

University of Lund Department of Economics

Marcus Brafors

Master's Thesis in Economics

Supervised by Jerker Holm

2015-08-26

Supplier selection methods in public procurement

On the impacts of transparency and independence

Abstract

In what follows, two properties characterizing supplier selection methods, namely, transparency and independence of irrelevant alternatives, will be properly discerned. Consecutively, three hypotheses, concerning the impact these properties have on the procurement outcome, will be suggested. Transparency is presumed to decrease the likelihood of having a locally established winner as well as to increase the intensity of competition. Independence of irrelevant alternatives, similarly, is presumed to lower the price paid to the winning tenderer. Each hypothesis is subsequently confronted by data on Swedish public procurements. The first, seemingly, is being lent support by this data while the second and third is not.

Keywords: Public procurement, supplier selection method, transparency, independence of irrelevant alternatives.

Contents

1. Introduction.....	3
2. Preliminaries.....	5
2.1 Timing of events.....	5
2.2 Supplier selection methods and scoring rules.....	6
3. Previous research.....	8
4. Theoretical analysis.....	11
4.1 Independence of irrelevant alternatives.....	11
4.1.1 An example of non-independence.....	12
4.2 Transparency.....	14
4.2.1 Non-independence implies non-transparency.....	15
4.3 Hypotheses.....	16
4.3.1 Transparency and locally established winners.....	16
4.3.2 Transparency and the number of tenders.....	18
4.3.3 Independence and price.....	20
5. Empirical analysis.....	23
5.1 Data.....	23
5.2 Regression analysis.....	26
5.2.1 Hypothesis 1.....	26
5.2.2 Hypothesis 2.....	28
5.2.3 Hypothesis 3.....	29
6. Concluding remarks.....	31
Appendix A.....	36
Appendix B.....	37

1. Introduction

According to Bajari and Lewis (2009, p. 1173), public entities in developed countries consume goods and services, acquired through public procurement, worth approximately 10-15% of their respective GDP. On a similar note, although restricting attention to the EU member states, Lundberg et al (2015, p. 2) declares that the proportion of EU's GDP disbursed on public procurements approaches 20%. Closely akin observations, presented by the Swedish Competition Authority (Lukkarinen, 2014, p. 7), hold that, in Sweden, the worth of goods and services purchased in 2013, by means of public procurement, amounts to, again, 20% of GDP. Undoubtedly, then, public procurement seems to delineate an important kind of transaction. Supposedly, this fact, namely, that public procurements constitute such a considerable economic force, is the reason why it has been devoted so much attention as of late. Within the EU, e.g., there are suggestions to the effect that the legislation, governing the particular way in which public entities procure, should be such that the procurements will enhance the EU member state's prospects of attaining their various commitments concerning reduced environmental impact. The contention here is that tenderers not abiding certain environmental standards should be screened so as to be disqualified from entering the market for the contract to be procured. In Sweden, similarly, the Minister of Public Administration has recently proposed that long term unemployment could perhaps be mitigated by the procurements carried out by public entities. The argument, in short, holds that one could adjust regulations so as to award contracts only to tenderers who will commit to hiring a certain number of the unemployed for the purpose of fulfilling the contract. Public procurement, then, has been largely recognized as an important means to achieve political aspirations. In spite of all this, unfortunately, public procurement comprises a subject matter largely neglected by economists.

Now, the present study concerns a particular component of the procurement process, namely, the supplier selection method. The latter can be endowed with the properties of transparency and independence of irrelevant alternatives. Regarding these properties, theoretical concerns have been raised in various reports published by the Swedish Competition Authority (Bergman & Lundberg, 2009; Lunander & Andersson, 2004). From these reports, in turn, a few academic papers, seemingly, have emerged (Bergman & Lundberg, 2013; Lundberg & Marklund, 2011). However, the scopes of these studies are restricted in that there is no attempt to empirically test the various conjectures one encounters throughout. In contrast, the contribution of the present study is twofold. Firstly, it holds additional theoretical considerations suggesting

that the properties just mentioned might have an impact on certain aspects of the procurement outcome. More specifically, these aspects are the price paid to the winner, whether the winner is locally established, as well as the number of tenders submitted to the purchaser. Secondly, and perhaps more importantly, the presumed effects will be tested, by means of regression analysis, against a data set consisting of 285 observations of public procurements carried out in Sweden. Note that this twofold contribution sharply distinguishes the present study from the rest of the field. Put differently, the theoretical considerations aforementioned has not been developed elsewhere, and, in addition, alleged impacts of transparency and independence (on the procurement outcome) has yet to be investigated empirically.

Consider the following outline: firstly, in section **2**, various institutional contingencies pertaining to public procurement in Sweden will be properly introduced. Consecutively, section **3** contains a concise survey of closely related research preceding the present study. Thereafter, in section **4**, begins the theoretical analysis. In this section one will find an introduction to the concepts of transparency and independence of irrelevant alternatives. Also, one is introduced to three hypotheses. Two of these relate transparency to, first, the probability of having a locally established winner, and, second, the number of tenders submitted. The third then relates independence of irrelevant alternatives to the price paid to the winner. The fifth part, section **5**, holds the empirical analysis. Here, first, one will encounter an introduction to the means by which the data has been obtained. A similar introduction will be held with respect to the disparate variables later to recur in the regression analysis. Subsequently, each of the hypotheses aforementioned will be subjected to regression analysis, and, one will find concluding remarks in section **6**.

2. Preliminaries

In general, “procurement” refers to the act, on part of some firm, of acquiring goods or services from another (external) firm. These goods or services are then to serve as input factors in the purchaser’s own production. “Public procurement”, then, denote a procurement in which the purchaser is instead a public entity such as a municipality or a governmental agency. Whatever is thus acquired is then used to provide (or “produce”) goods or services of various sorts. Typical instances include the acquisition of computers to be used in the school system, or perhaps the acquisition of services necessary to organize the city’s waste management. In what follows, we will concern ourselves exclusively with public procurement at the municipal level. The institutional environment pertaining to such procurements will now be briefly sketched. First, the various steps in the procurement process will be coarsely drawn out. Then, a particular component of this process, namely, the supplier selection method, will be probed more closely.

2.1 Timing of events

The legislative background is that of the Public Procurement Act which was implemented in the beginning of 2008. Once a municipality has decided to procure, the process preceding the actual transaction is closely regulated by this law. Firstly, the purchaser must commit to a supplier selection method. Their options are as follows: either they commit to selecting the tenderer which submits the lowest price, else they must select the tenderer with the “economically most advantageous tender” (henceforth, EMAT). The former method amounts to a first-price sealed bid auction, while the latter method will turn out to be either a scoring auction or a beauty contest (these supplier selection methods will be further elaborated on in the subsequent section). Secondly, the purchaser will commit to an entry mode. Here, the options are simplified entry, open entry, negotiated entry, and selective entry¹. The most prominent feature of these different entry modes is whether entry is open (in the sense that any supplier may submit a tender) or restricted (in the sense that one may not submit a tender unless one has been invited by the purchaser to do so). The former two modes are open in this sense while the latter two are restricted. Thirdly, the purchaser announces a call for tender which must contain information on the supplier selection method and entry mode chosen. Lastly, after having screened each

¹ Admittedly, there are additional entry modes available to the bureaucrat. However, these four are the only ones pertinent since no other modes were observed in the data.

submitted tender against a set of mandatory qualification criteria, a winner is selected in accordance with the supplier selection method.

2.2 Supplier selection methods and scoring rules

If the purchaser opts for awarding the contract to the tender containing the lowest price, the supplier selection method will be that of a first-price sealed bid auction². If instead EMAT is chosen, the supplier selection method will turn out to be either a scoring auction or a so called beauty contest. The latter is simply an auction in which the price is fixed at some level, and, because of this, the suppliers will have to compete in providing the highest possible quality (rather than lowest possible price). A scoring auction, on the other hand, is an auction in which the supplier, in addition to bidding in a price dimension, will bid in one or several quality dimensions. Quality is here to be understood in a wide sense so as to fathom the difference in quality between, say, high and low speed computer processors, but also, say, various aspects of working conditions (such as whether the employer respects minimum wage regulations). Similarly, environmental impact could also be construed as a quality dimension (lower impact would then mean higher quality). Once the tenders have been submitted, however, a winner will be selected by means of a scoring rule. Such a rule translates the price and the various quality levels into a single score. Then, the winner will be the tender with the best overall score³. There are several reports published by the Swedish Competition Authority, e.g. Lunander and Andersson (2004, p. 44) and Bergman and Lundberg (2009, pp. 45-46), in which one distinguishes between two different kinds of scoring rules. This distinction is also upheld in the more recent Bergman and Lundberg (2013, p. 75). The first kind is known as quality-to-price scoring while the other is called price-to-quality scoring. The former is such that the quality levels submitted in a tender are valued in price terms while the latter kind, in contrast, assigns a quality score to the quality levels and then, as it were, values the submitted price bid in quality terms.

$$S = P + V_p(Q) \tag{1}$$

$$S = V_q(P) + V_q(Q) \tag{2}$$

² A theoretical treatment of this auction format can be found in Engelbrecht-Wiggans and Katok (2009).

³ Theoretical properties of such auctions are discerned in e.g. Che (1993) and Branco (1997).

Here, P denotes the submitted price while Q denotes a vector of quality levels. $V_q(\cdot)$ and $V_p(\cdot)$ are functions that translate their arguments into a quality score and a price score respectively. Equation (1) exemplifies a quality-to-price scoring rule, and, similarly, equation (2) exemplifies a price-to-quality scoring rule. On both kinds of scoring rules, once the various aspects of the tender have been properly translated into the same metric, whether this metric turns on quality or price, they are compounded and an overall score S is obtained.

Henceforth, it is important to note that the expression “supplier selection method” might refer to a first-price sealed bid auction, a beauty contest, or any of the two scoring auctions aforementioned. Important properties of these supplier selection methods, hinted at in the introduction, will be discerned in section 4. Before this, however, there will be a short survey of closely akin studies preceding the present one.

3. Previous research

Although the present study is empirical in nature, it certainly draws on theoretical considerations, regarding supplier selection methods, put forward in the various reports by the Swedish Competition Authority. One such report is Lunander and Andersson (2004). There, the supplier selection methods aforementioned, and in particular the two kinds of scoring auctions, are compared with respect to various theoretical properties such as transparency and consistency⁴. In addition, the various supplier selection methods are exemplified by instances found in Swedish public procurements. The authors suggest that, in case of an EMAT procurement, the purchaser should choose quality-to-price scoring rather than price-to-quality scoring.

One can find similar conclusions in Bergman and Lundberg (2013). The authors, appealing to theoretical considerations akin to those of Lunander and Andersson (2004), prescribe that quality-to-price scoring is to be preferred over price-to-quality scoring. Furthermore, in situations where several of the tenderers can provide high quality and where the tenderers have good information on the production costs associated with different levels of quality, the prescription is the first-price sealed bid auction. The beauty contest, in contrast, is to be employed only when the procurement is considerable in size, i.e., consuming a major part of the purchaser's budget. The authors also present some descriptive statistics pertaining to the data they have gathered. They have surveyed 189 public procurements from within the time span stretching from 2002 to 2009. Most of these were carried out by municipalities and concerned the acquisition of cleaning services, waste transport, elderly care and food wholesale. In more than one third of the observations the associated supplier selection method was the first-price sealed bid auction. Different kinds of scoring auctions were used in about every other observation (slightly more than 50%, however).

It is also worth mentioning Chen (2008). As in the previously mentioned studies, concerns about transparency and independence of irrelevant alternatives emerge as well as examples of supplier selection methods employed in Dutch public procurements.

Lastly, on the matter of transparency, there is an interesting contribution, although somewhat peripheral, by Gal-or et al (2007). Their supplier selection method is sequential in the sense that the tenderers first submit a bid on quality, then, in the second round, they also submit a bid on price. Before the price bid, however, the purchaser (or auctioneer) may or may not disclose to the tenderers how their respective bids on quality have fared. The authors conclude

⁴ The concepts of transparency and consistency will be properly introduced in section 4. There, however, the latter will be denoted by “independence of irrelevant alternatives” rather than “consistency”.

that if information concerning the evaluation of the bids on quality is disclosed, one can expect more aggressive bidding on price in the second round. It seems, then, as if transparent supplier selection methods might increase competitive pressure.

None of the studies thus far mentioned are empirical in the sense that they resort to some kind of regression analysis. However, there are several such studies worth mentioning, in particular Lundberg et al (2015). There, the authors have amassed data, 1175 observations, on Swedish public procurements of cleaning contracts carried out by municipalities during two time periods, namely, 1990 to 1998 and 2009 to 2010. The more interesting variables include the number of tenderers, supplier selection method (or “auction format”), mode of entry, as well as (the size of) the winning bid. Similar to Bergman and Lundberg (2013), the descriptive statistics show how frequently each of the supplier selection methods were used. Here, about 70% were beauty contests, 20% were scoring auctions, and 10% were first-price sealed bid auctions. A great variety of statistical relationships are then tested against this data set. The authors seem to be interested in presumed effects of choice of supplier selection method on various aspects of the procurement outcome such as the number of tenderers, the size of the winning bid, and the choice of entry mode. Note that their study is explorative in the sense that their various regressions lack theoretical anchorage.

Unfortunately, there does not seem to be any additional empirical study the subject matter of which touches on Swedish public procurement. However, there are a few studies, albeit somewhat peripheral, worth brief mention. Decarolis and Branzoli (2014) investigate the effect of choice of supplier selection method on procuring outcomes such as entry and subcontracting. Their data consists of Italian public procurements of road construction and maintenance contracts. The main result is that first-price sealed bid auctions, when compared with average bid auctions, reduce entry as well as subcontracting. This study is deemed peripheral since the supplier selection methods available to the Italian purchaser are not the same as those available to the Swedish purchaser. Other closely akin aspects are investigated in e.g. Decarolis (2014). And perhaps one would also like to consider Lewis and Bajari (2011). In both instances, the data is from the U.S. and consists of roadwork contracts. The main result of the former study is that the use of first-price sealed bid auctions will induce a lower price but also poorer ex post performance by the winner. Similarly, the latter study shows that the application of scoring rules will improve ex post performance. In addition, there is Athey et al (2011) which exploits data on U.S. timber auctions. They compare sealed bid auctions to open bid auctions. The main result is that the former attract smaller tenderers and they also give rise to larger revenues for the seller. Again, these latter two studies are deemed peripheral since the choices, regarding supplier

selection method, open to the U.S. purchaser, do not coincide with those of the Swedish purchaser.

Seemingly, then, the present study distinguishes itself in that the impact of transparency and independence on the procurement outcome has not been previously investigated empirically. The latter conspicuous fact is in spite of the Swedish Competition Authority's efforts, mentioned a few paragraphs back, to highlight the prevalence of non-transparent and non-independent supplier selection methods.

4. Theoretical analysis

In this section, one will find an introduction to the concept of independence of irrelevant alternatives. This particular concept figures in many different shapes throughout economics, and, therefore, it is imperative to clearly state the meaning it carries in the context at hand⁵. In addition, the relevance of the property it denotes will be motivated by a simple thought experiment. In a similar fashion, one will then encounter the concept of transparency. As will become evident, these concepts are such that non-independence implies non-transparency. This relation between the two concepts will be of consequence when it comes to erecting dummy variables in section 5.1. Lastly, once the conceptual matters have been settled, a set of hypotheses, concerning the impact of transparency and independence on the procurement outcome, will be properly discerned.

4.1 Independence of irrelevant alternatives

In what follows, independence of irrelevant alternatives is to be construed as a property characterizing supplier selection methods. Before suggesting a definition, however, recall equations (1) and (2) from section 2.2. They serve as to illustrate quality-to-price scoring and price-to-quality scoring respectively. Similarly, the other two supplier selection methods, the first-price sealed bid auction and the beauty contest, can also be represented by equations. If we let (3) represent the first-priced sealed bid auction and (4) represent the beauty contest, the supplier selection methods available to the purchaser can be depicted thus:

$$S = P + V_p(Q) \tag{1}$$

$$S = V_q(P) + V_q(Q) \tag{2}$$

$$S = P \tag{3}$$

$$S = V_q(Q) \tag{4}$$

⁵ Ray (1973) highlights the fact that this concept has been used with many distinct senses, and, in addition, that this latter fact has not been properly recognized.

Hopefully, these simple formalizations, serving as a background, will make it easier to comprehend the subsequent definitions, namely, **(IIA)** and **(T)**.

(IIA) Let A , B and C denote distinct tenders which could be assembled into a set of tenders T . Then, a supplier selection method S is said to be independent of irrelevant alternatives if and only if; S orders A over B when $T = \{A, B, C\}$ if and only if S orders A over B when $T = \{A, B\}$.

Evidently, if a supplier selection method satisfies **(IIA)**, the pairwise ordering of tenders will not be sensitive to the constitution of the set T acquired by the purchaser. Put differently, the pairwise ordering of the tenders already figuring in T must be invariant to the expansion (or contraction) of T by additional tenders. The rationale behind the enforcement of this property is twofold. First, the property seems inherent to the concept of rationality. In other words, a rational decision maker would not use a non-independent supplier selection method. Secondly, there is a concern that the procurement process would otherwise be vulnerable to collusion among tenderers. If a procurement process implements a supplier selection method that lacks independence in the sense of **(IIA)**, it is easy to conceive of situations in which the pairwise ordering of tenders A and B is shifted, in favor of B , say, due to the inclusion of a third tender C . The two tenderers submitting B and C are induced to collude as long as the prospects of winning are sufficiently bright. As a consequence, since in the absence of C the supplier selection method, by hypothesis, would have chosen A , the surplus accruing to the purchaser is reduced. The relevance of this property for procurement procedures is stressed in several reports from the Swedish Competition Authority such as Bergman and Lundberg (2009, pp. 33-34) and Lunander and Andersson (2004, pp. 22-23). In addition, similar contentions can be found in Chen (2008, p. 408)⁶.

4.1.1 An example of non-independence

For the sake of comprehension, it seems conducive to consider the following example provided in Lunander and Andersson (2004, pp. 46-48). Hopefully, doing so will clearly distinguish the important features of supplier selection methods that lack independence in the sense of **(IIA)**. Now, imagine a procurement in which the purchaser has received five distinct tenders. The supplier selection method is price-to-quality scoring, i.e., it conforms to equation (2). Now,

⁶ The origin of the concept of independence of irrelevant alternatives is Arrow (1951). This publication does not directly pertain to procurement, however.

consider two frequently occurring instances of (2), they will be denoted by S_1 and S_2 respectively:

$$S_1 = V_{q,1}(P) + V_q(Q) \quad \text{where} \quad V_{q,1}(P) = \frac{P_L}{P} \cdot c$$

$$S_2 = V_{q,2}(P) + V_q(Q) \quad \text{where} \quad V_{q,2}(P) = \left(1 - \frac{P - P_L}{P_L}\right) \cdot c$$

Here, P_L is the lowest price bid found in T and c is a constant, which, in the present example, is equal to 5. Furthermore, $V_q(\cdot)$ is a function, used in both S_1 and S_2 , that translates its argument (the bid in quality) into a quality score. Similarly, $V_{q,1}(\cdot)$ and $V_{q,2}(\cdot)$ also translate their arguments (the bids in price) into a quality score. Below, the first table depicts a situation that will serve as a benchmark. The second table will convey what happens if the price bid of tender A is slightly adjusted. This example will hopefully convince the reader of the colluding potential associated with supplier selection methods that are non-independent.

Table 1: Benchmark

Tender	Price	$V_q(Q)$	$V_{q,1}(P)$	S_1	$V_{q,2}(P)$	S_2
A	12	2	5	7	5	7
B	12	3.7	5	8.7	5	8.7
C	13	4.15	4.62	8.77	4.58	8.73
D	14	4.46	4.29	8.75	4.17	8.63
E	15	3	4	7	3.75	6.75

Consider table one. Here, the total scores assigned to the tenders in $T = \{A, B, C, D, E\}$ are reported in columns five and seven. Both scoring rules are such that a higher total score is better than a lower one. Consequently, the shaded boxes in columns five and seven signify the winner of the procurement, namely, tender C . Now, notice what happens if T is amended in such a way that A is replaced by \bar{A} (a tender with a slightly lower price bid but identical in all other respects). This situation is conveyed in the second table where the adjustments are made salient by the shaded boxes. The pairwise ordering imposed on the tenders by S_1 is scrambled, and, as a result, tender D is now the winner. Similarly, \bar{A} distorts the order first imposed on T by S_2 in such a way that B is chosen before C .

Table 2: Adjusting tender A

Tender	Price	$V_q(Q)$	$V_{q,1}(P)$	S_1	$V_{q,2}(P)$	S_2
\bar{A}	11	2	5	7	5	7
B	12	3.7	4.58	8.28	4.55	8.25
C	13	4.15	4.23	8.38	4.15	8.24
D	14	4.46	3.93	8.39	3.64	8.1
E	15	3	3.67	6.67	3.18	6.18

As it turns out, then, neither S_1 nor S_2 is endowed with independence in the sense of **(IIA)**, and, consequently, they are both afflicted with the colluding potential discussed in the previous section.

4.2 Transparency

Yet another interesting property carried by certain supplier selection methods is transparency. This property, or so it seems, has been given different names in different contexts. One of the previously mentioned reports from the Swedish Competition Authority speaks extensively of predictability. Unfortunately, there is no explicit definition. But in the context of supplier selection methods, predictability seems to be a prerequisite for the tenderers to be able to choose the most appropriate combination of price and quality in submitting their tender (Bergman and Lundberg, 2009, p. 63). This concern seems akin to something stressed in Chen (2008, p. 415), namely, that transparency allows the tenderers to calculate the score a particular tender (i.e. a combination of price and quality levels) would be assigned by the supplier selection method at hand. Unfortunately, these remarks do not help one distinguish between the possibilities of, on the one hand, calculating the score while having access to information about the constitution of T , and, on the other, calculating the score without such information. This distinction is suggested by a passage in Lundberg and Marklund (2011, p.70). There, the authors say that, from the tenderer's perspective, there can be no transparency if the score assigned to a specific tender is sensitive to the constitution of T . If one keeps these remarks in mind, the following definition seems to fathom the most vital parts of the concept:

(T) A supplier selection method S is transparent if and only if a tenderer can establish the score assigned to its tender $A \in T$ without regards to anything but A and S .

For example, then, in case the specification of \mathcal{S} , found in the call for tender, is not precise enough, \mathcal{S} will be deemed non-transparent. In fact, the data contain several such instances. Often there is some component of \mathcal{S} , say, $V_p(\cdot)$, the specification of which is somehow imprecise, making it impossible for the tenderer to apprehend the score of its tender A without regard to anything but A and \mathcal{S} .

The definition seems congruent with the aforementioned remark by Bergman and Lundberg, namely, that transparency is a prerequisite in order for the tender to choose the most appropriate tender⁷. It also fits well with Chen's concern that the tenderer should be able to calculate the score to be obtained by any hypothetical tender. Also, as was stressed by Lundberg and Marklund in case the supplier selection method took any other arguments from T in addition to A , then, obviously, it would not be transparent.

4.2.1 Non-independence implies non-transparency

There is a noteworthy conceptual connection between independence of irrelevant alternatives and transparency. Under the current construal, it seems one cannot have a supplier selection method that is transparent while at the same time failing to be independent of irrelevant alternatives. To see this, suppose that an arbitrarily chosen supplier selection method \mathcal{S} is transparent. Then, by **(T)**, it must be the case that \mathcal{S} is such that any tenderer submitting a tender $A \in T$ can establish the score which \mathcal{S} accrues to A without regard to anything but \mathcal{S} and A . Now, suppose further that \mathcal{S} is not independent of irrelevant alternatives in the sense of **(IIA)**. Then, by hypothesis, there must exist some modification of T against which the order first imposed on T by \mathcal{S} is not invariant. This lack of invariance could not be unless the scores assigned throughout T somehow reconfigured due to the presumed modification of T . However, the need for such a reconfiguration could not arise, since, by hypothesis, \mathcal{S} is transparent. Put differently, since the score assigned to A by \mathcal{S} can be established without regard to anything but \mathcal{S} and A , this score should never reconfigure due to a modification of T . From this contradiction it follows that \mathcal{S} is non-independent, and, consequently, one can conclude that transparency implies independence of irrelevant alternatives. Thus, by contraposition, non-independence must imply non-transparency.

As will become evident in **3.1**, this result will be of consequence when considering a

⁷The obvious caveat is if the tenderer in question has obtained some additional information about the procurement process, e.g., the constitution of T , and, because of this, will be equipped to choose the most appropriate tender regardless of whether the supplier selection method is transparent.

particular set of dummy variables. These dummy variables serve to indicate whether the supplier selection method under consideration is independent and whether it is also transparent. Anticipating what will be said in the aforementioned section, there are, at first glance, four seemingly feasible constellations. A supplier selection method could be independent and transparent, independent and non-transparent, non-independent and transparent, and, finally, non-independent and non-transparent. However, in virtue of the observation made in the preceding paragraph, the third of these constellations is inconceivable.

4.3 Hypotheses

Within this section one will find three hypotheses. These will put transparency and independence of irrelevant alternatives in close interaction with the procurement outcome. Each hypothesis will be coupled with a modest theoretical motivation. This serves the purpose of making the present study less explorative. Later on, in the empirical analysis, these hypotheses will be confronted, by means of regression analysis, with data⁸ on Swedish public procurements.

4.3.1 Transparency and locally established winners

In Sweden, politicians operating on the municipal level have an incentive to keep their unemployment levels as low as possible. This is because a high unemployment rate would seriously reduce their municipality's tax income, which, in turn, would hamper the local politicians' capability to implement various policies. If a firm establishes itself within the municipality, and if it subsequently decides to hire, it will most likely hire an inhabitant of the municipality. This inhabitant, in case of employment, will then pay income tax to the municipality in question. Obviously, then, one would expect the purchasers, representing the municipality, to be anxious to preserve job opportunities nested within its close vicinity. If a local firm (or a non-local firm having a local branch)⁹ manages to secure a procured contract, which more often than not is considerable in size, then, any jobs associated with this firm will be likewise secured, and, of course, so will the municipality's tax income. Unfortunately for the purchaser, awarding the contract to a locally established firm solely due to the firm being so established is prohibited by the Public Procurement Act. Because of this, any tenderer that suspects the presence of such favoritism can press legal charges against the purchaser. Regardless of whether the purchaser is found guilty, participating in a legal process is costly and will therefore imply financial

⁸ The data set will be thoroughly introduced in section 5.1.

⁹ Henceforth, a firm that is either local or has a local branch will be abbreviated locally established firm.

repercussions to be absorbed by the purchaser. In addition, the contract to be procured cannot be properly signed until the legal process has reached closure. This delay will further add to the costs associated with a resort to favoritism. Henceforth, let home bias refer to this alleged tendency, on part of the purchaser, to award locally established firms in such a way as to conflict with the Public Procurement Act. In summation, then, the purchaser's decision to adhere to this kind of home bias is associated with a risk of increased costs. However, there is also a chance that the bias will go undetected, and, as was previously suggested, this would increase the benefits accruing to the purchaser through increased tax income.

For the sake of clarity, one could coarsely model the decision making of the purchaser in the following way. Having the considerations from the previous paragraph in mind, it seems plausible to think of the purchaser's utility function as having, as it were, internalized the welfare of the municipality as a whole. Let x serve as a binary variable being equal to 1 if the purchaser gives in to the home bias, and, instead, being equal to 0 in case the purchaser does not. Now, the purchaser can be perceived as maximizing the following utility function with respect to x :

$$U(x) = u - c + h(x) \quad \text{where} \quad h(x) = \begin{cases} p \cdot a + (1 - p) \cdot b & \text{if } x = 1 \\ 0 & \text{if } x = 0 \end{cases} \quad (5)$$

Here, the right-hand side of (5) consists of three terms. The first one, u , is a constant term that includes every benefit, accruing to the municipality, that is unaffected by the value of x . Put differently, this term denotes those benefits the acquisition of which does not entail breaking the law. Similarly, the second term, c , is a constant term and includes any costs associated with the procurement process (e.g. the price paid to the winning tenderer), excluding those spawning from being caught up in a legal process. The last term, $h(x)$, should be construed as the expected gain from resorting to home bias. Naturally, it equals zero whenever $x = 0$. However, when instead $x = 1$ it returns $p \cdot a + (1 - p) \cdot b$ where p is the probability of getting caught (and, of course, subsequently having to face the legal consequences), and $a < 0$ denotes the costs, not included in c , which stems from getting caught while $b > 0$ denotes the benefits associated with the home bias (e.g. increased tax income). A small p , then, will induce the purchaser to resort to home bias while a large p , rather, might prompt the purchaser to abstain. Although the relative (and absolute) sizes of a and b obviously have a significant impact on the purchaser's decision, the size of p is not to be disregarded.

Now, if a purchaser deploys a supplier selection method that is non-transparent in the sense of **(T)**, it seems one could expect p to decrease. The contention here is that, if one suspects that the home bias has influenced the awarding of the contract, it will be more difficult to

confirm one's suspicion in the absence of a transparent supplier selection method. To see this, consider a tenderer having received a score far below what was expected. Because of this, suspicion is raised, on part of the tenderer in question, as to the legitimacy of the procurement process. Say that the tenderer then decides to confront the purchaser. In case the supplier selection method is transparent, the tenderer can simply go back to the call for tender, extract the supplier selection method, and carry out its own evaluation of its own tender. If, then, the tenderer obtains a better score, this score could be appealed to in the argument with the purchaser. In arguing with the tenderer, the purchaser cannot invoke anything but the supplier selection method (available to the tenderer through the call for tender) and the tender in question (also available to its tenderer, obviously). This is because, by assumption, the supplier selection method is transparent. Now, suppose instead that the supplier selection method is non-transparent. This implies an asymmetry of information, holding between tenderer and purchaser, regarding what factors determine the score of any particular tender. Once confronted by the dissatisfied tenderer, the purchaser can simply exploit this asymmetry by invoking some aspect of the evaluation process that is beyond the tenderer's reach. As a result, the tenderer's suspicion will dissipate and hopefully the purchaser will have evaded prosecution. Hence, the suggested decrease in p . Having this in mind, it seems reasonable to entertain the following hypothesis:

Hypothesis 1: The awarding of a contract to a locally established tenderer will occur more frequently in case the supplier selection method is non-transparent.

In terms of equation (5), a large p means that $U(1)$ will be smaller than $U(0)$ while a small p , perhaps due to the non-transparency of the supplier selection method, will result in that $U(1)$ will be greater than $U(0)$.

4.3.2 Transparency and the number of tenders

The hypothesis to be considered next also stems from the transparency of supplier selection methods. This time, however, transparency will interact with the intensity of competition characterizing the market for the contract to be procured. The idea is that a lack of transparency, with respect to the supplier selection method, will make it more cumbersome for the (potential) tenderers to compile a proper tender and subsequently submit it for evaluation¹⁰. Naturally, this will add to the (wage) cost of preparing an optimal tender, and, subsequently enter the market. As a consequence, then, one might expect a lack of transparency to have a negative impact on the

¹⁰ As was previously mentioned in section 4.2, this concern has been raised by e.g. Bergman and Lundberg (2009, p. 63).

number of tenders submitted.

For clarity's sake, let us consider a purchase by the municipality of Stockholm in 2011. More specifically, the municipality wanted to procure the services of consultants to participate in the reconstruction of an important junction for public transport. The purchaser opted for an EMAT supplier selection method, namely, a quality-to-price scoring rule. This means (recall equation (1) from section 2.2) that any tender must consist of a price bid in addition to bids in a number of quality dimensions. Furthermore, once the purchaser has received the tender, the various levels of quality will be evaluated through $V_p(\cdot)$ in terms of price. In this particular case, there were four different quality dimensions. Each bid first received a grade (an integer from 0 through 6) and then it was translated into the price dimension.

One reason why this particular supplier selection method is deemed non-transparent is that some of the quality dimensions seem quite difficult to assimilate. For example, one quality dimension is the consultants "creativity and ability to cooperate". Now, of course there is a passage in the call for tender in which the purchaser elaborates on this particular phrasing. Unfortunately, it does not shed much light. Furthermore, in this dimension, it says, the level of quality will be graded by means of statements from referees submitted by the tender, and, in addition, if needed, the purchaser will subject the tenderer to an interview. Through these two mediums, then, the tenderer is expected to convey pertinent information to the purchaser. Unfortunately, due to the imprecise language permeating the call for tender, it is not obvious to the tenderer exactly what kind of information would be deemed pertinent by the purchaser. Put differently, it is not obvious to the tenderer how $V_p(\cdot)$ is specified. Recall that a supplier selection method $S = P + V_p(Q)$ is deemed transparent if and only if one can establish the score accruing to a tender A by considering nothing but A and $S = P + V_p(Q)$. The latter does not seem to be true of the supplier selection method deployed by the purchaser from our example due to the obscure nature of some of the quality dimensions rendering $V_p(\cdot)$ difficult to comprehend. Put differently, because of opaque expressions, such as "creativity", figuring in the descriptions of the quality dimensions, the tenderer submitting a tender A will not be able to establish $V_p(Q)$ by considering nothing but A and S . It seems reasonable, then, to deem the supplier selection method non-transparent.

Now, in order to see why this lack of transparency will influence the tenderer's decision to enter the market, consider first the following model. As in the previous section, x will denote a binary variable. This time, however, it will be equal to 1 in the case of entry and equal to 0 if the tenderer rather abstains. Furthermore, the tenderer is presumed to maximize the expected profit from entering the market as follows:

$$E[\pi(x)] = \begin{cases} p \cdot (r - c) + (1 - p) \cdot 0 - t \cdot w & \text{if } x = 1 \\ 0 & \text{if } x = 0 \end{cases} \quad (6)$$

Naturally, in case the tenderer decides not to enter, the expected profit will equal zero. This is exactly what happens in equation (6) when $x = 0$. In contrast, whenever $x = 1$, $E[\pi(x)]$ can be decomposed into $p \cdot (r - c) + (1 - p) \cdot 0$ minus $t \cdot w$. The former term is simply the expected profit associated with market entry. Consequently, p designates the probability of winning the procurement and $r - c$ is the surplus accruing to the winner. However, in case one should lose the procurement, the probability of which is $1 - p$, the surplus equals zero. The latter term in $[\pi(x)]$, contingent on $x = 1$, is such that t denotes the number of working hours the tenderer has devoted to various preparations necessary for entering the market. In particular, this includes time spent on preparing the optimal tender. This factor is then multiplied by w which signifies the hourly wage paid to whomever prepares the tender.

As suggested by the example from Stockholm a few paragraphs back, a supplier selection method that lacks transparency will make it more cumbersome for the tenderer to prepare an optimal tender. Supposedly, because of this more time will have to be spent preparing. In terms of equation (6), the additional time spent can be construed as an increase in t . Such an increase, obviously, will cause $E[\pi(x)]$, contingent on $x = 1$, to decrease. Now, the contention is that, at least for some tenderers, this decrease will imply $[\pi(1)] < E[\pi(0)]$, which, in turn, will induce the tenderer to remain outside the market rather than to enter. Now, with these considerations serving as a background, the following hypothesis is suggested:

Hypothesis 2: The number of tenders submitted will be reduced in case the supplier selection method is non-transparent.

As with the first hypothesis, this one will also be confronted with the data on Swedish public procurements in the empirical analysis. Before then, however, yet another hypothesis is to be properly introduced.

4.3.3 Independence and price

In the present context, collusion is to be construed as a mutual commitment abided by two or more tenderers. More specifically, this commitment concerns the way in which the distinct tenderers are to bid for the contract being procured. The idea is to agree to bid less competitively so as to secure a larger portion of the welfare generated by the transaction. Put differently, the sellers hope to secure a larger producer surplus at the expense of the consumer surplus accruing

to the municipality. The intuition behind the third hypothesis is that, if a supplier selection method is not independent of irrelevant alternatives, the procurement process will be exposed. More specifically, it will be vulnerable to collusion, and, in case the tenderers decide to collude, the price which the purchaser has to pay for the procured good or service will be somewhat higher compared to what would have been the case in the absence of such collusion. This intuition will be further elaborated in the next couple of paragraphs.

First, let us consider the general case. Imagine a procurement situation, say, a first-price sealed bid auction, with two tenderers A and B placing bids on price. Further, let $cost_A$ and $cost_B$ denote the cost, for A and B respectively, associated with supplying the good or service to be procured. Assume further that A is fully aware of $cost_A$, and, similarly, that B is fully aware of $cost_B$. However, the tenderers do not have any information on their respective competitor's production costs other than that $cost_A < cost_B$ ¹¹. Now, suppose first that there is no collusion. Let bid_A and bid_B denote the tenderers' respective bids, and, for simplicity, say that $bid_A = cost_A$ and similarly that $bid_B = cost_B$. Since the supplier selection method is that of a first-price sealed bid auction, this amounts to A being the winner due to $cost_A < cost_B$. This means that the producer's surplus is given by $bid_A - cost_A = 0$. Note, however, that A as opposed to B will acquire compensation, covering e.g. wage costs, for supplying the procured good (or service), which, admittedly, is better than nothing.

Consider now instead a scenario in which the two tenderers collude so as to raise the price. B recognizes that A is the stronger competitor, i.e., that $cost_A < cost_B$. This induces B to suggest to A the following proposition. Tenderer A should submit $bid_A^* > cost_B > cost_A$ while B will submit $bid_B^* > bid_A^*$. This latter tender will ensure that A wins despite bidding above its costs. B further suggests to A that some proportion of the surplus obtained by A , as a result of the collusion, will accrue to B , say, an amount equal to $bid_A^* - cost_B$. The remainder of the surplus, $cost_B - cost_A$, will be enjoyed by A . Recall that, in case of no collusion, the total producer's surplus amounted to $bid_A - cost_A = 0$. This is to be compared with the current situation in which the surplus equals $bid_A^* - cost_A > 0$ of which $bid_A^* - cost_B > 0$ accrues to A while $cost_B - cost_A > 0$ accrues to B . Consequently, then, both tenderers will be better off if they were to collude¹² while at the same time the purchaser will be worse off since the price has risen from bid_A to bid_A^* . However, there is an important caveat. The tenderers' incentive to

¹¹ This situation could arise, e.g., if one firm is considerably larger than the other.

¹² It is important to note that the kind of collusion sketched here does not imply that the colluders will have to reveal their cost structures to one another. When A suggests $bid_A^* > cost_B$ to B , A does not have to explicitly mention the magnitude of $cost_B$.

collude, suggested in the last couple of paragraphs, might be neutralized, or at least somewhat suppressed, by various institutional factors. For example, contingencies such as whether there are proper laws prohibiting collusion among suppliers (and whether such laws are properly enforced) could help inhibit the urge to collude. In other words, when asked by supplier *A*, supplier *B*'s decision to collude could be crudely modeled so as to maximize the following expected profit:

$$E[\pi(x)] = \begin{cases} r - c + p \cdot a + (1 - p) \cdot b & \text{if } x = 1 \\ r - c & \text{if } x = 0 \end{cases} \quad (7)$$

Akin to the models in the preceding sections, x is to be construed as a binary variable equal to 1 in case of collusion and instead equal to 0 otherwise. Further, r refers to what the tenderer in question will acquire from the purchaser for supplying the procured good (or service). The tenderer's expenditures for supplying is denoted by c . In addition, there is the term $p \cdot a + (1 - p) \cdot b$. Here, p denotes the probability of getting caught, conditional on $x = 1$, which means that $a < 0$ is the financial impact the tenderer suffers from (among other things, admittedly) the affiliated legal procedures. Consequently, $1 - p$ is the probability of not getting caught colluding, and, naturally, b is then the surplus gained, in addition to $r - c$ of course, from apprehending a higher price. If instead $x = 0$, this last term, that is $p \cdot a + (1 - p) \cdot b$, will be reduced to 0. The institutional factors aforementioned mainly affects a (e.g. laws prohibiting collusion might increase a) and p (e.g. in case the laws just mentioned are properly enforced, p can be expected to increase). However, it stands to reason, at least given a low enough p and a low enough $|a|$, that it will be the case that $E[\pi(1)] > E[\pi(0)]$. This clearly depicts the incentive, as perceived by the tenderer, to resort to collusion.

Admittedly, collusion, as construed in the previous couple of paragraphs, is not the only plausible explanation to why independence can be expected to have an impact on price. As suggested in 4.1.1, non-independent supplier selection methods are often scoring auctions of various kinds. These are often such that quality, in addition to price, might have a great impact on the score assigned to the tenders. Obviously, then, at least in some cases, it will be worth submitting higher quality at the expense of a lower price. Put differently, the purchaser's concern for quality might induce the tenderers to submit higher prices so as to be able to also submit better quality. Now, hopefully, considerations from the last couple of paragraphs will suffice to render the following hypothesis feasible:

Hypothesis 3: The price paid by the purchaser to the winning tenderer will tend to be higher in case the supplier selection method is not independent of irrelevant alternatives.

5. Empirical analysis

This third part will probe more closely into the various empirical details of the present study. First, there will be a section devoted to introducing the methods used to obtain the data. Closely affiliated with this, of course, one will find a detailed description of each variable, including how the pertinent data has been obtained, and also some descriptive statistics. The latter serves the purpose of conveying a picture, without being too meticulous, of what the data consists in. Secondly, one will find a section containing the regression analysis employed in order to test the three hypotheses previously introduced.

5.1 Data

In total, 285 observations have been amassed. Each observation corresponds to a public procurement carried out by a Swedish municipality within the time span stretching from 2009 to 2015. As was mentioned in the introduction, this kind of transaction is closely governed by the Public Procurement Act. This law dictates that the procuring entity has to estimate the value of that which is to be procured, and, depending on this estimation, the entity is compelled to properly announce that there is a contract up for procurement. This announcement can be materialized in different ways, the most common, however, is to advertise the upcoming procurement in a commercial database run by a company called Visma Commerce. In this database, as suggested by EU legislation, goods and services are categorized by means of a large number of signatures known as CPV-codes. An advertised procurement has to be coupled with at least one such code. This serves the purpose of facilitating the process of finding an appropriate seller. By including CPV-codes in the advert, purchasers clearly signal to the sellers what kind of good or service they are interested in. In terms of such CPV-codes, the data can be partitioned into three distinct kinds. The first is personal computers, the second is the cleaning of facilities, and the third is intellectual services. This last category denotes consultant services of various sorts. The rationale behind considering these rather disparate sets of goods and services is a concern that there would be too little variation in the data otherwise. Now, any procurement is associated with two specific documents, namely, the call for tender and the contract notice. Both can be retrieved from the database aforementioned, and, from these in turn, data on the variables of interest can be extracted. In addition to what has been retrieved from Visma Commerce, a few variables concerning various characteristics of the procuring municipalities (rather than the particular procurement process itself), has been supplied by Statistics Sweden.

Now, let us first consider the variables obtained from Visma Commerce. The first one, **Bids**, is the number of tenders submitted to the purchaser. Data on this variable was easily extracted since it is explicitly stated in the contract notice. Secondly, there is the size of the winning price bid denoted by **Price**. This is also stated explicitly in the contract notice. Thirdly, there is a dummy variable, **Open**, which indicates whether the procurement under consideration is open or restricted¹³. This information is likewise easily obtained from the call for tender. Fourthly, there are dummies signifying which CPV category the good or service to be procured belongs to. There is one for the cleaning of facilities, namely, **Cleaning**, and the other, **Computer**, is for personal computers. Consequently, the excluded¹⁴ category is intellectual services. As was mentioned previously, this kind of information has to be stated explicitly in the call for tender and is therefore easily obtained. Fifthly, the call for tender contains a section devoted to the evaluation of tenders. Here, one can easily discern which kind of supplier selection method is being employed, and, therefore, it is easy to extract data regarding the dummies distinguishing between supplier selection methods. Here, **Beauty** is for the beauty contest, **P-to-Q** is for price-to-quality scoring and **Q-to-P** is for quality-to-price scoring. Consequently, then, the excluded category is the first-price sealed bid auction. Seventhly, there is a dummy variable, **Local**, exclaiming whether the winner of the contract is locally established. To qualify as established in this sense, the winning firm has to be either registered in the municipality or else have a local branch within the municipality. Seventhly, and lastly, one could obtain data on the matter of whether the supplier selection method used was transparent and whether it was independent of irrelevant alternatives. At first glance, at least with respect to transparency and independence, it might seem as if a given supplier selection method would have to be placed in one out of four divisions. More specifically, it would seem as if each would have to be transparent and independent, non-transparent and independent, transparent and non-independent, or, lastly, non-transparent and non-independent. However, hinging on the nature of **(T)** and **(IIA)**, there was an observation made in section 4.2.1 to the effect that no supplier selection method can be both non-independent and transparent at the same time. That means that the second of the four divisions should be disregarded. As a consequence, there are in fact only three divisions. Regardless, there will be two dummy variables. **Transparency**, naturally, will indicate transparency while the other, **Independence**, will indicate independence. However, it is not possible for the former to be equal to 1 while the latter is equal to 0.

The matter of transparency can be easily attended by considering the section of the call for

¹³ The more fine-grained distinctions, mentioned in section 2.1, will be suppressed. A similar decision is made in Lundberg et al (forthcoming).

¹⁴ Put differently, a procurement concerning intellectual services will imply that the two dummy variables aforementioned will be equal to zero.

tender describing the supplier selection method. There, its various components are described in detail (although, admittedly, with varying degrees of precision). Once one has grasped every aspect of it, the test for transparency is simple: construct an artificial tender A and if one then manages to assign a score to A without regard to anything but A and S , the supplier selection method is transparent (otherwise it is non-transparent). As for independence of irrelevant alternatives, again one has to consult the call for tender. The test here is to see whether the supplier selection method S is somehow sensitive to the constitution of T . More precisely, if one of the arguments of S is such that it could be taken from some other tender in T , then, S is deemed non-independent (and independent otherwise). The idea here is that, if the former condition is satisfied, one could, in principle at least, change T so as to shift the pairwise order holding between any pair of tenders A and B . This, as you recall, would violate the **(IIA)**. In order to illustrate these tests for transparency and independence, consider again the token supplier selection method, S_1 , figuring in section 4.1.1:

$$S_1 = V_{q,1}(P) + V_q(Q) \quad \text{where} \quad V_{q,1}(P) = \frac{P_L}{P} \times c$$

Here, P_L again denotes the lowest price bid found in the set T and c is again equal to 5. This supplier selection method cannot be said to be transparent since one cannot apprehend the score of one's tender A without regards to anything but A and S_1 . This is because, in order to establish the score, one would also need to know P_L . Admittedly, it might just be the case that P_L is the price bid from A , but, unfortunately, this cannot be verified unless one has access to every tender in T . Similarly, S_1 does not pass the test for independence. This is because S_1 have an argument, namely, P_L , that could come from some tender in T distinct from A . Note that this is in accordance with the example in 4.1.1 where the pairwise order of some of the tenders in T shifted due to a change in T (A was substituted by \bar{A} , as you recall).

As was announced in the beginning of this section, there are a few additional variables data on which have been retrieved from Statistics Sweden rather than Visma Commerce. More specifically, there are three of them and they will serve as control variables in some of the regressions yet to be presented. The first, **Education**, measures the level of education characterizing the inhabitants of the municipality. In detail, it equals the percentage of the inhabitants that have attained a post-secondary education equivalent to at least three years of schooling. The second variable, **Unemployment**, measures the level of unemployment afflicting the municipality. It indicates the percentage of inhabitants, dwelling within the age span between

20 and 64, that are either unemployed or engaged in some sort of welfare program¹⁵. Lastly, there is a variable, **Density**, indicating the population density, meaning the number of inhabitants per km², of the procuring municipality.

Now, in **Appendix A** there will be two tables by means of which the reader can at least crudely apprehend the nature of the data set considered in this study. The first table depicts the continuous variables while the second is devoted exclusively to dummy variables (in addition to the excluded categories of course).

5.2 Regression analysis

Having properly introduced the data set, it is now appropriate to declare how the testing of the hypotheses, previously considered in section 4.3, is supposed to materialize. Here, there will be one section devoted to each hypothesis starting with the one concerning the presumed interaction between transparency and the occurrence of locally established winners. In total, there will be three tables holding the information from the regression outputs and each of these can be found in **Appendix B**.

5.2.1 Hypothesis 1

Recall from section 4.3.1 that home bias is construed as the choice, on part of the purchaser, to award the procurement contract to a locally established tenderer in spite of having received a disparate (competing) tender that would be deemed superior from an unbiased point of view. And according to the first hypothesis, this kind of behavior should occur more frequently in case the applied supplier selection method lacks transparency in the sense of **(T)**. For the purpose of testing this hypothesis, or so it seems, the two most suitable variables at our disposal would be **Local** and **Transparent**. In detail, four different specifications of a binary choice model, namely, a logit regression, with **Local** serving as the dependent variable, has been estimated. Admittedly, the admission of a locally established tenderer is not necessarily due to the prevalence of a home bias since the tender in question, obviously, might also be preferred from an unbiased point of view. However, the contention here is that, in case the probability of such a tender being admitted increases in the absence of transparency, the most plausible explanation would seem to be the home bias. Now, the regression output is depicted in table five. The four distinct specifications are labeled model one through four and the first contains **Transparent** as only independent variable. The topmost digit in each cell denotes the marginal effect (while holding

¹⁵ The latter includes e.g. relief and sick pay.

the remaining independent variables constant at their respective means) of the independent variable in question on the dependent variable. Slightly beneath, embedded in parentheses, is the corresponding p-value. Note also that the last row contains the corresponding McFadden R^2 obtained from the estimations. The latter three models are variations of the first. The intention here is to include various control variables so as to see whether the prospective effect of transparency is robust. The second model resembles the first with the addition of dummy variables sensitive to what kind of good or service is being procured. These, as you recall, are denoted **Cleaning** and **Computer**. However, they are replaced in the third model by another set of dummies, namely, **P-to-Q** and **Q-to-P**, sensitive to which supplier selection method is being utilized¹⁶. Lastly, the fourth model expands on the second by also encompassing the municipality characteristics measured by **Education**, **Unemployment**, and **Density**. Interestingly enough, the coefficient attached to **Transparent** is statistically significant across three of the four models. This fact speaks for the robustness of the effect. The significance level attained in the first two models is 5% while in the fourth it has increased to 10%. In contrast, the estimation of the third model rendered the same effect insignificant at the 10% level. Note that **Transparent** seems to be negatively correlated with both **Q-to-P** and **P-to-Q**. This is indicated by the correlation coefficients being equal to -0.53 and -0.51 respectively. If one concedes that a correlation coefficient exceeding +/- 0.4 is suggestive of multicollinearity, one should perhaps not take the results obtained from estimating model three too seriously. Put differently, in spite of the effect of transparency being deemed insignificant (as well as pointing in the wrong direction), one should not be too concerned about the robustness of the conjectured effect due to the signs (i.e. the correlation coefficients exceeding +/- 0.4) of multicollinearity afflicting the specification¹⁷. On a similar note, one might expect that the correlation coefficient associated with **Unemployment** and **Education** would also exceed the aforementioned threshold. This is because, or so the argument goes, high levels of education could be presumed to alleviate unemployment. However, at least in the present sample, this does not seem to be the case, and, therefore, there is no reason to be concerned about multicollinearity in model four. As to the size and direction of the suggested effect, it seems as if, in case the purchaser commits to a transparent supplier selection method, the probability of a local winner decreases with approximately 12-14%. Seemingly, then, the first hypothesis is being lent support by the data. The estimations, however, reveal something more. The second and fourth models both suggest

¹⁶ Due to insufficient variation in the data, **Beauty** is being left out of the regression analysis altogether. This implies that the excluded category is the first-price sealed bid auction.

¹⁷ Note also that these two pairs of independent variables are the only pairs whose correlation coefficient exceeds +/- 0.4.

that local tenderers will be awarded more frequently in case the procurement contract concerns the cleaning of facilities. The effect is significant at the 5% level and the 10% percent level respectively. Furthermore, the size of the effect, seemingly, lies somewhere between 13% and 16%. Similarly, the two models aforementioned also suggest that the opposite is true of computers. In other words, in case the procurement concerns personal computers, the probability of a local winner is decreased by, approximately, 18-21%. In the second model, this effect is significant at the 1% level while in the fourth model, the significance level is 5%. Unfortunately, however, these two latter effects were not anticipated by the theoretical considerations developed in section 4.3.1. Before moving on, consider again the results from estimating model four. Both **Unemployment** and **Education** seem to have a strong and highly significant (positive) effect on the probability of having a local winner. Regardless of not being suggested by the theoretical considerations found in 4.3.1, this find is not surprising. The former variable having a positive effect seems reasonable since high unemployment, presumably, will intensify the pressure felt by the purchaser to award a local tenderer (since doing so might preserve job opportunities). Similarly, the latter variable having a positive effect is also to be expected since high levels of education could be thought of as making the (local) workforce more competent. This, in turn, would make local tenderers, hiring from the local workforce, more competitive (which, naturally, increases their chance of winning procurement contracts).

5.2.2 Hypothesis 2

In order to test the second hypothesis, **Bid** was regressed on **Transparent**. Recall that the second hypothesis holds that transparent supplier selection methods will facilitate competition. The particular estimation method used was OLS, and, as with the testing of the first hypothesis, several additional estimations, encompassing various control variables, were carried out. In this respect, models six and eight correspond to models two and four respectively. The seventh model, however, does not resemble model three. Here, instead, due to the high correlation coefficient associated with **Q-to-P** and **P-to-Q**, the natural log of **Price** has replaced the supplier selection method dummies aforementioned. An additional rationale for including this variable is that the price finally paid by the winning tenderer can be perceived as a proxy for the value of that to be procured. One line of argument might hold that the higher the value of that to be procured the greater the number of tenderers. Put slightly differently, the number of tenders submitted will increase with the value of the procurement contract. But, admittedly, one could as easily imagine an effect going in the opposite direction. Presumably at least, the number of tenders will affect the price of the procurement contract since more tenders means more intense

competition, which, in turn, converts into a lower price of the contract. If one recognizes this contention, one would also have to admit that there seems to be a slight endogeneity problem afflicting one's models. However, due to a lack of space this alleged endogeneity of **Price** will be disregarded and instead the seventh model will be estimated as it stands. Now, the different specifications of the OLS model are denoted models five through eight. This can all be seen clearly from table six. Furthest down, contained in the last row of the table, are the conventional R^2 obtained from the estimations. The cells in the table contain, firstly, the estimated coefficient attached to the variable in question, and, secondly, the corresponding p-value embedded in parentheses. As opposed to the estimations from the last section, here, there does not seem to be a strong case for the prevalence of an effect from **Transparency** to the dependent variable. According to the estimations of models five, six, seven and eight, the occurrence of a transparent supplier selection method increases the number of tenders submitted to the purchaser by approximately one half. However, only the estimations of models six and seven renders this effect significant at the 10% level, according to each of the remaining estimations it is instead insignificant. All things considered, then, it seems as if the data is inconclusive. The aforementioned effect of **Price** is not detected either, rather, the coefficient attached to this variable is highly insignificant. Lastly, estimations of model six and eight suggest unambiguously that there is approximately 1.7-1.9 more tenders in case the procurement contract concerns the cleaning of facilities. These estimations are both significant at the 1% level. Again, however, these effects are not suggested by the theoretical considerations put forward in section 4.3.2.

5.2.3 Hypothesis 3

The third hypothesis, as you recall, concerns the relationship between independence of irrelevant alternatives and the price paid to the winner of the procurement. Briefly put, the contention is that, in case the supplier selection method is non-independent, the procurement process is vulnerable to collusion between tenderers, which, in turn, might result in the contract being sold at a higher price. In order to investigate the prevalence of this relationship, the natural log of **Price** was regressed on **Independent** by means of an OLS model. In addition to the first specification, three more, containing different constellations of control variables, are estimated as well. The motive, again, is a concern for the robustness of the alleged effect. In total, then, four models are estimated. These are referred to as models nine through twelve and what ensued from their estimation is declared in table seven. Again, the last row contains the conventional measure of goodness-of-fit, namely, R^2 , while the cells, again, contain the estimated coefficients of the variables, found in the leftmost cells of the table, coupled with the corresponding p-values in

parentheses. Note that, in model eleven, **P-to-Q** has been excluded due to a concern for multicollinearity. As It turns out, the correlation coefficients holding between this variable and **Independent** equals -0.68 which greatly the exceeds the threshold +/-0.4 mentioned in the previous section. Now, the estimations seem to reveal a quite robust effect reaching from **Independent** to the dependent variable. The effect is positive and significant at the 5% level in each model. Furthermore, it has almost the same size throughout, namely, an independent supplier selection method will increase the price paid by the purchaser by approximately 36-41%. This must be taken to speak conclusively against the third hypothesis. Additionally, the estimations of models ten and twelve suggest that the price paid by the purchaser is 48-55% higher in case the contract concerns personal computers. What is more, this latter and conspicuously large effect is significant at the 1% level in model ten as well as model twelve. However, it is important to note that this latter effect is not provided any anchorage by the theoretical considerations of section **4.3.3**.

6. Concluding remarks

The intention behind this study has been to, first, discern the properties of transparency and independence of irrelevant alternatives, and, secondly, to suggest three hypotheses concerning the relation between these properties and the procurement outcome, and then, thirdly, to test these hypotheses by means of data on Swedish public procurements.

Now to the matter of where one stands. As you recall, the first hypothesis holds that the awarding of a contract to a locally established tenderer will occur more frequently in case the supplier selection method is non-transparent. First, in order to see the basic idea behind this hypothesis, one must recognize that there is an incentive, on part of the purchaser, to award locally established tenderers. This incentive is the prospect of increased tax income. However, it is illegal to take such contingencies into consideration when selecting the winner. This fact, presumably, will counteract the incentive. But in case the supplier selection method is non-transparent, the chances of getting caught will diminish, and, consequently, the purchaser's incentive will be amplified. Now, the results from the regression analysis seem to lend support to this hypothesis. As it turns out, the application of a transparent supplier selection method would seem to reduce the probability of the purchaser awarding a locally established tenderer by approximately 12-14%. Consequently, the results obtained from these estimations seem to have an important policy implication, namely, that one should (somehow) encourage the use of transparent supplier selection methods over non-transparent ones.

The second hypothesis holds that the purchaser can expect fewer tenders to be submitted in case the supplier selection method is non-transparent. Put briefly, the intuition here is that non-transparency will compel the purchaser to devote more time to assemble the optimal tender. This translates into increased wage cost, which, in turn, decreases the expected profit from entering the market for the procurement contract. The data, however, seems inconclusive on this matter. According to the estimations, the occurrence of a transparent supplier selection method increases the number of bids submitted to the purchaser by approximately one half. However, in but two specifications the effect is rendered significant at the 10% level. According to each of the remaining specifications it is instead insignificant. All things considered, then, it seems as if the data is inconclusive. Put differently, the anticipated effect was not found to be robust enough. This could be ensued by the theoretical considerations being erroneous in some way, or perhaps there is a measurement error afflicting the data. The former explanation seems the more credible due to the coarse nature of the theory. It would not be surprising, in other words, if some important aspect of the decision process has been left out of the model. This, perhaps, could be

mitigated by further theoretical research. However, pending further investigation, the second hypothesis will have to be denounced.

Lastly, the third hypothesis holds that the price paid by the purchaser to the winning tenderer will be higher in case the supplier selection method is not independent of irrelevant alternatives. In short, the contention here is that a lack of independence will induce tenderers to collude so as to raise the price. Put differently, the tenderers will agree to bid less competitively so as to secure a larger portion of the welfare generated by the transaction. In sharp contrast to this conjecture, however, the data instead suggests that an independent supplier selection method will increase the price by approximately 36-41%. Needless to say, this result is unexpected. The effect is not of the conjectured sign, and, in addition, it seems conspicuously large. This is rather alarming considering the several studies, preceding this one, prescribing the use of independent supplier selection methods (Bergman & Lundberg, 2009; Lunander & Andersson, 2004; Bergman & Lundberg, 2013; Lundberg & Marklund, 2011). Due to the conspicuous sign and size of this effect, further research, probing the relationship more closely, and subjecting it to more rigorous tests, is definitely warranted.

In summation, then, the present study can be said to contribute to the field in two important ways. Firstly, it builds on the concerns about independence and transparency, raised in preceding studies, by suggesting three hypotheses relating these properties to the procurement outcome. The theoretical considerations motivating these hypotheses have not been developed elsewhere. Secondly, the aforementioned hypotheses are subjected to empirical test by means of a unique data set. This is unprecedented in the sense that alleged effects of transparency and independence have so far only been investigated in a non-empirical fashion.

There are, however, a few noteworthy caveats. First of all, the number of observations used to confront the hypotheses could have been considerably larger. Although the number is greater than that of Bergman and Lundberg (2013), namely, 189, the more recent Lundberg et al (2015) holds 1175 observations. Presumably at least, this could be taken as having an impact on the estimation results. Secondly, one must also keep in mind that there is no established practice of categorizing supplier selection methods with respect to transparency and independence. Perhaps, then, the attempt carried out in the present study is not reliable in the sense that the same supplier selection methods would have been categorized the same way by a different observer. This concern is worth stressing especially with respect to **(T)** since this concept has not been properly developed elsewhere, and, consequently, neither has it been seen to be applied consistently across different observers. Thirdly, one must not neglect the fact that the theoretical considerations put forward are coarse-grained to say the least. Put differently, the “models”

should be construed as nothing but modest first attempts at establishing the hypotheses aforementioned.

In conclusion, however, it seems reasonable to at least concede that the spirit of the present study is commendable. Public procurements are an important economic node in most societies in that it often constitutes a large portion of GDP, and, in addition, in conducting this particular kind of transaction, one lays waste to tax money, which, obviously, is always of great concern for the public.

Bibliography

- Athey, S., et al., (2011), "Comparing open and sealed bid auctions: evidence from timber auctions", *The Quarterly Journal of Economics*, 126: 207–257.
- Arrow, K., (1951), *Social choice and individual values*, New York: John Wiley & Sons.
- Bergman, M., & Lundberg, S., (2009), *Att utvärdera anbud – utvärderingsmodeller i teori och praktik* (KKV forskningsrapport 2009:10), Stockholm: Konkurrensverket.
- Bergman, M., & Lundberg, S., (2013), "Tender evaluation and supplier selection methods in public procurement", *Journal of Purchasing & Supply Management*, 19: 73–8.
- Branco, F., (1997), "The design of multidimensional auctions", *RAND Journal of Economics*, 28: 63-81.
- Branzoli, N., & Decarolis, F., (2014), "Entry and subcontracting in public procurement auctions" [pre-print], submitted to *Management Science*, available from: http://people.bu.edu/fdc/MS-13-01882_Manuscript.pdf, [4 May 2015].
- Che, Y., (1993), "Design competition through multidimensional auctions", *RAND Journal of Economics*, 24: 668-680.
- Chen, T.H., (2008), "An economic approach to public procurement", *Journal of Public Procurement*, 8: 407-430.
- Decarolis, F., (2014), "Awarding price, contract performance, and bids screening: evidence from procurement auctions", *Applied Economics*, 6: 108-132.
- Engelbrecht-Wiggins, R., & Katok, E., (2009), "Regret and feedback information in first-price sealed bid auctions", *Management Science*, 54: 808–819.
- Gal-Or, E. et al., (2007), "Optimal information revelation in procurement schemes", *RAND Journal of Economics*, 38: 400-418.
- Lewis, G. & Bajari, P., (2011), "Procurement contracting with time incentives: theory and evidence", *The Quarterly Journal of Economics*, 126: 1173-1211.
- Lukkarinen, J., (2014), *Siffror och fakta om offentlig upphandling* (KKV forskningsrapport 2014:1), Stockholm: Konkurrensverket.
- Lunander, A., & Andersson, A., (2004), *Metoder vid utvärdering av pris och kvalitet i offentlig upphandling* (KKV forskningsrapport 2004:1), Stockholm: Konkurrensverket.
- Lundberg, S., et al., (2015) "Design of public procurement auctions: evidence from cleaning contracts", available from: <http://ssrn.com/abstract=2562840>, [3 May 2015].

Lundberg, S., & Marklund, P., (2011), "The pivotal nature of award methods in green public procurement", *Environmental Economics*, 2: 64-73.

Paramesh, R., (1973), "Independence of irrelevant alternatives", *Econometrica*, 41: 987-991.

Appendix A

Descriptive statistics

Table 3: Descriptive statistics; continuous variables

N=285	Bids	Price (SEK)	Education	Unemployment	Density
Min. value	1	102 620	11.7%	5.1%	0.8
Max. value	16	14 661 150	56.1%	24.6%	4872.8
Average	4.5	1 477 380.2	26%	14.3%	558.4
Standard deviation	2.9	2 071 273.3	10%	3.8%	1206.9

Table 4: Descriptive statistics; dummy variables and excluded categories

Variable	Frequency	Proportion (N=285)
Local	101	35.3%
Non-local	184	64.7%
Open	279	97.6%
Non-open	6	2.4%
Cleaning	100	35%
Computer	88	30.8%
Intellectual	97	34.2%
Beauty	2	0.7%
Q-to-P	82	28.7%
P-to-Q	62	21.7%
Lowest price	139	48.9%
Transparent	148	51.8%
Independent	240	84.2%
Non-independent and non-transparent	15	15.8%

Appendix B

Regression outputs

Table 5; Hypothesis 1; Binary choice regression output; Dependent variable is the probability of having a local winner

Variable	Model 1	Model 2	Model 3	Model 4
Transparent	-0.147** (0.010)	-0.120** (0.044)	-0.140 (0.309)	-0.122* (0.056)
Cleaning	-	0.162** (0.014)	-	0.134* (0.050)
Computer	-	-0.212*** (0.009)	-	-0.185** (0.031)
P-to-Q	-	-	-0.075 (0.621)	-
Q-to-P	-	-	0.076 (0.586)	-
Education	-	-	-	2.583*** (0.000)
Unemployment	-	-	-	5.165*** (0.000)
Density	-	-	-	0.000 (0.133)
Goodness-of-fit	0.018	0.087	0.028	0.184

Significance levels are denoted as follows: *p<0.1, **p<0.05, ***p<0.01. All models include an intercept.

Table 6; Hypothesis 2; OLS regression output; Dependent variable is the number of submitted tenders

Variable	Model 5	Model 6	Model 7	Model 8
Transparent	0.529 (0.131)	0.585* (0.087)	0.571* (0.091)	0.522 (0.130)
Cleaning	-	1.896*** (0.000)	1.901*** (0.000)	1.752*** (0.000)
Computer	-	-0.169 (0.690)	-0.194 (0.651)	0.105 (0.806)
Ln(Price)	-	-	-0.059 (0.702)	-
Education	-	-	-	2.180 (0.363)
Unemployment	-	-	-	2.880 (0.616)
Density	-	-	-	0.001*** (0.008)
Goodness-of-fit	0.008	0.112	0.013	0.149

Significance levels are denoted as follows: *p<0.1, **p<0.05, ***p<0.01. All models include an intercept.

Table 7; Hypothesis 3; OLS regression output; Dependent variable is the natural log of price

Variable	Model 9	Model 10	Model 11	Model 12
Independent	0.387**	0.382**	0.418**	0.362**
	(0.033)	(0.032)	(0.023)	(0.041)
Cleaning	-	-0.084 (0.589)	-	-0.129 (0.409)
Computer	-	0.482*** (0.003)	-	0.550*** (0.001)
P-to-Q	-	-	-	-
Q-to-P	-	-	-0.149 (0.313)	-
Education	-	-	-	0.233 (0.804)
Unemployment	-	-	-	-1.421 (0.526)
Density	-	-	-	0.001** (0.034)
Goodness-of-fit	0.016	0.064	0.024	0.091

Significance levels are denoted as follows: *p<0.1, **p<0.05, ***p<0.01. All models include an intercept.