," meaning that GPP is able to enlarge the market for environmentally friendly goods and services. However, the authors also point out that there has been inadequate attention given in the academic literature to the impact of GPP. Zipperer (2019) provides evidence on the relationship between GPP and firms' innovation activities. Her findings confirm the demand-pull effect of GPP for general product innovations, but not specifically for environmental innovations. Czarnitzki, Hünermund and Moshgbar (2018) find a robust and significant effect of innovation-directed public procurement on turnover from new products and services. However, the effect seems to be restricted to innovations of a more incremental nature instead of market novelties. Cecere, Corrocher, Gossart and Ozman (2014b) propose that access to public funds and fiscal incentives contribute to improve firms' ability to introduce eco-innovations as firms consider public funding to be complementary to other external finance.

The question of how public procurement is linked to a firm's financial strength has received little attention in both corporate finance and innovation research. This is surprising. A firm's financial strength may influence their success in a public procurement tender. In addition, winning a procurement contract may influence the successful firm's financial strength and, via this channel, their access to future funding. There is clearly a blind spot in research regarding traditional public procurement tenders but there is literally no research considering the link between green public procurement and a firm's financial strength for firms neither in general nor for SMEs in particular. The pecking order theory claims that internal financial strength is key for a firm's capability to invest (Myers and Majluf 1984). Accordingly, the question arises whether the firm's financial strength affects the chance to win a tender in a public procurement. Hottenrott and Peters (2012) argue that the access to external finance depends on firms' creditworthiness. Whether gaining a contract award contributes positively to the creditworthiness of innovators is still an open question. We address these important issues using a self-constructed dataset that combines financial firm data and public procurement data. The particular strength of our dataset is the possibility to exploit the

heterogeneity of firms across different dimensions of interest, overall vs. green public procurement specifically and firms in general and SMEs in particular.

Causal inferences have paramount importance in econometric research to estimate the effect of policies (Hünermund and Czarnitzki, 2019). There are couple of biases in estimating causal effects in policy research including but not limited to sample selection, and confounding effects (Bareinboim and Pearl 2016). As Hünermund and Czarnitzki (2019) discusses on firms that receive R&D grants, there are several screenings in place before a firm can receive R&D grant which consists of observable and unobservable firm characteristics. As a result, a naive sample selection of funded and unfunded firms would fail to consider confounding variables. Hence, it is recommended to consider confounding variables as much as possible with help of collaboration with funding organizations, and financial variables (Hünermund and Czarnitzki, 2019). In this study, we used key financial and size variables to create reliable groups of treatment and control firms.

Data

The Tenders Electronic Daily (TED) database and the AMADEUS firm database are the two sources on which we base our assessment. TED is the public procurement database of the European Union, containing Contract Award Notices (CAN). It "publishes 746 thousand procurement [contract] award notices a year, including 235 thousand calls for tenders which are worth approximately € 545 billion."[1] Calls for tenders are invitations to bid for a project. Public tenders are those in which governments and other public authorities such as cities and communities invite enterprises to bid for projects. The invitation is a formal procurement document issued by the buyer specifying the terms, which the potential suppliers must meet in order to submit an acceptable bid.

The TED database only contains details of those firms, which have submitted a successful bid, as documented in a CAN. Those firms are the Contract Award (CA) firms. All information obtained from the CAN is available at the firm level. In 2014, the European Union implemented a Public Procurement policy reform aimed at enhancing SME participation. The key feature was that large contracts could be broken up into smaller lots. Those smaller lots should enable SMEs to submit a tender for a lot instead of the total contract value. The CAN data in the estimation sample range from 2015-2018 (post-SME reform period) and cover ten European countries, Belgium (BE), Denmark (DK), Germany (DE), Great Britain (GB), Italy (IT), Norway (NO), Portugal (PT), Slovakia (SK), Spain (ES) and Sweden (SE).[2]

1 https://ted.europa.eu/TED/main/HomePage.do

2 The XPRESS project focuses on these countries.

To produce causal inference on the two questions of how a firm's financial strength affects the likelihood to be a successful bidder and how success influences the bidder's financial strength afterwards, CA firms must be compared with appropriate control firms. Bidding firms that failed to receive a CA would be the ideal candidates for the control group of successful CA firms, but data on the unsuccessful bidders is not available in the TED database. Thus, we must apply an alternative strategy to establish a suitable control group, making use of AMADEUS, a database of European SMEs compiled by BvD. AMADEUS contains financial data from the companies' balance sheet and income statements. We select companies with yearly financial and employment data in the period 2010–2019 from their unconsolidated accounts. As Amadeus reports financial data in domestic currencies, we apply the official ECB exchange rates to obtain Euro (EUR) values. We retain only those AMADEUS firms that are in the same industries as the CA firms from the TED database.

Table 1 - Number of observations for Contract Award (CA) firms and control firms

	Firm-years	**Percent**	**Cumulative Percent**
noTED	**5952**	48.50	48.50
TED	**6325**	51.50	100.00
Total	**12277**	100.00	.

Source: TED and Amadeus, own calculations

In the first step of building the sample of treated and control firms, we merge the CA firms from TED with financial and employment data from AMADEUS. The merging assigns key information to each CA firm for the years prior to success, in the year of success and the following years. In the second step, we apply a matching technique to select control firms from the AMADEUS database to be added to the CA firms. The matched firms did not receive a CA, but are similar to the successful firms in year (t-1) prior to the CA in key indicators, the equity ratio, total assets, and employment. Their similarity one year before the CA year is crucial, as it supports identifying the causal effect of the CA on the successful firms' financial strength.

The entire sample of treated CA firms and non-treated control firms consists of 12277 firm-years in total. 6325 firm-years belong to Contract Award (CA) firms from the TED dataset, and 5952 firm-years are observed in the group of control firms taken from the AMADEUS database. In total, between 2015 and 2018 we observe 1022 firms that have received a CA in one of 10 EU countries. The number of firms varies significantly across the 10 countries under consideration. For example, the final sample contains 226 CA firms from Great Britain but only 45 CA firms in Denmark. In an ideal

setting the number of observations (firm-years in total) would equal the number of firms times the number of observed years. However, the complete range of years is often not observed. Thus, the panel is unbalanced, and the shares in firm-numbers and firm-years deviate from each other for the total of all 10 countries as well as for single countries.

The CA firms are almost evenly distributed over this period as Table 2 below shows. The highest frequency of CA incidences is observed in the year 2017 but the differences in the frequencies across years are rather small.

Table 2 - Distribution of successful firms over years of observation

Year	Number of firms	Percent	Cumulative Percent
2015	**218**	21.26	21.26
2016	**242**	23.72	44.98
2017	**284**	27.95	72.93
2018	**278**	27.07	100.00
Total	**1022**	100.00	.

Source: TED and Amadeus, own calculations

The Common Procurement Vocabulary (CPV) allows us to identify tenders from the area of Green Public Procurement (GPP). Table 3 below shows the CPVs of GPP tenders (see the different tender types in more detail in the Appendix). We label the successful suppliers of goods, services and works as green companies. The sample contains 1399 observations for green companies. The green CA firms are most frequently active in the areas "Electricity, heating, solar and nuclear energy", "Electric vehicles", "Wood fuels" and "Heat pumps". The least number of firm-years are observed in the areas of "Solar collectors for heat production" and "Wind farms".

Table 3 - Green CA firms

CPV: CA in Green Public Procurements (GPP)	Firm-years	Percent	Cumulative Percent
Fuel wood	**11**	0.79	0.79
Wood waste	**24**	1.72	2.50
Wood fuels	**126**	9.01	11.51
Biodiesel	**11**	0.79	12.29

Electricity, heating, solar and nuclear energy	**295**	21.09	33.38
Solar energy	**81**	5.79	39.17
Solar panels	**49**	3.50	42.67
Solar collectors for heat production	**5**	0.36	43.03
Solar photovoltaic modules	**58**	4.15	47.18
Solar installation	**45**	3.22	50.39
Wind energy generators	**42**	3.00	53.40
Wind turbines	**10**	0.71	54.11
Wind farm	**8**	0.57	54.68
Semiconductors	**10**	0.71	55.40
Electric vehicles	**270**	19.30	74.70
Electric buses	**44**	3.15	77.84
Heat pumps	**104**	7.43	85.28
Parts of refrigerating and freezing equipment and heat pumps	**2**	0.14	85.42
Hydro-electric plant construction work	**79**	5.65	91.07
Thermal power plant construction	**30**	2.14	93.21
Wind-power installation works	**34**	2.43	95.64
Solar panel roof-covering work	**61**	4.36	100.00
Total	**1399**	100.00	

Source: TED and Amadeus, own calculations

In addition, we identify tenders that may or may not belong to the area of GPP (see Appendix 1). We label those suppliers as “green possible” firms. Those firms are most frequently active in the areas "Petroleum products, fuel, electricity and other sources of energy", "Electricity", "Energy and related services" and "Electricity distribution and control apparatus".

Unfortunately, we cannot uniquely infer from the CPV codes whether “green possible” tenders definitely belong to the GPP segment. Clearly labeling such tenders either as compatible or incompatible with the EU Green Deal and, thus, GPP goods, services and works would avoid any ambiguity and support incentivizing green innovation. Many governments intend to increase their issuances of "green sovereign bonds". Of course, money in itself is not green, and so the proceeds from those issuances are not in itself green. Those bonds can only be advertised as green if the

proceeds from the issuance are used to finance investments in green projects or purchases of green goods and services. Therefore, an easier identification of those tenders that qualify for public promotion and, thus, can be financed by issuing sovereign green bonds would most likely support the development of a strong and highly liquid market for sovereign green bonds (Wulandari, Schäfer, Stephan and Sun 2018). In addition, easy identification facilitates better auditing and supports the prevention of "greenwashing".

Finally, for reasons of completeness, we identify the tenders that certainly do not deserve the green label. We name the respective CA firms as brown firms (see Appendix 1). The brown firms are most frequently active in the areas "Refuse incineration services", "District-heating mains construction work" and "District-heating plant construction work".

Empirical Approach

The following sections present the multivariate analysis of CA firms vìs-à-vìs the control firms. As a first step, we construct key financial ratios that are appropriate to indicate financial strength. We consider the equity ratio, the long-term debt ratio, the short-term debt ratio, the loan ratio, the trade credit ratio and the turnover ratio. Those indicators of financial strength are expressed as a percentage of total assets.

Table 4 - Financial strength and size indicators

Variable	Description
	Financial strength indicators
Equity ratio	Shareholder funds (Equity) divided by total assets
LTDB ratio	Noncurrent liabilities: long-term debt (LTDB) to total assets
STDB ratio	Short-term debt ratio: sum of loan and credits divided by total assets
LOAN ratio	Loan divided by total assets
CRED ratio	Trade credit divided by total assets
TURN ratio	Turnover divided by total assets
	Size indicators
Log (Total Assets)	Logarithmic transformation of Total Assets
SME/nonSME	SME if the firm has less than 250 employees, non SME otherwise

Source: Amadeus, own calculations. The Equity ratio is winsorized at the 1th percentiles. Log (Total Assets) is winsorized at 1th and 99th percentiles

We first hypothesize:

H1: The likelihood of winning a public procurement tender depends on the firms' financial strength.

To test this hypothesis, we use a probit model with the dependent variable *TEDyear* and firm characteristics as independent regressors. *TEDyear* takes on the value of one in the year the firm wins the TED contract award and zero otherwise. The main variable of interest is the indicator of the firm's financial strength. The control variables are the log of total assets, a dummy indicating being an SME, year dummies from 2015 to 2018, industry and country dummies. We use the EU standard definition, which labels any firm with less than 250 employees an SME.

We consider four subsamples as defined in Table 5. The most interesting ones are the subsamples of all firms, which received a CA in a GPP tender and their non-treated control firms (3), and the subsample of all SMEs which received a CA in a GPP tender and their non-treated control SMEs (4).

Table 5 - Definition of the indicator variable TEDyear depending on the subsample under consideration.

Dependent Variable (Sample)	Sample description
TEDyear (1)	= 1 if the firm wins any tender, zero otherwise (Overall sample: **All firms** which received a CA and control firms)
TEDyear (2)	Among SMEs: = 1 if the SME wins any tender, zero otherwise (Subsample: **All SMEs** which received a CA and control SMEs)
TEDyear (3)	Among firms winning a green public procurement (GPP CA): = 1 if the firm wins a tender, zero otherwise (Subsample: **All firms** which received a **GPP CA** and control firms)
TEDyear (4)	Among SMEs winning a green public procurement (GPP CA): = 1 if the firm wins a tender, zero otherwise (Subsample: **All SMEs** which received a **GPP CA** and control SMEs)

In the second step, we hypothesize:

H2: Winning a tender has an impact on the firm's financial strength in the years after the contract award.

To explore this hypothesis, we apply the flexpanel difference-in-difference approach (DiD) (Dettmann et al. 2020) to similar subsamples as those defined in Table 5. The DiD approach reveals whether firms with a CA (treatment group) develop differently in the years after winning the contract award than the similar firms without a CA (control group). In order to create the treatment and control

groups, we construct a dummy variable called *treated* with values 1 if the company has won a public procurement contract between year 2015 and 2018 (treatment group) and zero otherwise (control group). Then, to capture the period effect that applies to both treated and non-treated firms, we create another dummy called *Posttreatment period.* This variable takes on the value of one starting from year *t+1* where *t* is the year of success. Our main variable of interest is the *Treatment effect*. This dummy variable represents the interaction between the variables *treated* and *Posttreatment period*. The *Treatment effect* is zero if, and only if, the dummy variable *treated* is 0. It is 1 if the dummies *Posttreatment period* and *treated* are 1. Table 6 describes the main treatment variables used in flexpanel DiD regression equation.

Table 6 - Treatment effect

Treatment effect	Dummy variable	Values
Winning a tender	treated	0: no win; 1: winning at least one contract award (CA) in 2015 and 2018
Period effect for both the treated and the non-treated firm(s)	Posttreatment period	0 for treatment and matched control firm before the contract award (CA) success; 1 for both firm types one year after winning a tender, and then it repeats afterwards. A maximum of three years after winning a tender between 2015 and 2018 is considered.
Interaction between winning a tender and post treatment effect	Treatment effect (treated # Posttreatment period)	0: no effect; 1: effect Full interaction effect between winning a contract award and the period after the treatment

Previous studies propose various control variables. Aschhoff and Sofka (2009) include control variables capturing market innovation. Fazekas and Tóth (2017) use country labels and indicators of market level interventions. Ghisetti (2017) adds control variables for environmental innovation. The TED dataset provides a variety of candidates for control variables. We abstain from incorporating a multitude of control variables to keep the model as simple as possible. We use total assets, country, firm type, NACE codes and time dummies for the years between 2011 and 2018 as control variables in the flexpanel DiD models.

Does financial strength affect the likelihood of winning a tender?

We start with the first question of whether the likelihood of winning a public procurement tender is associated with a higher financial strength. Table 7 shows the descriptive statistics of the financial strength indicators of interest separately for TED firms and the noTED companies in the overall Sample (1). The Table reveals that the CA firms in the estimation samples have on average a lower equity ratio, a higher short-term debt ratio, a higher trade credit ratio and a higher turnover ratio.

Table 7: Descriptive statistics of financial ratios and size indicators for TED and noTED firms in the overall sample (1)

	Obs.	Mean	Q1	Median	Q3	Min	Max	STD
Variable	**TED firms**							
Equity ratio	2748	0.33	0.15	0.32	0.49	0.00	1.00	0.23
LTDB ratio	2367	0.11	0.00	0.02	0.16	0.00	1.00	0.17
STDB ratio	2646	0.25	0.07	0.19	0.38	0.00	1.00	0.23
LOAN ratio	2663	0.09	0.00	0.01	0.11	0.00	1.00	0.15
CRED ratio	2686	0.17	0.03	0.11	0.25	0.00	1.00	0.18
TURN ratio	1962	2.22	0.76	1.25	2.43	0.00	840.40	19.03
Log (Total Assets)	1973	17.38	15.73	17.63	18.90	10.91	23.00	2.32
SME	1973	0.74	0.00	1.00	1.00	0.00	1.00	0.44
Variable	**noTED firms**							
Equity ratio	2593	0.38	0.15	0.36	0.56	0.00	1.00	0.26
LTDB ratio	2224	0.11	0.00	0.01	0.16	0.00	1.00	0.19
STDB ratio	2480	0.21	0.04	0.15	0.32	0.00	1.00	0.22
LOAN ratio	2499	0.08	0.00	0.01	0.09	0.00	1.00	0.14
CRED ratio	2510	0.14	0.02	0.08	0.19	0.00	1.00	0.16
TURN ratio	1788	1.42	0.53	1.07	1.88	0.00	21.62	1.42
Log (Total Assets)	1797	17.15	15.48	17.44	18.61	11.23	23.00	2.29
SME	1797	0.76	1.00	1.00	1.00	0.00	1.00	0.43

Source: Amadeus, own calculations. The Equity ratio is winsorized at the 1th percentiles. The other variables including the Log (Total Assets) are winsorized at 1th and 99th percentiles. The descriptive statistics are obtained from the estimation sample of the Probit regression on the overall sample (1). The regression employs the lagged versions of either the Equity ratio, LTDB ratio, STDB ratio, LOAN ratio, CRED ratio or TURN ratio as independent variable. The descriptive statistics for the control variables Log (Total Assets) and the dummy variable SME are obtained from the Probit regression in which the lagged TURN ratio is the independent variable.

Table 8 shows the descriptive statistics for Sample (3), the sample of successful firms in Green Public Procurements (TED firms) and their control firms (noTED firms). The Table for the Green Public Procurement

contracts shows again that the CA firms in the estimation sample have on average a lower equity ratio, a higher short-term debt ratio, a higher trade credit ratio and a higher turnover ratio.

Table 8 - Descriptive statistics of financial ratios and size indicators for TED and noTED firms in the sample of successful firms in Green Public Procurements and their control firms.

	Obs.	Mean	Q1	Median	Q3	Min	Max	STD
Variable	**TED firms**							
Equity ratio	460	0.31	0.12	0.27	0.46	0.00	0.99	0.23
LTDB ratio	411	0.10	0.00	0.01	0.10	0.00	1.00	0.18
STDB ratio	443	0.27	0.08	0.22	0.42	0.00	1.00	0.23
LOAN ratio	443	0.09	0.00	0.01	0.15	0.00	0.71	0.15
CRED ratio	448	0.18	0.04	0.12	0.27	0.00	1.00	0.18
TURN ratio	344	1.57	0.58	1.15	2.10	0.00	16.90	1.55
Log (Total Assets)	345	16.74	15.00	16.70	18.63	10.91	21.45	2.35
SME	345	0.78	1.00	1.00	1.00	0.00	1.00	0.41
Variable	**noTED firms**							
Equity ratio	2367	0.37	0.14	0.35	0.56	0.00	1.00	0.26
LTDB ratio	2017	0.11	0.00	0.01	0.13	0.00	1.00	0.18
STDB ratio	2274	0.22	0.04	0.16	0.33	0.00	1.00	0.22
LOAN ratio	2289	0.08	0.00	0.00	0.10	0.00	1.00	0.14
CRED ratio	2303	0.14	0.02	0.09	0.20	0.00	1.00	0.17
TURN ratio	1614	1.45	0.50	1.11	1.96	0.00	21.62	1.44
Log (Total Assets)	1621	17.05	15.35	17.24	18.58	11.23	23.00	2.34
SME	1621	0.76	1.00	1.00	1.00	0.00	1.00	0.43

Source: see notes in Table 7

The following Tables 9-13 show the Average Marginal Effects (AME) of the probit regressions. The first probit regression models in Table 9 assess whether the probability of CA success depends on the *Equity ratio* before the year of winning the CA. Column (1) and (2) report the coefficients for the overall sample vìs-à-vìs SMEs. Column (3) and (4) show the estimation results for GPP contracts. We find across all specifications a significantly negative effect of the equity ratio (one year before the contract award) on the chance to win a CA. Firms with high equity ratios are less likely to receive a CA**.** A possible explanation for this result could be that companies which have a high debt ratio are in their expanding phase. Such companies are more likely to participate in the public procurement market and to put effort and resources into winning tenders than settled firms with higher equity

ratios. The negative effect of the equity ratio on the CA success probability is even stronger for SMEs. The strongest negative effect is obtained in the subsample of SMEs receiving a GPP tender. Equity-poor SMEs bidding in a green tender may have even higher incentives than large firms to overcome their constraints and to be successful. In this case, the low equity ratio indicates high constraints but also high incentives to overcome these constraints, and, thus, works as an advantage rather than a disadvantage.

Table 9 - Likelihood of winning a contract award (prob TEDyear) depending on the lagged Equity ratio

	(1)	(2)	(3)	(4)
	All firms	All SMEs	All firms with GPP CA	All SMEs with GPP CA
TEDyear				
Equity ratio (t-1)	-0.0889***	-0.0995***	-0.0375**	-0.0569***
	(-3.33)	(-3.49)	(-2.29)	(-2.90)
log(Total Assets)	0.0183***	0.0115***	0.00118	-0.000823
	(5.76)	(3.07)	(0.66)	(-0.35)
SME	0.0301**		0.0218**	
	(1.97)		(2.40)	
lnsig2u	-1.442***	-2.017***	-2.673**	-2.498**
	(-7.44)	(-5.89)	(-2.26)	(-2.12)
Year Dummies (2015-2018)	YES	YES	YES	YES
Country Dummies	YES	YES	YES	YES
Industry Dummies	YES	YES	YES	YES
N	5341	3865	2827	2072
# firms	1382	1060	729	570

Average marginal effects. t statistics in parentheses,*p < 0.10, **p < 0.05, ***p < 0.01

Firm size has a significant effect on winning a tender in the overall sample and the SME sample. However, firm size is insignificant in the subsamples in which the treated firms received a green tender (GPP CA). In other words, size seems to be an important determinant of success in traditional but not in green tenders. SMEs have a higher chance of winning compared to non-SMEs. This advantage of being an SME is stronger among the firms that have won a green tender.

Table 10 reports the findings with respect to the role of the short-term debt ratio for winning a CA. We also investigated the importance of the long-term debt (LTDB) ratio for the chance of receiving a CA. However, we obtained insignificant results across all samples. In contrast, the *STDB ratio* appears to have an impact. The effect is positive and significant only in the overall and in the SME sample. The significant coefficients show that companies which have a higher combination of short-term borrowing and trade credits (relative to their balance sheet amounts) are more likely to win tenders.

In other words, firms which are in the expansion phase and use heavily trade credits and loans to grow the company are more likely to be successful. Importantly, this effect does not come through in GPP tenders. Within this segment, the STDB ratio does not significantly affect the firms' chance of winning a CA.

Table 10 - Likelihood of winning a contract award (prob TEDyear) depending on the lagged STDB ratio

	(1) All firms	(2) All SMEs	(3) All firms with GPP CA	(4) All SMEs with GPP CA
TEDyear				
STDB ratio (t-1)	0.0873***	0.0803**	0.0251	0.0192
	(2.96)	(2.53)	(1.49)	(0.90)
log(Total Assets)	0.0180***	0.0112***	0.00168	-0.0000738
	(5.49)	(2.84)	(0.89)	(-0.03)
SME	0.0268*		0.0213**	
	(1.71)		(2.29)	
lnsig2u	-1.409***	-1.902***	-2.621**	-2.386**
	(-7.22)	(-5.87)	(-2.31)	(-2.21)
Year Dummies (2015-2018)	YES	YES	YES	YES
Country Dummies	YES	YES	YES	YES
Industry Dummies	YES	YES	YES	YES
N	5192	3748	2756	2012
# firms	1366	1044	721	560

Average marginal effects. t statistics in parentheses, $^{*}p < 0.10$, $^{**}p < 0.05$, $^{***}p < 0.01$

Disentangling the joint effect of the STDB ratio into a separate loan and trade credit effect provides a clearer picture about the drivers of the above results. The LOAN ratio in Table 11 shows a significantly positive coefficient in the overall sample of firms. In other words, in principle, the higher the loan share in the balance sheet of companies the higher is the chance of winning a tender. However, the LOAN ratio has no effect for SME success and does also not affect the chances of winning in a GPP. Total assets are again a decisive factor for winning a tender, but not in the samples of GPP tenders. SMEs are advantaged in winning tenders compared to bigger companies.

Table 11 - Likelihood of winning a contract award (prob TEDyear) depending on the lagged LOAN ratio

	(1) All firms	(2) All SMEs	(3) All firms with GPP CA	(4) All SMEs with GPP CA
TEDyear				
LOAN ratio (t-1)	0.0916**	0.0693	0.00815	0.00851
	(2.14)	(1.44)	(0.31)	(0.27)
log(Total Assets)	0.0179***	0.0112***	0.00173	-0.000104
	(5.51)	(2.86)	(0.93)	(-0.04)
SME	0.0276*		0.0215**	
	(1.77)		(2.32)	
lnsig2u	-1.394***	-1.875***	-2.480**	-2.281**
	(-7.24)	(-5.94)	(-2.48)	(-2.31)
Year Dummies	YES	YES	YES	YES
Country Dummies	YES	YES	YES	YES
Industry Dummies	YES	YES	YES	YES
N	5214	3770	2763	2019
# firms	1366	1044	721	560

Average marginal effects. t statistics in parentheses, $^{*}p < 0.10$, $^{**}p < 0.05$, $^{***}p < 0.01$

The *CRED ratio* effects in Table 12 reveal that only this particular type of short-term debt affects the chance of winning a CA in a GPP. The coefficients are not only positive and significant in the overall and in the SME sample, but also in the overall sample of all firms covering GPP. A high share of trade credits increases the chance of winning in a GPP. With trade credits firms lend to each other. Watson (2021) emphasizes that trade credits are a crucially important sources of short-term financing for firms (Watson 2021). A higher share of trade credits is an even stronger indication of rapidly expanding firms with high financing needs than a high share of short-term loans. Such rapidly expanding firms have a higher chance of success also in GPP tenders. The effect of the total assets variable is restricted to the *All firms* and *All SMEs* samples. SMEs are advantaged in winning tenders compared to bigger companies.

Table 12 - Likelihood of winning a contract award (prob TEDyear) depending on the lagged CRED ratio

	(1) All firms	(2) All SMEs	(3) All firms with GPP CA	(4) All SMEs with GPP CA
TEDyear				
CRED ratio (t-1)	0.0871**	0.102**	0.0392*	0.0301
	(2.20)	(2.43)	(1.67)	(1.03)

log(Total Assets)	0.0185***	0.0112***	0.00149	-0.000560
	(5.66)	(2.85)	(0.79)	(-0.22)
SME	0.0274*		0.0221**	
	(1.76)		(2.42)	
lnsig2u	-1.388***	-1.922***	-2.787**	-2.524**
	(-7.29)	(-5.88)	(-2.17)	(-2.13)
Time Dummies	YES	YES	YES	YES
Country Dummies	YES	YES	YES	YES
Industry Dummies	YES	YES	YES	YES
N	5235	3768	2773	2023
# firms	1371	1048	722	562

Average marginal effects. t statistics in parentheses, $^{*}p < 0.10$, $^{**}p < 0.05$, $^{***}p < 0.01$

The turnover ratio (*TURN ratio*) has no significant impact on winning a tender (Table 13). This finding is in line with the notion that expanding firms are more likely to win a tender, but less so firms, which are already settled in terms of equity and turnover. Overall, our findings partially confirm Hypothesis 1. The equity ratio lowers the chance of winning a CA in tradition PP and even more so in GPP. A high short-term debt share increases the likelihood of success for firms and SMEs in general but not for green firms. In GPP, only a high share of trade credits vìs-à-vìs the control firms has that effect.

Table 13 - Likelihood of winning a contract award (prob TEDyear) depending on the lagged TURN ratio

	(1) All firms	(2) All SMEs	(3) All firms with GPP CA	(4) All SMEs with GPP CA
TEDyear				
TURN ratio (t-1)	-0.000241	-0.000246	0.00169	0.00212
	(-0.91)	(-1.00)	(0.61)	(0.68)
log(Total Assets)	0.0169***	0.0143***	0.00147	0.00101
	(4.14)	(3.15)	(0.61)	(0.34)
SME	0.00240		0.0183	
	(0.12)		(1.56)	
lnsig2u	-1.301***	-1.692***	-11.44	-14.70
	(-6.08)	(-5.27)	(-0.00)	(-0.00)
Year Dummies	YES	YES	YES	YES
Country Dummies	YES	YES	YES	YES
Industry Dummies	YES	YES	YES	YES
N	3770	2836	1966	1502
# firms	980	756	509	400

Average marginal effects. t statistics in parentheses, $^{*}p < 0.10$, $^{**}p < 0.05$, $^{***}p < 0.01$

Does winning a public procurement tender promote a firm's financial strength?

In this section, we turn to testing Hypothesis 2. We fit DiD models to assess the impact of winning a CA in a public procurement on a firm's future financial strength. Our focus is on the *Equity ratio* and the *STDB ratio* as the two indicators were found to have a significant impact on the chance of winning a tender.

Table 14 reports the DiD results for the *Equity ratio*. The *Treatment effect* is significantly negative in the samples of *All firms* and *All Firms with GPP CA*. The success lowers the firms' equity ratio over the next years no matter whether the success is in a general PP or a GPP tender. In contrast, the coefficients of the *Treatment effect* of SMEs remain insignificant. SMEs with lower equity ratios have a higher chance to be successful in a tender, but after the success the equity ratios of SMEs in treatment and control group are non-distinct. Firm size measured in *log(Total assets)* reduces the *Equity ratio* across all examined samples.

Table 14 - DiD – The impact of success on the equity ratio for different samples, posttreatment period 3 years

	(1) All firms	(2) All SMEs	(3) All firms with GPP CA	(4) All SMEs with GPP CA
Treatment effect	-0.0188**	-0.0135	-0.0239*	-0.0103
	(-2.41)	(-1.49)	(-1.68)	(-0.72)
Posttreatment period	0.00420	0.00613	-0.00823	0.000542
	(0.56)	(0.71)	(-1.03)	(0.06)
log(Total Assets)	-0.0505***	-0.0437***	-0.0463***	-0.0399***
	(-7.54)	(-5.32)	(-5.22)	(-3.50)
Constant	1.144***	1.002***	1.064***	0.935***
	(10.22)	(7.56)	(7.27)	(5.13)
Year Dummies	YES	YES	YES	YES
Country Dummies	YES	YES	YES	YES
Industry Dummies	YES	YES	YES	YES
Observations	12350	8172	7234	4855
R^2	0.066	0.059	0.070	0.067
# firms	1382	1111	786	642

t statistics in parentheses, $^{*}p < 0.10$, $^{**}p < 0.05$, $^{***}p < 0.01$

Table 15 presents the DiD models' results for the effect of the CA on the short-term debt ratio (*STDB ratio*). The *Treatment effect* shows mainly insignificant coefficients. In comparison to the peer group, the successful firms do not take on higher nor lower short-term debt ratios. The only exceptions are SMEs with success in a GPP tender. For those firms CA success leads to a lower *STDB ratio* in the post

treatment period than that of non-treated firms in the control group. This finding may on the one hand indicate that those successful green firms are capable of lowering their short-term debt share in the years after the award. On the other hand, it could point to banks' inability to recognize green SMEs' success, as those firms are not allowed a higher short-term debt share even if they have been successful in a GPP. Firm size significantly increases the short-term debt ratio. Overall, similar to Hypothesis 1, we can confirm Hypothesis 2. Success in a PP affects the successful firm's future financial strength, but the effect is observed only for some types of firms and Public Procurement procedures.

Table 15 - DiD – The impact of success on the STDB ratio for different samples, posttreatment period 3 years

	(1) All firms	(2) All SMEs	(3) All firms with GPP CA	(4) All SMEs with GPP CA
Treatment effect	0.00482	-0.00386	-0.0217	-0.0273*
	(0.60)	(-0.40)	(-1.43)	(-1.87)
Posttreatment period	-0.00807	0.00678	0.0109	0.0228**
	(-1.02)	(0.72)	(1.28)	(2.21)
log(Total Assets)	0.0433***	0.0453***	0.0436***	0.0408***
	(6.60)	(5.38)	(6.12)	(3.99)
Constant	-0.476***	-0.454***	-0.470***	-0.368**
	(-4.34)	(-3.34)	(-3.99)	(-2.25)
Year Dummies	YES	YES	YES	YES
Country Dummies	YES	YES	YES	YES
Industry Dummies	YES	YES	YES	YES
Observations	12002	7965	7034	4728
R^2	0.035	0.034	0.041	0.039
# firms	1378	1098	784	633

t statistics in parentheses, $^{*}p < 0.10$, $^{**}p < 0.05$, $^{***}p < 0.01$

Conclusions

The study tackles the question of whether the financial strength of firms winning PP contract awards, conditional on their SME status, is causally linked to the procurement of contracts from local governments and municipalities. We focus in particular on the procurement of RES contracts. The basis for the analysis is a combined dataset of the Tender Electronic Database (TED) 2015-2018 and the AMADEUS firm database covering the 10 European countries under investigation in the XPRESS project. The dataset consists of TED (treated) firms and matched control firms which did not receive a CA but are similar to the treated firms. According to *The Common Procurement Vocabulary (CPV)*

the majority of observed contracts are either in the Green Public Procurement segment or in the "green possible" Public Procurement segment.

We structure the analysis along two main research hypotheses: first, the likelihood of winning a public procurement tender is affected by a firm's financial strength, and second, the impact of winning a public procurement award benefits a firm's future financial strength. To capture the impact of financial strength on the winning chance we apply probit models on samples of successful firms and control firms. To test the causal effect of receiving a contract award on the firm's financial strength we apply the flexpanel DiD approach.

The probit models' estimation results show that the equity ratio has a significant and negative impact on the chance to win a tender. A lower equity ratio increases the likelihood to be successful in a PP tender. One explanation could be that the equity-rich companies might fall victim of the "fat cat" syndrome and exert less effort to be successful in public procurements compared with expanding firms with low equity ratios, as a low equity ratio is a typical characteristic of quickly expanding firms. Firms with low equity ratios are usually more financially constrained and are more in need of funds and liquidity that accompany a contract award. The short-term debt ratio has a significant and positive effect on winning a tender. Firms with higher short-term debt ratios are more likely to win tenders. The effect may reflect the high liquidity needs of expanding firms. Those firms may be more willing to heavily engage in winning public procurement tenders.

When analyzing the causal impact of winning a contract award on the firms' financial strength, we focus on equity and the short-term debt ratio. We find that success lowers the equity ratio of the successful firms in the years after the success no matter whether the firm receives a traditional or a GPP contract. In contrast, we only find an impact of contract awards on the STDB ratio in the sample of SMEs receiving a GPP contract. In summary, the DiD analysis provides evidence that receiving an award allows those firms to work with low equity ratios. This may indicate that the award is a substitute for a high equity ratio and, thus, works in favor of improving the firm's access to debt financing after receiving an award.

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Appendix 1: Tender types

CODE SELECTION	SHORT CODE SELECTION		Type of tender (1 = GPP, 2 = GPP possible, 3 = Brown tender)
31121300-3	31121300	Wind-energy generators	1
31121310-6	31121310	Windmills	3
31121320-9	31121320	Wind turbines	1
31121330-2	31121330	Wind turbine generators	1
31121331-9	31121331	Turbine rotors	2
31121340-5	31121340	Wind farm	1
38126400-8	38126400	Wind surface observing apparatus	3
45251160-0	45251160	Wind-power installation works	1
09300000-2	9300000	Electricity, heating, solar and nuclear energy	1
09330000-1	9330000	Solar energy	1
09331000-8	9331000	Solar panels	1
09331100-9	9331100	Solar collectors for heat production	1

09331200-0	9331200	Solar photovoltaic modules	1
09332000-5	9332000	Solar installation	1
31712347-4	31712347	Power or solar diodes	2
38126200-6	38126200	Solar radiation surface observing apparatus	3
45261215-4	45261215	Solar panel roof-covering work	1
31712331-9	31712331	Photovoltaic cells	1
45251120-8	45251120	Hydro-electric plant construction work	1
45251140-4	45251140	Thermal power plant construction work	3
45251141-1	45251141	Geothermal power station construction work	1
45248000-7	45248000	Construction work for hydro-mechanical structures	3
42511110-5	42511110	Heat pumps	1
42530000-0	42530000	Parts of refrigerating and freezing equipment and heat pumps	1
42533000-1	42533000	Parts of heat pumps	1
09134230-8	9134230	Biodiesel	1
09134231-5	9134231	Biodiesel (B20)	1
09134232-2	9134232	Biodiesel (B100)	1
31124000-1	31124000	Steam-turbine generator and related apparatus	2
42112100-8	42112100	Steam turbines	3
42112200-9	42112200	Hydraulic turbines	3
42113100-5	42113100	Parts of steam turbines	3
51130000-2	51130000	Installation services of steam generators, turbines, compressors and burners	3
42113200-6	42113200	Parts of hydraulic turbines	3
42112210-2	42112210	Water wheels	3
42113400-8	42113400	Parts of water wheels	3
42121000-3	42121000	Hydraulic or pneumatic power engines and motors	2
42121100-4	42121100	Hydraulic or pneumatic cylinders	2
42121200-5	42121200	Hydraulic power engines	2
42121400-7	42121400	Hydraulic power motors	2
42122210-5	42122210	Hydraulic power packs	2
42124150-0	42124150	Parts of hydraulic power engines or motors	2
42124221-9	42124221	Parts of hydraulic power packs	2
09111400-4	9111400	Wood fuels	1
03416000-9	3416000	Wood waste	1
03413000-8	3413000	Fuel wood	1
24327200-4	24327200	Wood charcoal	3
45251142-8	45251142	Wood-fired power station construction work	1

34144900-7	34144900	Electric vehicles	1
34144910-0	34144910	Electric buses	1
51111000-3	51111000	Installation services of electric motors, generators and transformers	2
51111100-4	51111100	Installation services of electric motors	2
31100000-7	31100000	Electric motors, generators and transformers	2
31110000-0	31110000	Electric motors	2
31160000-5	31160000	Parts of electric motors, generators and transformers	2
31161000-2	31161000	Parts for electrical motors and generators	2
50532100-4	50532100	Repair and maintenance services of electric motors	2
71314000-2	71314000	Energy and related services	2
65400000-7	65400000	Other sources of energy supplies and distribution	2
09000000-3	9000000	Petroleum products, fuel, electricity and other sources of energy	2
09310000-5	9310000	Electricity	2
31200000-8	31200000	Electricity distribution and control apparatus	2
31682000-0	31682000	Electricity supplies	2
24111600-1	24111600	Hydrogen	2
09323000-9	9323000	District heating	2
42515000-9	42515000	District heating boiler	3
45251250-8	45251250	District-heating plant construction work	3
45232140-5	45232140	District-heating mains construction work	3
42320000-5	42320000	Waste incinerators	2
45252300-1	45252300	Refuse-incineration plant construction work	3
51135110-1	51135110	Installation services of waste incinerators	2
90513300-9	90513300	Refuse incineration services	3