The Determinants of Suppliers' Performance in E-Procurement: Evidence from the Italian Government's E-Procurement Platform

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Summary

Participation of small businesses in the market for public contracts is widely recognized as a key policy issue. It is also commonly held that the adoption of e-procurement solutions can be effective in pursuing such an objective. To this end, we analyze the transactions completed in the period 2004-2007 through the Italian Government's e-procurement platform, that is, the marketplace managed by the Italian Public Procurement Agency (Consip S.p.A.). Although descriptive statistics indicate that micro suppliers are the most represented group of firms in the marketplace, our econometric treatment provides some evidence that the former are less successful than *all other* suppliers in getting public contracts. Degree of *loyalty* with buyers, *location* and the use of other MEPA negotiation *tools*, also emerge as relevant factors of success in the e-procurement market.

Keywords: E-Procurement, Small Suppliers, Request For Quotations, Performance, Public Contracts, Count Data

JEL Classification: D44, H57, C16, C25, L25

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1. Introduction

E-procurement is increasingly recognized as an effective tool to reduce purchasing costs and streamline processes in both private and public[2] sector. According to the European Commission's estimates, "*if online procurement is generalised, it can allow governments to save up to 5% on expenditure and up to 50-80% on transaction costs for both buyers and suppliers"*.[3]

The recent trend of demand aggregation (that is, centralization) in public procurement – witnessed by the several central purchasing bodies created in the early 2000 in Europe and in the U.S. – is often accompanied by a more intensive use of e-procurement.[4] Coupling centralization with e-procurement may, in fact, improve the efficiency of procurement processes (Somasundaram, 2004). Well designed e-procurement strategies, moreover, are able to soften potentially adverse effects of centralization – such as hampering smaller firms' access to the procurement markets – and therefore can encourage full participation of *all* firms in the competition for public contracts. One of the most pressing issues in the political agenda is indeed to reconcile (increased efficiency from) demand aggregation with a more extensive participation of smaller firms.[5]

After Consip S.p.A. (Consip henceforth) was mandated by the Italian Government to operate as a central procurement agency in 2000, Italy has been among the first countries in Europe to raise the challenge, seeking for the most effective ways to pursue at the same time a greater demand aggregation and participation of smaller firms in the procurement market. The Governments' e-procurement platform (the Italian acronym being MEPA), launched in 2003, is arguably the most important e-procurement tool designed so far. By exploiting the benefits of web-based/internet procurement, Consip took the role of a "market maker", by setting up an e-marketplace for acquisitions below the EU threshold.[6] The Marketplace connects thousands of public bodies (PBs), both at a central and local level, distributed all over the Italian territory with a currently large set of micro and small, but also medium and large suppliers. Public bodies and suppliers have today access to a free trading platform – an "open market" – populated by many potential sellers/buyers other than those usually present in each geographical area.

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[2] In the EU, the possibility for public administrations to use electronic procurement systems was formalized by the European Directive 18/2004 (Point 12 of introduction).

[3] See the EU "Action plan for the implementation of the legal framework for electronic public procurement" (2004). See also Moon (2005) for a discussion on the determinants of e-procurement in centralized systems.

[4] Empirical evidence from Moon (2005) suggests that centralization is one of the main determinants of the diffusion of e-procurement. See Dimitri, Dini and Piga (2006) for a more detailed discussion of centralization trends in public (and private) procurement. See also Carpinenti, Piga and Zanza (2006) for an overview of central procurement agenciess in Europe, in the U.S. and the more recent patterns in Latin America.

[5] In the U.S., for instance, the Small Business Act (SBA) in the U.S. promotes full participation of small firms in the federal (and non-federal) public procurement market. It also monitors that public agencies achieve the set-aside objectives set by the law.

[6] €137.000 is the threshold for supply and services.

The Marketplace enables PBs to purchase directly from e-catalogues of qualified suppliers or to compare products and prices by making Requests for Quotations (RFQs). In 2007, the volume of all purchases completed through the MEPA since its launch in 2003 achieved €160 Millions. Pushed also by recent legislative modifications[7] – that made the use of the Marketplace compulsory for central public bodies – the MEPA is playing a key role in the Italian public e-procurement scenario, absorbing about 80% of annual e-catalogue-based transactions of *all* Italian PBs.[8]

After five years of activity, the level of development of the MEPA allows us to open the "black box" and start analyzing what has happened, especially in terms of structure of the supply and characteristics of most active suppliers. Looking at available data concerning RFQs, transactions appear rather concentrated in the hands of a restricted pool of suppliers. Despite concentration, data exhibit a great dispersion in the number of awarded contracts. This is essentially due to the fact that, despite active bidding, about 25% of suppliers is never awarded a contract, while the top 1% accounts for more than 20%.[9] One issue worth addressing is indeed the identification of the characteristics of this set of "top suppliers" and, symmetrically, what factors affect the low or non-success of many other suppliers. In more general terms, we look at the determinants of suppliers' success in the MEPA. In answering this question we will also be able to investigate whether (and in what direction) firm's size is a relevant characteristics for success, therefore providing some insights on the effective role of the MEPA in promoting the inclusion of smaller firms in the market for low-value public contracts.

To this end, we analyze a unique, large sample of 3.360 RFQs completed in the Marketplace during the period 2004-2007. Basic descriptive statistics show that "micro" suppliers, defined as those with at most 9 employees, are arguably the most represented group of firms in the Marketplace, absorbing 61% of RFQs and 42% of the volume of the overall transactions. However, when controlling for i) bidding for a RFQ, ii) location, iii) revenue and iv) other characteristics, the picture appears rather different. Measuring suppliers' performance with the frequency of awarded contracts (Y) over the sample period, estimations suggest that the predicted value of Y varies with the firm's size in a direction that is not in favour of the *smallest* suppliers (i.e., micro suppliers). Most performing suppliers are non-micro suppliers (small, medium and large) based in the North, more inclined to serve a selected pool of purchasing PBs. Small and medium enterprises (SMEs) appear as performing as large suppliers. Micro suppliers are, instead, significantly less performing than all other suppliers.

[7] This is due to the recent Italian Financial Law for the 2008.
[8] See the final Report of the Osservatorio B2B - Politecnico di Milano, for an analysis of e-procurement in the Italian Public Sector (www.osservatori.net).
[9] Henceforth we will use RFQ and contract interchangeably.

Location, size and degree of loyalty with buyers emerge therefore as relevant factors explaining performance.

Descriptive statistics also suggest that public bodies located in historically less developed areas tend to award a large fraction of contracts to non-local suppliers. Public bodies tend to purchase from non-local suppliers only if these are more efficient or more able to fit their needs. One possible explanation of this finding is that the efficiency advantage of non-local suppliers more that compensate higher transaction/transportation costs.

The rest of the paper is organized as follows. We first survey the economic literature on e-procurement and e-platforms. In Section 3 we describe the MEPA's institutional/legal framework and stated goals. Section 4 is dedicated to the evolution and the performance of the MEPA in the period 2004-2007, with focus on the dynamics of transactions, volumes, and registered users (demand side). In Section 5 we look in more detail at the supply side, in terms of number, and size and performance of suppliers. After a brief description of the estimation methodologies, Section 6 presents the results on the determinants of suppliers' performance. Section 7 concludes.

2. Related Literature

To our knowledge this is the first paper that investigates empirically policy issues in the field of public e-procurement. Most of the economic and business research on e-procurement is concentrated on popular online platforms such as the one of eBay and Amazon. These marketplaces are today well developed. In the last ten years, they have been providing theorists with puzzling phenomena to ruminate, and econometricians with valuable data to analyze, IT experts/engineers with ideal environments to study technological evolutions and applications for e-commerce. B2G and other public e-procurement marketplaces, instead, have been launched only recently by public authorities.[10] Economic research in this area is therefore only at its infancy. Nonetheless, economists and e-business researchers have already started addressing important issues. Some of the most fertile fields of research are across economics and business. One is the relationships between e-procurement and centralization (Somasundaram 2004, Subramaniam and Shaw 2003, and Neef 2001). Another field is the determinants of e-procurement (Moon, 2005). Dimitri, Dini and Piga (2006) present a survey on these topics.

Despite the economic literature on e-platforms being very recent, research has already produced insightful results. Most theoretical research relates to the field of "two-sided

[10] Some of the most important public e-platforms in the USA, such as Myflorida Marketplace and North Carolina@yourservice, were built up in 2002-2003. Consip itself was activated at the end of 2003. See Caripenti, Piga and Zanza (2006) for a benchmarking on public e-procurement platforms.

markets". In this field, researchers have mainly focused on two main issues known as the "chicken and egg problem" (Armstrong 2006, Gaudeul and Jullien 2001, Rochet and Tirole, 2004, and Jullien 2005), and "competiting e-platforms" (Caillaud and Jullien 2003, and Rochet and Tirole 2003). The empirical literature on e-procurement focuses mainly on big B2B platforms for which valuable data are available. Most papers look at the issue of price formation in e-auctions (such as the ones performed by eBay and Amazon) and the effects of online reputation/feedback mechanisms on participation and bidding behaviour. The role of online feedback mechanisms has also been extensively analyzed. Jullien (2006), Dellarocas (2007) and Bajari and Hortacsu (2004) provide extensive surveys on the topic.

3. MEPA: The Institutional Context

Italy was one the first EU countries to adopt an e-procurement regulation. With the Presidential Decree No. 101/2002 the Italian Government introduced the use of digital procedures in public procurement allowing the Italian public sector to perform acquisitions below the EU threshold through the Public Administration Marketplace. The MEPA was created to promote electronic-based procurement and to streamline purchasing processes. More generally, it aims at "updating" the culture and the practice of public purchasing management.

The MEPA is conceived, at its core, as a complementary tool with the set of framework contracts that Consip awardes on behalf of PBs for acquisitions above the EU threshold.[11] Very often small firms[12] cannot handle high-value framework contracts, usually resulting from demand aggregation of many PBs.[13] As a result, the Italian policy makers created the MEPA in order to have micro and SMEs in a better position to be awarded public contracts below the EU threshold.

The Marketplace is open to qualified suppliers according to non-restrictive selection criteria. After qualification, suppliers' catalogues are uploaded into the MEPA, displayed in a dedicated web site and thus made available to the entire community. Suppliers can provide a non-binding geographical area of coverage for their business. Catalogues are presented in a standardized template in order to make easier for PBs the evaluation of different products. Any PB freely registers to the Marketplace, browses catalogues, compares products and

[11] Since 2000 Consip operates as a central public procurement station for the acquisition of goods and services (works are excluded),

[12] Hereforth, we will use firms and suppliers interexchangeably.

[13] The idea that big framework contracts represent an entry barrier to participation of smaller firms is a widely accepted view. However, empirical evidence supporting or confuting this is to our knowledge absent. First evidence of this effect are in Albano, Dini, Zampino (2008) who empirically test the relationship between participation and contract value in the context of IT services contracts awarded by a large public buyer. Results indicate that large contract value discourage participation and at the same time favours joint bidding.

prices, makes requests for quotation or purchases directly from e-catalogues. The entire transaction process is digital, supported by digital signature in order to ensure legal compliance and overall transparency of process. Figure 1 provides a conceptual scheme of the Marketplace. The MEPA is not fee free. Business is financed through the Ministry of Economy and Finance's (MEF) transfers to Consip.

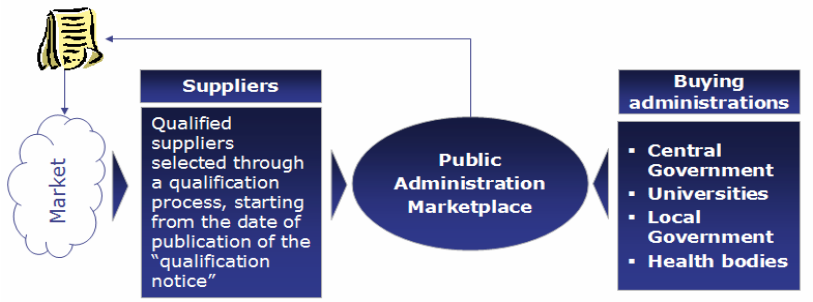
Potential advantages to PBs would include:

- reduction of purchasing and transaction costs;
- development of human capital;
- broadening of suppliers base;
- enhanced transparency and ease of comparison among different goods/services;
- purchases logging and subsequent expenditure monitoring.

Potential advantages for suppliers include:

- selling cost reduction (due to broadening of potential customers base, lower intermediation costs and free digital platform);
- major visibility with respect to the span of PBs;
- B2G introduction in addition to existing B2B and B2C.
- extending the platform of potential buyers.

Figure 1 - MEPA: the conceptual scheme



3.1. E-procurement tools in the MEPA

Public bodies can purchase goods and services on the MEPA by means of two alternative tools:

- Direct Purchase (DP);
- Request for Quotation (RFQ).

The DP allows the PB to buy directly from the e-catalogue at a pre-fixed (i.e., posted) price. It is usually adopted to purchase very low-value items. It can also be suitable when the PB needs to satisfy urgent needs thus avoiding delays generated by a competitive procedure. The

RFQ is a competitive selection procedure through which the PB solicits all qualified[14] or a certain group of suppliers to submit a tender. Responding suppliers provide both a price quotation and the details of technical/quality improvements when required. The contract is awarded to the most preferred price-quality combination without using an explicit, that is, publicly announced, scoring rule. Thus PBs have some discretionary power in awarding RFQs. Contracts may be awarded to a supplier who is not first in the *price ranking* of the product but, for instance, offers valuable services that are not offered by other suppliers (e.g., fast shipping) or is able to deliver it at lower costs. A RFQ is then conceived as a way to introduce some degrees of competition in the acquisition of relatively more valued product/services.

4. Evolution of the MEPA in the period 2004-2007.

At the end of 2007 the MEPA achieved the following results: 1.250 registered Purchasing Units (PUs)[15], more than 52.000 transactions (including both RFQs and DPs), for a total value of about €160 Millions (see Table 1). In 2007, all business indicators improved considerably. Transaction volumes doubled with respect to 2006 and the number of transactions became 2.5 time the value of 2006. The exponential growth of the last year is also due to the 2007 Italian Financial Law that made compulsory the use of MEPA for some PBs (mainly central government). The average value per transaction was €2.640 in 2004 and 2.969. In the sample period 2004-2007 the average value increased up to €3.048 (+15%).

Tab. 1 – Number of Transactions and values (2004-2007)[16]

Year	*2004*	*2005*	*2006*	*2007*	*Cumulative*
Transactions	3.143	9.675	11.467	28.168	52.453
Millions of €	8,3	29,90	38,04	83,64	159,88

Table 2 illustrates the evolution of PU registrations to the marketplace. Registrations have been steadily growing over the three years. In early February 2008, PUs were almost 5.900, with an increase of about 457% with respect to 2004. One important indicator is the growth of "active" PUs. A PU is defined active if it has purchased at least once in the current year. Active users were 1.097 in December 2005, 1.253 in 2006. In 2007, they achieved 2.726 (+118% over 2006): about 50% of registered PUs adopted the MEPA for at least one purchase.

[14] That is, all suppliers that were qualified to sell the category of products included in the RFQ.
[15] Purchasing Units are departments, structures or other units belonging to the same public body. The Purchasing Unit is the lowest level of authority endowed with "budget power" in the Italian Public Administration.
[16] Source: Bertini L. and A. Vidoni (2007).

"Loyals", namely those users who have bought at least once in the current *and* in the previous year, were 600 in 2006 and 714 in 2007. However, in 2007 the share of loyal PUs over active (714/2726) is 26%. In 2007 the fraction of loyal over active halved with respect to 2006. This is because the number of registrations increased significantly and much more than the "loyals" because of the new rules making the MEPA compulsory for central bodies.

Tab. 2 - Purchasing Units in the period 2004-2007

	2004	*2005*	*2006*	*2007*	*2008 (10/02)*
Registered	1.288	1.038	601	2.185	228
Cumulative Registered	1.288	2.326	2.927	5.653	5.888
Active	-	1.097	1.253	2.726	-
Loyal	-	-	600	714	-
New Entry	-	-	653	2.012	-

On the supply side, 1.293 (active) suppliers are registered in the MEPA, accounting for a total of 2050 e-catalogues (as of January 2008)[17]. ICT and office supplies represent a large fraction of total catalogues (78%) as reported in Table 3.

Tab. 3 - Distribution of catalogues for supplies, 2008.

At January 2008: 1.293 Stayers; 2050 catalogues uploaded				
ICT	Office	Services	Health materials	Others
43.5%	34.5%	14%	1%	7%

5. The supply side: basic statistics

Before investigating the determinants of suppliers' performance we provide an overview of the supply side of the MEPA. We look in more detail at the information contained in the large sample of transactions drawn from MEPA in the period 01/2004-05/2007. This period does not include transactions made under the regime of compulsory introduced by the Financial Law 2008.[18]

Table 4 reports a summary of the sample data. We focus our attention on purchases performed through RFQs. There are several reasons to have a closer look at RFQs rather than DPs:

- they explain the greater part of total transaction volume (65%);

[17] Source: internal reporting system.
[18] The obligation to use the MEPA is after July 1st, 2007.

- by looking at direct purchases we only observe the selling supplier (who is committed to sell at a predetermined price that is posted in the e-catalogue), whereas the analysis of RFQs reveals how and when all invited suppliers respond and, most importantly, who are most successful suppliers;
- the use of discretionary power by PUs may reveal the latter's purchasing patterns/preferences.

Tab. 4 – Summary of the sample (January 2004 – May 2007).

	Volume	*%*	*N. transactions*	*%*	*Average value*
RFQ	**€ 50.557.040**	**65%**	**3.360**	**14%**	**€ 15.046,74**
DP	€ 26.997.540	35%	20.188	86%	€ 1.337,31
Total	€ 77.554.580	100%	23.548	100%	€ 3.293,47

The dataset comprises detailed information on 3.360 RFQs and 1.351 invited suppliers. 1053 suppliers are invited to provide quotations for a "single" category of supply (e.g., ICT). 281 out of 1053 suppliers were invited to submit proposals for a "bundle" of supplies , 50% of which regarded the bundle ICT + office materials). 425 out of 1053 placed a bid after PUs invitation. Table 5 shows the distribution of suppliers by dimension as measured by the number of employees.[19]

Table 5-6 report that micro suppliers are 54% of total active suppliers in our sample, covering 61% of awarded RFQ and 42% of total transaction volume. Total transaction volume declines with size. Micro suppliers' volume is 7 times higher than large suppliers' (Figure 2). However, the average value of awarded contracts increases with the supplier's size (Figure 3). This suggests that small suppliers are awarded many low-value RFQs, while larger suppliers are awarded few but larger RFQs.

Tab. 5 - Distribution of suppliers (01/2004-05/2007)

Firm Size	*Freq.*	*Percentage*	*Cum.*
Micro	529	53.87	53.87
Small	287	29.23	83.10
Medium	103	10.49	93.58
Large	63	6.42	100.00
Total	982	100.00	

[19] Since we do not have data on revenues and on participation/control, the classification by size is only based on the number of employees. We use the EUROSTAT classification: micro [0-9], small [10-49], medium [50-249] and large [≥250].

Tab. 6 - Distribution of RFQs by suppliers' size

Size	*N. of awarded RFQ*	*Average value of awarded RFQ*	*Total Value of awarded RFQ*
Micro	2060 (61,3%)	€ 10.241,9	€ 21.098.232 (41,8%)
Small	850 (25,4%)	€ 18.289,6	€ 15.546.192 (30,7%)
Medium	361 (10,7%)	€ 29.678,3	€ 10.713.869 (21,2%)
Large	89 (2,6%)	€ 35.940,9	€ 3.198.747 (6,3%)
Overall	3.360	€ 15.046,7	€ 50.557.040

Figure 2 – Distribution of awarded RFQ value by suppliers' size

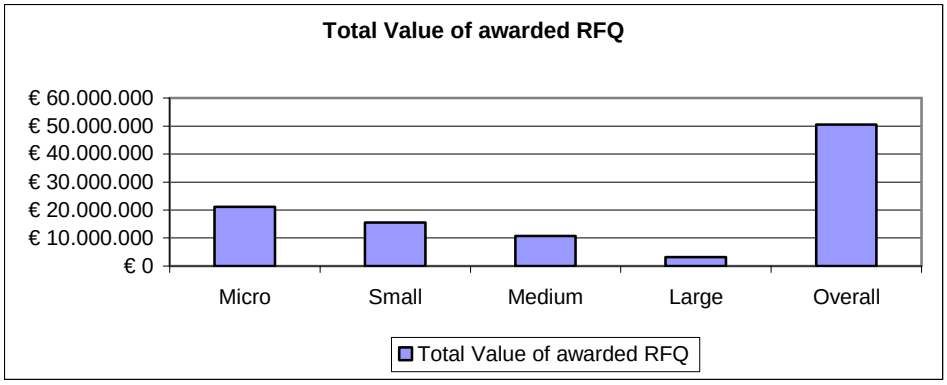


Figure 3 – Distribution of RFQ average value by suppliers size

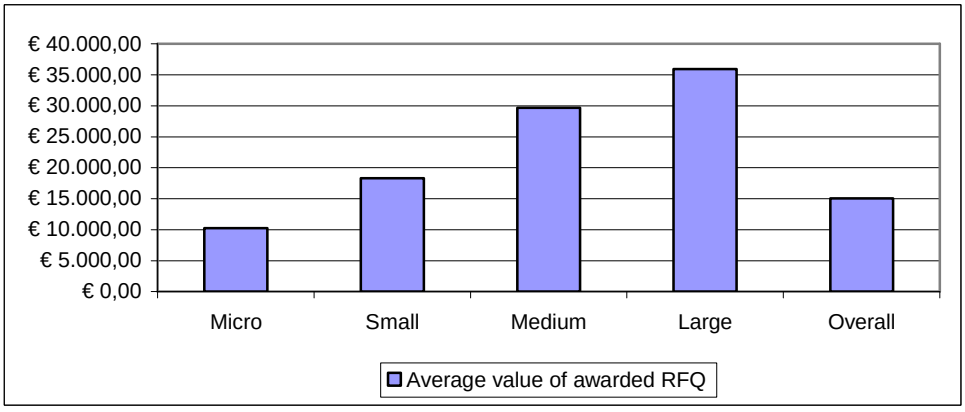


Table 7 reports the distribution of firms by size and localization. Several things are worth noting. Suppliers located in the North are the ones most present into to the MEPA for any given size: 35%, 49%, 53% and 43%, respectively from small size towards large size. Micro, small and medium suppliers represent 85% of total firms. Micro firms are the most represented in all geographical areas (ranging from 45% to 74%).

Northern regions "contribute" more to suppliers participation, but this contribution is more focused on medium/large suppliers. Overall, the presence of medium-large and very large firms is modest and rather concentrated in the more developed areas of the country (Center and North-West). These numbers suggest that the MEPA seems to achieve its important target of "hosting" a large number of micro and small suppliers.

Tab. 7 – Firms' area vs. firms' size

	Suppliers' Size				
Suppliers' location	*micro*	*Small*	*Medium*	*large*	*Total*
Center	185 (59%)	82	32	13	312
Islands	76 (74%)	21	2	4	103
North-East	72 (46%)	56	20	8	156
North-West	114 (45%)	86	35	19	254
South	82 (56%)	42	14	7	145
n.a.	0	0	0	12	12
Total	529 (53,8%)	287	103	63	982

In table 8, we match localization of suppliers with that of PUs. We thus obtain a sort of "regional business balance". The North is the area awarding the highest fraction of contracts (through RFQs) to local suppliers (approx. 74%). It is interesting noting, however, that Southern regions and Islands are those most purchasing from non-local suppliers, 27% and 32%, respectively.

Tab. 8 - Business Balance (awarded RFQs from 01/2004 until 05/2007).

	Suppliers' location (Italy)					
PUs' location	*Center*	*Islands*	*North*	*South*	*n.a.*	*Total*
Center	**1.085**	46	738	86	2	1.957
	(55.4%)	(2.4%)	(37.7%)	(4.4%)	(0.1%)	(100.0%)
Islands	107	**147**	159	44	4	461
	(23.2%)	**(31.9%)**	(34.5%)	(9.5%)	(0.9%)	(100.0%)
North	263	25	**907**	27	9	1.231
	(21.4%)	(2.0%)	**(73.7%)**	(2.2%)	(0.7%)	(100.0%)
South	150	24	224	**156**	1	555
	(27.0%)	(4.3%)	(40.4%)	**(28.1%)**	(0.2%)	(100.0%)
Total	1.605	242	2.028	313	16	4.204
	(38.2%)	(5.8%)	(48.2%)	(7.4%)	(0.4%)	(100.0%)

6. Suppliers' performance

Plot 1 and Table 9 show the frequency distribution of RFQs among suppliers (number of suppliers on y-axis for given number of awarded RFQs on x-axis). Two things are worth noting: dispersion and concentration. Out of 425 "interested" suppliers, namely those who placed at least a bid, roughly 90 were awarded no contract, while 3 suppliers were awarded more than 100 RFQs. While 20% of suppliers is awarded no RFQs and 50% of them are awarded just 2 RFQs, the "top" 25% is awarded the largest fraction of the contracts. Although the average number of RFQs is 7.9, variance is extremely large (453.5). The frequency of suppliers declines with the number of awarded contracts. On the one hand, data indicate that many suppliers competing in the market for RFQs are completely unsuccessful. On the other side, data also indicate that RFQs are rather concentrated in the hand of few suppliers (the first 25%, roughly 106) among which 4 suppliers (1%) are awarded the 20% of total RFQ (693/3.360),[20] with 3 out of them experiencing outstanding performance (much above 100 RFQs each).

Our main goal is to identify the characteristics of "top 25%". To this end, we exploit information on suppliers' characteristics (such as size, location, loyalty, revenue from the MEPA etc.) that preliminary statistics seem to indicate as the most relevant factors in explaining the differences in the number of awarded contracts.

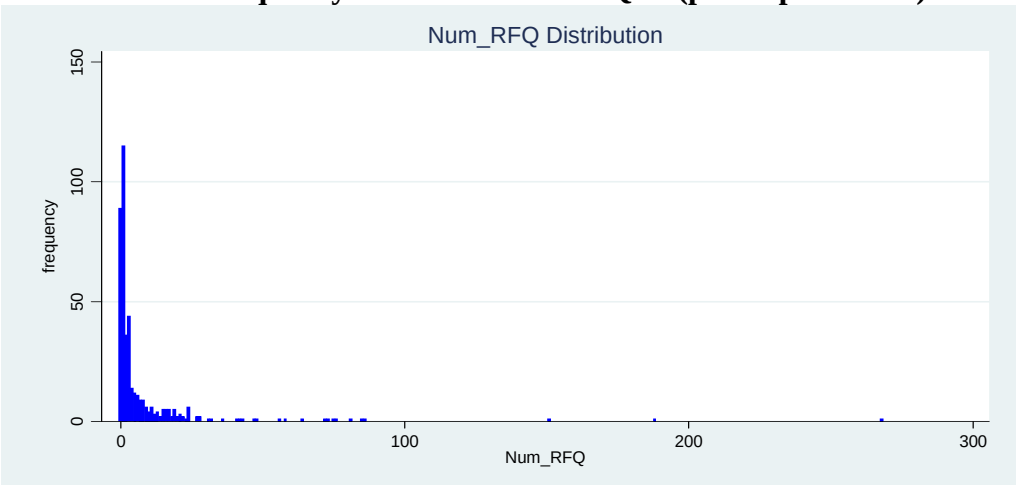
Tab. 9 – RFQ in percentiles (when RFQ participation >0)[21]

Percentiles		*N. Suppliers*	*Smallest*		
1%	0	4.25	0		
5%	0	21.25	0	*Obs.*	425
10%	0	42.5	0	*Sum of Wgt.*	425
25%	1	106.25	0		
50%	2	212.5		***Mean***	**7.9**
			Largest	*Std. Dev.*	21.29
75%	6	318.75	86		
90%	19	382.5	151	***Variance***	**453.5**
95%	28	403.75	188	*Skewness*	7.2
99%	85	420.75	268	*Kurtosis*	71.9

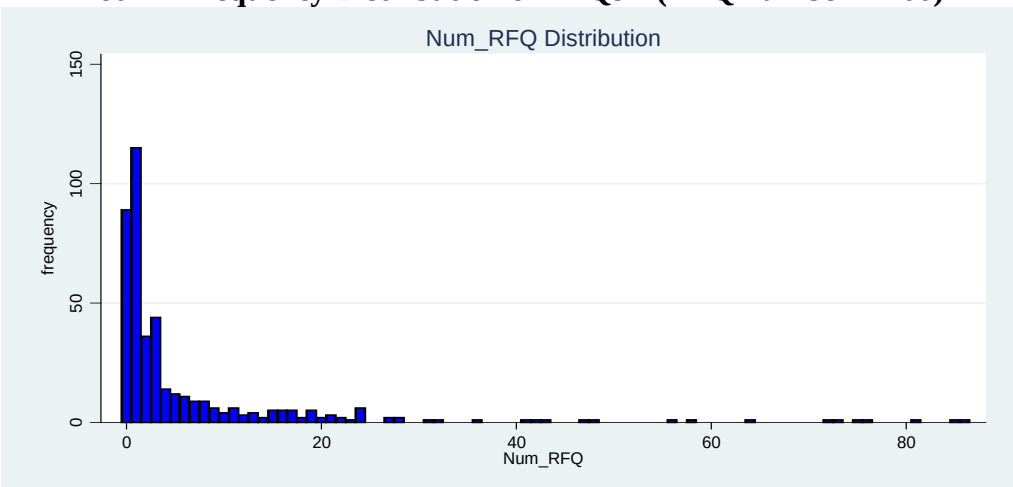
[20] See the details on RFQ counts in table 9.

[21] Here, only suppliers who placed a bid after invitation to quote from the PU are considered (i.e., participation >0). The same holds for plot 1.

Plot 1 – Frequency Distribution of RFQs – (participation > 0)



Plot 2 – Frequency Distribution of RFQs – (RFQ number < 100)



6.1. Methodology: the Count Data Approach

In many economic environments, the dependent variable of interest is a non-negative integer or count which the researcher wishes to explain in terms of a set of covariates. With respect to the classical regression model, the dependent variable (y) is discrete with a distribution that assigns probability mass at non-negative integer values only (Cameron and Trivedi, 1999). Standard OLS are no longer feasible to analyze these data. Regression models for counts, as well as other discrete models such as the logit and probit, become more suitable, as their properties are strictly connected to discreteness and nonlinearity.

Count data models are appropriate for measuring the "frequency" of occurrence of an event. A classical example comes from demography, in which fertility is usually modelled as the number of live births over a given age interval of the mother. The demographer is interested in analyzing how fertility varies with the mother's schooling, age, and household income, etc. Accident analysis studies model airline safety, for example, as measured by the number of

accidents experienced by an airline over some period, and wishes to examine its relationship to airline profitability and financial health.

The analysis of frequencies implies controlling for the risk – exposure – that the event may occur. In the example of fertility, the exposure is the age of the mother, while in the case of airline accident is the number of flights in the period.[22]

Count data approach is the most appropriate for our dataset. Our dependent variable is the number of times (Y) each supplier is awarded an RFQ, so we refer to it as the proxy for his performance (or success) in the MEPA. Suppliers' performance is controlled for participation (exposure) to the RFQ. Exposure is then the number of times each supplier bids for a contract and, therefore, is exposed to the likelihood of being awarded a contract. That is, while analyzing the number of times each supplier is awarded a contract we control for the number of times he bids for an RFQ: winning 10 contracts of course would have a completely different meaning if bidding occurred 10 times instead of 100 times!

Non-linearity and discreteness are key features of models for count data. Plot 1 clearly indicates this to be the case for our sample. Models for count data, such as Poisson[23] or Negative Binomial regressions, appropriately account for such features by working with the logs of dependent, given the original exponential form of independent variables.[24] The Poisson model imposes the restriction that the conditional variance equals the expected value of the dependent variable $E[Y] = \text{var}[Y] = \lambda$. However, this restriction is often rejected in economic applications.[25] This is our case as shown in table 9: the variance is much greater than the mean (453.5>7.9), displaying the classic "overdispersion" trouble. In case of overdispersion, Cameron and Trivedi (1986) suggest to use the Negative Binomial (NB) regression,[26] which relaxes the assumption about mean-variance equality, by including a

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[22] Applications of such models are quite common in the economic literature. Cameron A.C., P.K. Trivedi, Milne and Piggott (1988) apply the count data approach to analyze the determinants of the choice of health insurance type and types of health care services in Australia, using micro-level data from the 1977-78. Other applications to heath care are due to Cameron and Windmeijer (1996) and Freud, Kniesner and LoSasso (1996, 1998).

[23] The Poisson distribution is a discrete probability distribution that expresses the probability of a number of events occurring in a fixed period of time (distance, area, etc.) if these events occur with a known average rate (λ) and independently of the time since the last event.

$f_y(y) = f_y(y;\lambda) = \frac{e^{-\lambda}\lambda^y}{y!}$ for y=0, 1, 2, …; $f_y(y) = f_y(y;\lambda) = 0$ otherwise.

[24] $E[Y/X] = e^{X\beta}$ where *E[.]* is the expected count of the dependent variable conditional to the vector of covariates *(X)* and β is the vector of estimated coefficients. See Greene (2003) for a basic treatment of these models. See also Cameron and Trivedi (1986) and Cameron and Trivedi (1998) for an overview of standard models for count data.

[25] Another assumption in the Poisson regression is that the events must be independent in the sense that the occurrence of one event will not impact the occurrence probability of another event. We are not able to assess how much this assumption holds in our case. However, the single RFQ awarding event (per supplier) may be reasonably thought independent from the outcomes of someone else; if a form of dependence there was, it would be due to the supplier's past performance in previous contracts.

[26] The Negative Binomial distribution is a discrete probability distribution that expresses the probability of a number of events occurring in a fixed period of time (distance, area, etc.) according to following distribution

stochastic term (ε_i) in the parameter μ_i, where ε_i follows a gamma distribution. In the NB regression, the variance is equal to $\mu + \alpha\mu^2$, where μ is the mean of the dependent variable and $\alpha \geq 0$ is known as the overdispersion parameter. The NB allows the econometrician to account for some unobserved heterogeneity among individuals that may help explaining dispersion and model this complex form of heteroskedasticity. Indeed, the term α permits the form of heteroskedasticity where the conditional variance exceeds the conditional mean, which is prevalent in count data. The NB model collapses into Poisson specification as α approaches zero.[27] The NB model is appropriate to gain consistent estimators even if there is some heterogeneity in the data. This heterogeneity, however, should not be due to a permanent unobservable effect. If it was the case, permanent heterogeneity would present itself as persistent serial correlation in the residuals (Blundell et al., 1995). Furthermore, if qualitative difference between transition from zero events to the first occurrence and from the first to further occurrences was reasonably supposed in our data, a more complicated model specification would need. Green (1994) shows the suitability of zero-inflated models if there is a two stage process governing occurrences. The former stage would lead to structural treatment of the binary event between being awarded or not. Fortunately, this is not our case. In fact, we have at most 20% of zero occurrence on 425 observed suppliers. The Vuong test[28] does not support the hypothesis that the excess of zero is a problem in our data.

As shown in the next section, the test does not reject the hypothesis of overdispersion, suggesting that the NB model is more appropriate for our data. Fitting NB regression is similar to fitting Poisson regression, therefore the log of the mean μ, is a linear function of independent variables.

We define the *incidence rate* (i_r) as the average number the event occurred given the times it could have occurred:

$$(i_r)_i = \frac{\text{Count of events}}{\text{N. of times event could have occurred}}, \qquad (1)$$

where the denominator is the "exposure". We model the logarithm of the incidence rate as a linear function of more explanatory variables:

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function: $f_y(y) = f_y(y;r,p) = \binom{-r}{y} p^r (-q)^y$ for y=0, 1, 2, …; $f_y(y) = f_y(y;r,p) = 0$ otherwise; where the parameters are r=1, 2, 3… and $0 < p \leq 1$ and $q = 1 - p$. Then, $E[Y] = \frac{rq}{p} = \mu$ and $\text{var}[Y] = \frac{rq}{p^2} = \mu + \alpha\mu^2$, assuming $\alpha = \frac{1}{r}$.

[27] NB model is thus a robust generalization of the Poisson.

[28] The computed value is V = 0.50, 0.26 for ZIP and ZINB models, respectively. See Vuong (1989) for details on this tests.

$$\ln(i_r)_i = {}'x_i \cdot \beta + \varepsilon_i \,. \tag{2}$$

Alternatively, the model describes logs of expected event counts:

$$\ln(\text{expected count})_i = \ln(\text{exposure}_i) + {}'x_i \cdot \beta + \varepsilon_i \,, \tag{3}$$

such as:

$$\ln(\mu_i) = \ln(N_i) + {}'x_i \cdot \beta + \varepsilon_i \,. \tag{4}$$

NB regression finds the maximum-likelihood estimates of the β parameters. We recall that:

- $\ln(\mu_i)$-$\ln(N_i)$=$\ln(\mu_i / N_i)$ is the log of the conditional mean of the number of awarded contract for each supplier "i";
- $'x_i$ is the vector of explanatory variables;
- β is the vector of estimated coefficients for each covariate;
- ε_i is an individual unobserved heterogeneity effect to control for variance. This component plays a double role of measuring both the specification error (as in the classical linear regression model) or the kind of cross sectional (i.e. cross-suppliers) heterogeneity.

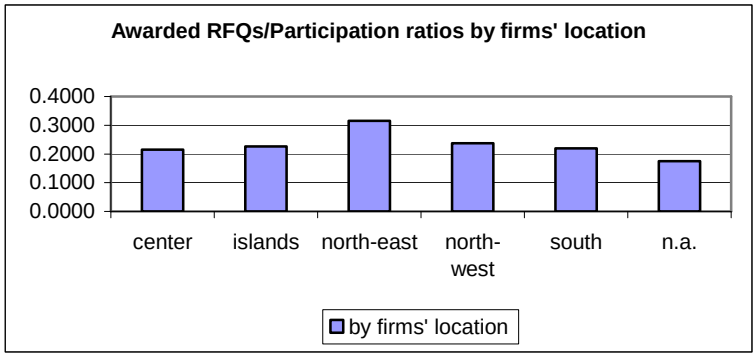
The vector of explanatory variables is a set of variables capturing the individual characteristics of suppliers:

- **ln(MEPA_revenue)** measures the suppliers' overall turnover (in terms of natural logarithm to smooth absolute gaps) realized on the MEPA since their registration on the platform. This can be a proxy of the size of the supplier in the specific context of the MEPA. It is computed on the total revenue from both RFQ and DP sales. We expect this number to be positively correlated with the number of awarded RFQs.
- **DP_Num** is the number of direct sales through DPs realized in the sample period. This variable proxies how performing is the supplier in the other selling tool offered by the MEPA. The level of performance in DPs may help us to say something about the suppliers' performance in RFQs. A positive coefficient indicates that good performance in DPs may help being performing also in RFQ (RFQ and DP are somewhat *complementary*). A negative coefficient might indicate that the supplier is more specialized in one of the two (the tools may be *substitutes*).
- **PU_Num**: number of different PUs served by each supplier. This variable measures whether the supplier sells to many different PUs rather than a restricted pool of PUs.
  It is the number of unique PUs the supplier interacted with in the sample period, including both RFQs and DPs. This variable is a proxy for *loyalty* between suppliers and PUs, thus measuring whether and how the degree of loyalty impacts suppliers'

success in being awarded an RFQ. The variable may give some understanding of the *nature* of success. A negative correlation means that, all else being equal, success goes in the same direction of interacting with few PU but repeatedly. A positive correlations may instead indicate that success goes in the direction of less frequent interactions, but with many different PUs.

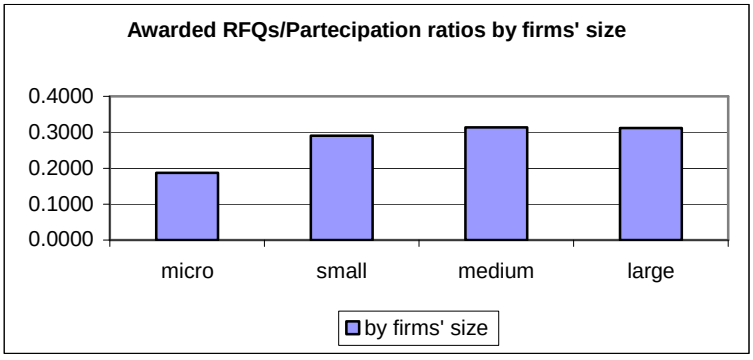
- **Dummy_firm_nord**: this dummy equals 1 if the supplier is located in the North of Italy, 0 otherwise. The dummy captures the contribution of geographical location to success. As Figure 4 suggests, suppliers located in the North – especially North-East, the Italian most developed industrial area – appear more successful than those located in other areas (they experience higher awarding rates, i.e., higher number of awarded contracts/number of invitations to bid from PUs).
- **Dummy_micro_firm**: this dummy equals 1 if the supplier is a micro firm [≤9 employees], 0 otherwise. This dummy variable is constructed following indications from Figure 5. Micro suppliers are awarded a lower number of contracts with respect to all other suppliers, while SMEs and large suppliers display comparable success rates. Awarding rates for micro firms appear much lower with that of all others' (about 0.2 vs. 0.3).[29]
- **Dummy_outlier_RFQ**: there are 3 suppliers who are awarded a significantly higher number of RFQs with respect to everyone else (over 100 RFQs each). It can be the case that these suppliers face with some very specific features that allow them to be much more performing than all other suppliers, thus we control for this *outlier factor*.
- **RFQ_Partec**: is the *exposure* variable in our model. This is the number of times each supplier bid/responded to an invitation to quote from purchasing units. This variable is not directly included in the estimation of the parameters, however is taken into appropriate account for its calibration by the estimation procedure.

Figure 4. Awarding rates by firms' location



[29] The awarding rate is equal to the number of awarded RFQs over the number of times suppliers placed a bid after the invitation to quote from the PU.

Figure 5. Awarding rates by firms' size



6.2. Results

In this section we present the results of a number of model specifications in order to check the robustness of regression analysis. As it is shown in table 10 the Wald test indicates largely significant coefficients in the model of interest, even if accounting for the variance of awarded RFQ. The variance is much greater than the mean, therefore, revealing that the distribution of the dependent variable is clearly affected by considerable overdispersion (this is also confirmed by likelihood ratio tests).

The large value for χ^2 (1034) as goodness-of-fit confirms this conjecture and suggests that the Poisson distribution is not a good choice for our data.[30] However, we first treat overdispersion by adjusting standard errors with the square root of the Pearson χ^2 dispersion (see the second column of estimations in table 10). The coefficients, identical to the previous analysis, display standard errors adjusted for the overdispersion in the Poisson model. Coefficients show a decrease in z-scores, but all keep a very high statistical significance. An alternative solution to scaling the standard errors would be to use the NB regression, which is usually appropriate as discussed above. Estimated coefficients still show a reduction in z-scores, but preserve an appropriate statistical significance. The direction of correlations are confirmed all over the regression models. Estimation results are reported below in column 3 of table 10.

Estimated coefficients measure how the expected number of awarded RFQ vary as covariates vary. In particular we can interpret the regression coefficients as a difference between the logs of expected counts. Formally, this can be written as $\beta = \ln(\mu_{x_{0+1}}) - \ln(\mu_{x_0})$, where the subscripts indicate the points in which the predictor variable x is evaluated (at x_{0+1} and x_0, implying a one unit change in the predictor variable x). This is equivalent to $\beta = \ln\left(\frac{\mu_{x_{0+1}}}{\mu_{x_0}}\right)$, which allows us to interpret coefficients in terms of the log of the ratio of expected counts. The exposure

[30] The likelihood ratio test for $\alpha=0$ (table 10, column III) is a test of the over-dispersion parameter α. When this parameter is zero the negative binomial distribution is equivalent to a Poisson distribution. In the case, α is significantly different from zero and thus reinforces that Poisson distribution is not appropriate.

term allows us to be more rigours, by interpreting the regression coefficients as the log of the rate ratio. On the contrary, the *IRR* β-estimations (see column 5) provides the exact *incidence rate ratios* $\left(\frac{\mu_{x_{0+1}}}{\mu_{x_0}}\right)$ arising from the one unit change in the regressors.

Coefficients indicate that revenue, location, size, loyalty and direct purchases significantly affect suppliers performance. The estimated predicted number of awarded RFQs is about **1.9** for each supplier on average over the explanatory variables. It is worth noting how this number varies in response to variation of the independent variables (table 10, column 6).

For instance, being located in the North allows the supplier to increase of 0.517 his expected number of awarded RFQ that is: roughly +27% (≈0.517/1.919). Being a micro supplier, however, reduces the number of expected awarded RFQs of 0.31, more or less of 16%. Indeed, the *incidence rate ratios (IRR)* show straightforward the effects (intensity, signs and significance are confirmed overall model specifications) on expected contracts award occurrences. Revenue also has a sizeable positive impact (+18%). The signs of direct purchases and the number of different purchasing units are consistent with the expected directions, despite they show very modest in size (+0.001% and -0.004%, respectively).

The role of firm's size is somewhat surprising given the preliminary statistics (see table 6) according to which micro firms absorb 61% of total RFQs. *Despite absorbing more than 60% of RFQ, regressions indicate that micro firms are the least successful suppliers in the MEPA.* One possible explanation for this is that micro suppliers absorb a great part of the transactions simply because they are statistically more present in the marketplace than all other suppliers. This might also suggests that each (of the many) micro suppliers is awarded a very limited number of RFQs.[31] Instead, many RFQs are awarded to other, arguably less represented suppliers.

The variable PU_Num has a negative sign but quite weak impact (-0.004). This suggests the existence of some loyalty effects in MEPA. The negative sign seems to confirm that suppliers interacting with a limited number of unique PUs experience an increase in the expected value of awarded RFQs.[32]

The log of the overall transaction value (MEPA_revenue) is also largely significant in our estimations (+0.162) and with positive sign it goes in the direction of higher revenues associated to higher number of transactions (instead of less transactions of higher value). The log-log formulation allows us to interpret the coefficient as an elasticity. That is, 1% increase in revenue is associated to a 16% increase in expected number of awarded contracts. Suppliers' transaction value is a proxy for their relative size with respect to the MEPA. High-MEPA revenue suppliers are also more performing than low-MEPA revenue suppliers.

[31] Except three micro firms which account for the three largest counts of awarded contracts (over 100 contracts).

[32] It would be interesting investigating casualty effects, i.e., whether is success to drive repeated interactions or vice-versa.

The number of DPs – the proxy of performance with respect to the alternative MEPA selling tool – does not seem to influence suppliers' performance on the RFQ side, although its significance is kept in the transition between Poisson models to Negative Binomial. However, this does not necessarily exclude some complementarities between the two as long as the positive sign is maintained across the different estimation techniques.

Model 4 in table 10 aims at capturing some potential bias effect of the three most successful suppliers (three suppliers collected over 100 RFQs each). The outlier dummy control, however, is not significant although the estimates still exhibits robustness.

In summary, evidence suggests that most successful suppliers are non-micro suppliers, located in the most developed areas of the country (North of Italy), interacting with a limited ("privileged") pool of administrations. Interestingly, a non-micro supplier located in the North is expected to be successful roughly 45% more than micro supplier located in the South. Revenue from MEPA and good performance on DPs side also arise as additional factors of success.

Table 10. Estimation of RFQ with alternative count data regression models

	RFQ_Number Regressions					
RFQ_Num	*I. Poisson Regression*	*II. GLM_Poisson Scaled (x2)*	*III. Negative Binomial (1)*	*IV. Negative Binomial (2)*	*V. Negative Binomial_IRR*	*VI. Marginal effects (3)*
Ln(MEPA_revenue)	*0,142*** (7,94)*	*0,142*** (4,70)*	*0,162*** (5,81)*	*0,162*** (5,83)*	*1,176*** (5,81)*	*0,311*** (6,63)*
DP_Num	*0,001*** (7,86)*	*0,001*** (4,66)*	*0,001*** (2,61)*	*0,001*** (2,81)*	*1,001*** (2,61)*	*0,002*** (2,58)*
PU_Num	*-0,003*** (-7,46)*	*-0,003*** (-4,42)*	*-0,004*** (-3,39)*	*-0,004*** (-3,56)*	*0,996*** (-3,39)*	*-0,008*** (-3,35)*
Dummy_ Firm_nord	*0,366*** (9,69)*	*0,366*** (5,74)*	*0,263*** (3,36)*	*0,256*** (3,26)*	*1,301*** (3,36)*	*0,517*** (3,25)*
Dummy_ Micro_firm	*-0,142*** (-3,67)*	*-0,142** (-2,17)*	*-0,16** (-1,97)*	*-0,171** (-2,10)*	*0,852** (-1,97)*	*-0,31** (-1,92)*
Dummy_ Outlier_RFQ	-	-	-	*-0,347 (-1,13)*	-	-
Constant	*-3,493*** (-15,82)*	*-3,493*** (-8,37)*	*-3,46*** (-10,36)*	*-3,443*** (-10,33)*	-	-
RFQ_Partec			*exposure = ln(RFQ_Partec)*			
Obs.	*425*	*425*	*425*	*425*	*425*	-
LR chi²	*342,44*	-	*64,22*	*65,56*	*64,22*	-
Pseudo R²	*0,14*	-	*0,036*	*0,036*	*0,036*	-
Goodness-of-fit Chi²	*1034,17*	-	-	-	-	-
(1/df) Deviance	-	*2,468*	--	--		-
(1/df) Pearson		*2,847*				
LR-test (α)=0	-	-	*371,22 (α=0,201)*	*341,59 (α=0,199)*	*371,22 (α=0,201)*	-

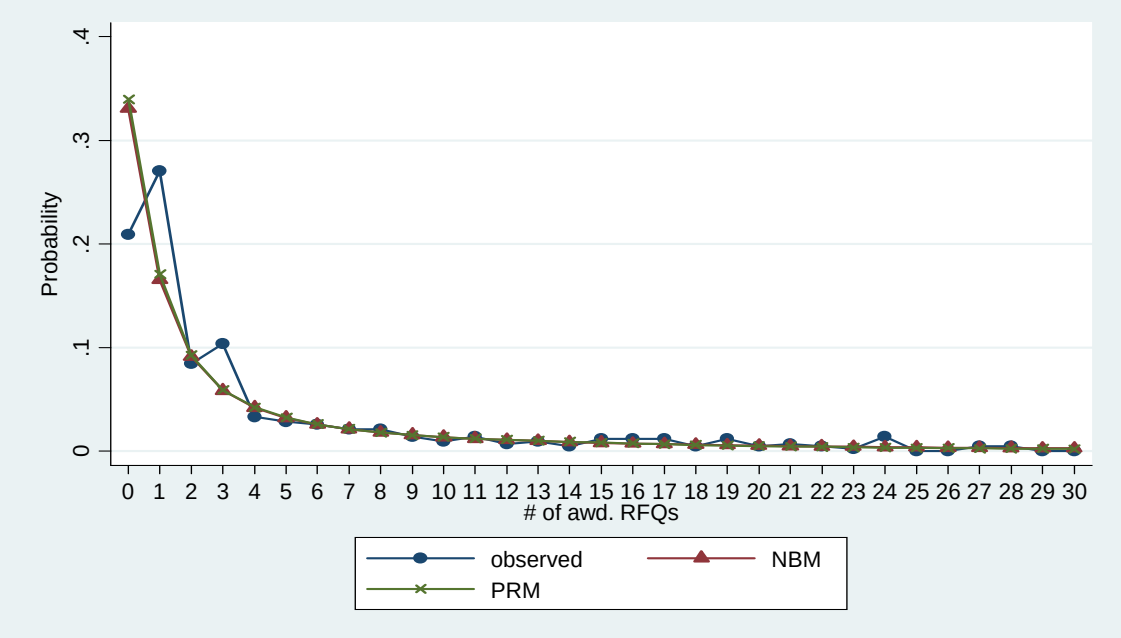
*z-scores shown in parentheses; significant levels at *0.10, **0.05, ***0.01.*

(x2) Generalized Linear Modeling for Poisson distribution scaled with standard errors using square root of the Pearson chi-square dispersion, in order to deal with the over-dispersion.

(3) Marginal effects after "nbreg"; y = predicted number of events (1,919) and dy/dx = marginal effects at the means of the independent variables, also for discrete change of dummy variable from 0 to 1.

Robustness of our results is confirmed by comparing magnitude and statistical significance of coefficients under different prediction models. Coefficients vary a little when estimating by Poisson rather than NB. Plot 3 compares graphically model predictions and count observed distribution. Robustness of estimations are still confirmed. The graph displays predictions of NB and Poisson models, and either fit well the observed data.

Plot 3 – Comparison of Prediction Models and Observed Distribution



7. Conclusions

In this paper we have analyzed the suppliers' performance in the MEPA.
The regression analysis supports some basic intuitions about the direction of effects of the variables influencing suppliers' performance. Location, revenue and loyalty play a relevant role in explaining success. More successful firms appear those located in the North, having large revenue in the MEPA, and interacting with a selected pool of purchasing administrations. Quite surprisingly, success varies with the supplier's size in a direction that is not in favour of the most represented group suppliers. Micro suppliers appear less successful than all other suppliers. Micro suppliers is awarded a limited number of RFQs in relation to the number of times bidding occurs. Among all other suppliers, small, medium and large suppliers show similar patterns of performance.

Our paper is the first step to understand what is driving suppliers' success in the MEPA, and in general, what could be at the root of suppliers' performance in MEPA-like marketplaces. A

full analysis of this issue can be important for providing policy indications to market makers and marketing insights to suppliers for business/selling strategies.
One point worth highlighting is that the increase of suppliers' base constantly over time might not be sufficient to achieve well developed and functioning e-procurement platforms if contracts end up awarded to a very restricted pool of suppliers. Potential concerns may arise if part of this phenomenon relates to factors other than suppliers' efficiency or ability to satisfy buyers' needs, as local favouritism. One adverse consequence could be the early exit of some suppliers that may lower the level of competition in the future.

Further research will extend the analysis of performance to account for these and other factors that we are aware may play a role in explaining suppliers' success in the MEPA. For instance, investigating whether success is driven by efficiency rather than favouritism would help the market maker but also competing supplier in understanding more on the real the nature of success.

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