Centre for Transport Studies
STOCKHOLM

How Many Want to Drive the Bus?
Analyzing the number of bids for public transport bus contracts

Andreas Vigren
Transport Economics, VTI, Swedish National Road and Transport Research Institute

CTS Working Paper 2017:13

Abstract
This paper examines how different factors relating to contract characteristics, and the operational and tender environment affect the number of unique bidders placing bids in tenders for bus contracts. A generalized Poisson model is used with a comprehensive data set containing most of the recently tendered bus contracts in Sweden, spanning the period 2007-2015.

The main finding from the analysis is that most contract characteristics change participation in tenders by around 0.1-0.5 bidders. Operator-restricting measures, such as special requirements on buses, have a similar limited effect. Further, the number of tenders that are open at the same time as a specific tender was shown to reduce participation by almost 2 bidders. Finally, there is evidence that the local competitive environment is of importance, and the public transport authorities therefore need to be concerned with entry barriers in their tenders.

Keywords: Tendering, Bidding, Bus, Public transport, Contract design, Count data

JEL Codes: H57, L91, L16, L11, C31

Centre for Transport Studies
SE-100 44 Stockholm
Sweden
www.cts.kth.se

How Many Want to Drive the Bus?
Analyzing the number of bids for public transport bus contracts☆

Andreas Vigren[a,b]

[a] *Swedish National Road and Transport Research Institute (VTI), Teknikringen 10, 114 28 Stockholm, Sweden*
[b] *Centre for Transport Studies (CTS), same as above*

Abstract

This paper examines how different factors relating to contract characteristics, and the operational and tender environment affect the number of unique bidders placing bids in tenders for bus contracts. A generalized Poisson model is used with a comprehensive data set containing most of the recently tendered bus contracts in Sweden, spanning the period 2007-2015.

The main finding from the analysis is that most contract characteristics change participation in tenders by around 0.1-0.5 bidders. Operator-restricting measures, such as special requirements on buses, have a similar limited effect. Further, the number of tenders that are open at the same time as a specific tender was shown to reduce participation by almost 2 bidders. Finally, there is evidence that the local competitive environment is of importance, and the public transport authorities therefore need to be concerned with entry barriers in their tenders.

Keywords: Tendering, Bidding, Bus, Public transport, Contract design, Count data

1. Introduction

Swedish public transport[1] has a long history of providing services using public entities, which are the main buyers of services today with an annual value of 35 billion SEK. Bus operations amount to 21 billion SEK of the total value (Transport Analysis, 2017). The vast share of bus services is competitively tendered on a regular basis and has been since the early 1990s when most Public Transport Authorities (PTAs) switched from a licensing system to procurement (Jansson and Wallin, 1991). For a review of the historical events in Swedish public transport, see, for instance, Jansson and Wallin (1991) and Nilsson (2011). It is fair to say that competitive tendering is mature in Sweden and that the tendering units, the 21 county-based organized PTAs, thus should have experience in this process. Nevertheless, contract design, awarding

☆The author is grateful to Svante Mandell, Jan-Eric Nilsson, Samuel Lindgren, and Sofia Lundberg for much appreciated help, comments, and suggestions while writing this paper. Thank you also to participants at the ITEA Conference 2017, Thredbo 15 conference, CTS lunch seminar series, and VTI seminar. Financial support from Centre for Transport Studies is gratefully acknowledged.

Email address: andreas.vigren@vti.se (Andreas Vigren)

[1] In this paper, the term "public transport" is used to denote non-commercially run transport services by bus.

mechanisms, and types of services differ not only across PTAs but also within PTAs. Because most bus traffic is competitively tendered, bus operators' willingness to participate in procurements is crucial in achieving a competitive environment and, in the end, cost-efficient production and higher-quality services.

This paper investigates what impacts different forms of contract design have on the participation in PTAs' procurements. The purpose is to determine how specifications and requirements in contracts affect the number of bidders in tendered public transport bus services.

Generally, for tendered contracts, or auctions, more bidders are viewed as better for the tendering party. Hong and Shum (2002) note that the "Walrasian analogy of markets as auctions" would imply that more bidders push prices down. While this is true with pure private-value auctions, the same might not hold for common-value auctions due to how bidders take into consideration the "*winner's curse*" effect and bid less aggressively as the number of competitors increases (Hong and Shum, 2002). Cantillon and Pesendorfer (2006) argue that bus tenders are more similar to private-cost auctions because operators have little cost information asymmetries in most input factors (there are well-functioning markets for labor and fuel) and because the opportunity costs for capital and rolling stock are more likely to differ across operators, the latter being the main source of uncertainty.

Hensher and Wallis (2005) compared international studies of the introduction of competitive tendering and noted that there were initial cost savings[2], but the savings were reduced as more tendering rounds were carried out. Thus, the competitive effect on price could be regarded as potent, at least initially. Similarly, Amaral et al. (2013) note that a greater number of bidders, no matter whether they are actual or potential bidders, lowers the amounts of the bids. The number of bidders, and how to attract them, should therefore be of central interest to the tendering authorities, in this case the PTAs. The fact that contract design differs across, and within, Swedish counties further motivates research on the issue because tendering and contract design might affect bidding participation in different ways. The variation also gives good scope for analyzing these effects quantitatively.

While competitive tendering is the dominating tool for procuring bus services, at least in Sweden (and other parts of Europe), the literature in the field has also been concerned with deficiencies in the method. For contracts in general, Williamson (1976) notes that, when negotiating for longer-term contracts, some of the main difficulties revolve around "*artificial or obscure initial award criterion*", problems or deficiencies in production, and competition on unequal terms when the contract is re-tendered. Hensher et al. (2007) discuss competitive tendering of public transport, focusing on the incompleteness of contracts. While a complete contract specifies compensations for every ex-post outcome, an incomplete contract is the real-world case because it is not possible to describe every potential scenario in detail (Hart and Moore, 1988). With

[2]In interpreting cost savings from the introduction of competitive tendering, the "pre-tendering" settings must also be taken into consideration.

this in mind, Hensher et al. (2007) argue that a "*strong continuing trusting partnership through negotiated performance-based partnership*" is the key to successful public transport provision when the process of competitive tendering has matured. Although Hensher writes that trust can be achieved using tendering, negotiated contracts might do better because of the incompleteness in contracts. Because the contracts are more or less always incomplete, there is a wide range of different contract designs in use across and within different PTAs, as noted above.

For public transport, previous quantitative studies on bid participation are scarce. Although focusing on the impact on costs from bid participation for bus tenders in London, Amaral et al. (2013) also note in their data description that the number of bidders for a contract is lower the higher the production of bus miles the contract calls for. In studying operator changes following tenders, Augustin and Walter (2010) performed an additional analysis on the number of bidders for contracts and found that longer contracts increased the number of bids[3]. In a review of studies of competitive tendering in Germany, Beck (2011) performed a similar analysis using the same method and found a statistically significant negative effect of the contract starting year on the number of bidders, implying a negative trend in the number of bidders on contract areas (lots).

Participation in tenders and auctions has seen more attention in several other areas, ranging from procurement of cleaning contracts to timber auctions. Athey et al. (2011) compared participation in open and sealed bid auctions for timber and found a significant relationship between bidder participation and auction type (open or sealed bid), with small actors participating to a higher degree in sealed bid auctions. Lundberg et al. (2015) studied green public procurement (GPP) in Sweden and the effect that mandatory green criteria have on, among other things, the number of bids. The authors applied a similar methodology to the one used in this paper, but they used data on internal regular cleaning contracts. The main finding of that paper was that GPP does not affect supplier behavior to any significant degree and that GPP is not serving as an effective environmental policy instrument. In the analysis for the Lundberg et al.-study, positive and statistically significant effects on the number of bidders for a contract were found for contract size, number of contracts per procurement, and the number of potential suppliers of a contract.

The remainder of the paper starts with a description of the institutional settings of the public transport sector in the next section. Section 3 outlines the empirical framework and presents the estimating model, the data, and the estimating equation. The results are given in Section 4 and are discussed in Section 5. Section 6 concludes the paper.

[3]It is worth noting that the analysis on the integer-dependent variable, that is, the number of bidders, was made using OLS, not a count data model, which might give wrong inferences as discussed later in this paper.

2. Institutional settings

Public transport in Sweden is the responsibility of the 21 PTAs, which are public entities organized by each county. The PTA decides upon what services should be run where and whether this traffic will be awarded through (competitive) tendering or provided through an in-house operator (own regime). The Public Transport Act from 2012 also states that the PTA should consider what traffic can be left for commercial interests and therefore not tendered, but this is seldom done in practice (Transport Analysis, 2014). Of the 21 PTAs, all but one have used tendering as the main awarding tool for at least two decades, while the other runs its operations in-house.[4] In 1989, following the organizational reform passed in 1988, the share of traffic awarded by tendering was 20 percent, and this increased to 50 percent in 1993 and to 90 percent in the late 1990s (Alexandersson and Pyddoke, 2010). This means that the Swedish PTAs are familiar with and have accumulated knowledge about tendering as a tool and that tendering should be regarded as mature in Sweden.

Input factors are almost exclusively bought and owned or employed by the operator, and the two most important are the vehicles and the drivers. There are instances where a new operator is forced to take over some of the previous operator's vehicles, either by purchasing or leasing, but most of the fleet is still owned by the operator. Further, the PTA typically decides on the timetable to be run for the next traffic period, often with minor involvement of the operator. There are, however, cases where the operators are more involved in this planning process, and there are even instances where the operator itself plans the traffic (with final veto power held by the PTA). In all cases the fares are set by the PTA, and the traffic is run under the PTA's brand and color design.

2.1. The tendering process

The PTAs regularly review their needs for public transport services and decide which traffic should be tendered. As an artifact of previous tenders, all or fractions of the traffic in a county will be subject to an upcoming tender depending on when the previous tender was carried out and the contract length of the previous tender. The PTA decides whether the tender should contain one single contract area (usually structured at the line or route level) or should be divided into two or more contracting areas. Also, new tenders usually have characteristics from the previous tenders regarding the extent of the service and the geographical area to be served.

The preparation of enquiry documentation varies according to many factors, such as the size and complexity of the contract. The PTA decides on a range of different issues from requirements on the vehicles, timetables, and payment model (whether to include incentives to the operator) to the contracting period

[4] The county of Västmanland runs its operations in-house for all of its public transport. A few PTAs do the same for single contract areas in their counties.

and the awarding method.[5] This preparation process will not be described in greater detail in this paper. When the documentation and framework are finalized, the tender is announced through channels such as tender databases (for example, the EU's TED (Tenders Electronic Daily) or Visma, a commercial Swedish database) or in the press.

The time between tender announcement and the final day to place a binding bid is four months on average. During this time, the interested operators analyze the documentation, decide on whether to participate, and calculate a bid. The operators can ask questions of the PTA about the tender, which along with the answers are made public during the process. If new information is added, or terms changed, the PTA is obliged to inform all parties at the same time in line with the principle of equal treatment, which is usually done using a bulletin on the Internet. Before the deadline, the bid(s) are placed on the preferred contract area(s) using the form provided in the documentation, and these are kept secret until the PTA has evaluated the bids and decided on the winning bid. In many cases, the PTAs also allow for combining more than one contract area in a single bid. This combinatorial bidding could be a way for larger operators to utilize potential scale economics, while still allowing smaller operators to bid for single contracts.

In evaluating which bidder to award the contract to, the PTA uses the method specified in the enquiry documentation. Generally, two methods are used for awarding contracts - the lowest price or the bidder with the economically most advantageous tender (EMAT). The latter is a way of incorporating, for example, quality factors in the evaluation and requires some scoring rule that converts price and quality into comparable entities. In the estimation sample of this paper, EMAT was used to award 40 percent of the tenders. Of these, roughly half used a scoring rule where quality was monetized (quality-to-price scoring following Bergman and Lundberg (2013)) and half converted the price into quality points (price-to-quality scoring). Bergman and Lundberg (2013) note, based on their data, that EMAT scoring rules are often not designed in line with economic theory, and this reasoning carries over to a large extent to the tenders investigated in this paper. They also argue that price-to-quality scoring is especially inappropriate because it is not transparent and it often violates the principle of equal treatment across bidders.

When the tender is awarded, the operator normally starts its services within one year. There is, however, the possibility for the losing operators to appeal the PTA's decision in court. Depending on the legal process and the court's outcome, the traffic start could either be delayed if the court rules with the PTA or the tendering must be redone if the court rules against the PTA. Between 2007 and 2015, 216 appeals to court were made following public transport tenders, of which the PTA won in two-thirds of the cases in the first instance (Camén and Fellesson, 2015). Of the 216 appeals, 81 were appealed to the second highest court,

[5] There are cases where interested parties have been invited to discuss the upcoming tender and the content of the same, for example in Västra Götaland.

and 24 were taken to the highest court, with over 90 percent of the court cases eventually won by the PTA (Camén and Fellesson, 2015). It is important to note that these figures probably also include tenders for school and special transport services, which are not the focus of this paper.

When the operator starts running the tendered traffic, it and the PTA are expected to follow the terms and conditions in the documentation and are entitled to the agreed upon payments and penalties. Because of the law on government procurement (LOU, SFS 2016:1145), this is important because changes in the contract might be judged as unequal treatment of the bidders and eventually lead to an appeal through the courts.

2.2. Operators

According to data from Statistics Sweden, there are about 220 operators relevant[6] to bus tenders active in Sweden, of which 95 placed a bid for at least one tender during the period 2007-2015. Over this time period, there was almost no difference in the number of active companies, indicating a fairly stable market[7]. Operators are of all sizes, ranging from 1 to 2,293 buses, and the profit margins of the 30 largest companies (weighted by turnover) are around 3.9 percent (The Swedish Bus and Coach Federation, 2016). Excluding the four largest operators, the margin increases to 4.8 percent. The southern parts of Sweden have a higher concentration of operators than does the north. For this paper, three categories of operators will be defined - large operators, cooperation companies (below called "*co-ops*"), and other operators.

In Sweden, four operators stand out with almost twice as large turnovers as the fifth operator, and these are Nobina, Keolis, Arriva, and Transdev (in order of turnover). These operators run traffic nationwide in both urban and rural areas and are, except for Nobina, majority-owned by foreign states. Because of their size and extensive traffic, it is assumed that these operators have more rigorous and developed methods in how they monitor the market and in how they calculate bids for tenders. With a larger organization, the capacity and knowledge are arguably greater than among smaller operators. Therefore, it is assumed that large operators have the potential to enter bids anywhere in the country, something that will be returned to in the variable definitions below.

[6]Using SCB SNI 2007-codes 49.31 (urban and suburban passenger land transport) and 49.39 (other passenger land transport not elsewhere classified). For SNI 2002, the corresponding codes are used. This number also excludes companies with no employees or no revenue, as well as excluding pure coach operators and non-relevant companies (for example, PTAs or holding companies).

[7]This implication is actually at odds with the annual report of bus industry statistics by The Swedish Bus and Coach Federation (2016) where there were about 60 fewer companies in 2015 compared to 2007. A potential explanation for the difference is that The Swedish Bus and Coach Federation includes all companies with a certain SNI-code, thus including companies that do not necessarily provide bus transport at all.

The second operator type is the co-ops. A co-op is a company that several operators of varying size have formed with the original purpose to enjoy economies of scale both in the bidding stage and in production through, for example, bulk purchases of input factors. The members in a co-op thus bid as a single unit, with the original idea that the co-operation made it possible to bid for contracts that a single operator could not bid for on its own. In 2015, eight co-ops existed[8] in Sweden with about 130 operators being a member in at least one co-op, and the largest concentration of these was found in the north.

The third type is simply called "*other operators*" and includes all operators not included in the two former types, that is, small or mid-sized operators. Although these operators are probably heterogeneous, there are no apparent differences as there are with the larger and co-op operators that would make a case for dividing this group into smaller groups.

3. Empirical framework

The estimated model to analyze the number of bidders is defined as

$$y_{ijk} = \alpha + \boldsymbol{\beta}'(p_i) + \boldsymbol{\delta}'(c_i) + \boldsymbol{\zeta}'(w_{ij}) + \boldsymbol{\eta}_k + \boldsymbol{\theta}_t + \epsilon_{ijk}, \tag{1}$$

where y_{ijk} is the outcome integer variable (the number of bids) for contract (area) i in tender j carried out by county k. α is a constant, $\boldsymbol{\beta}$, $\boldsymbol{\delta}$, and $\boldsymbol{\zeta}$ are the vectors of the control variables' parameters to be estimated, and $\boldsymbol{\eta}_k$ and $\boldsymbol{\theta}_t$ are the matrices with county and year (t)-specific dummy variables, and ϵ_{ijk} is an error term. The lower-case letters are groups of variables described below, and their variable definitions are given in the next data section.

p_i includes production-related variables measuring contract size and environmental conditions. The variables are supposed to capture differences in the amount of traffic procured and the spatial setup of the traffic and include vehicle kilometers driven (VKM), the number of lines included (LINES), and the median length of the lines (MEDLINE). All three variables are measured at the contract level. While VKM, which is the product of timetable kilometers and the number of vehicles, is a relatively straightforward measure of the production in a contract, it might need to be complemented with additional measures in order to consider some special characteristics of the traffic. Most notably, the distinction between urban and rural traffic would be preferable, which the variables MEDLINE and LINES are thought to capture. Given two contracts with identical VKM, the one with more and longer lines is considered to cover traffic in more rural areas.

c_i contains variables related to contract characteristics specified by the PTA and are observed at contract level. The included variables are intended to show how some of the more important contract characteristics affect the number of bidders for a contract and give guidance for PTAs in how they might tweak contracts

[8] In 2016, the co-op Förenade Buss filed for bankruptcy and no longer exists. Because the data used in this paper go up until 2015, it is considered an existing co-op for all contracts in the sample.

to allow for more competition. The included variables are the contract length (or duration) (LENGTH) in years, two dummy variables indicating whether combinatory bidding is allowed (COMB) or EMAT is used (EMAT), and two more dummy variables for whether the contract includes some form of incentive payment (INC.PASS and INC.QUAL). Also, three dummy variables are included to cover instances where the PTA in some way restricts the operator's degrees of freedom, and these are presented in the next paragraph. It must be noted that no valuation is placed on whether such restrictions are motivated or not. LENGTH is thought to capture differences in operators' willingness to bid for contracts that are of different time lengths. The hypothesis is that fewer bidders will be observed in contracts with short duration because the winning operator would have little time to, for example, write off vehicles, and the operator would lack a secure longer-term revenue stream. One way to capture this effect is to include a dummy variable with a cut-off point at a certain contract length (for example, five years) and to define these as "short" contracts. Another way is to include higher-order forms of the LENGTH variable to allow for flexibility in the relationship between bids and contract length, thus not needing to specify a certain cut-off point. The latter approach is used here, and LENGTH is included in its cubic form. As noted in Section 2, combinatory bidding (COMB) frequently occurs in bus tenders and allows operators to combine two or more contract areas into a single bundle. Smaller operators still have the possibility to bid for the smaller contracts, while larger operators can bundle contracts in order to extract economies of scale. If anything, the possibility for bundling should increase the number of unique bidders for a single contract, thus enhancing competition. As also described in Section 2, contracts are awarded according to lowest price or EMAT, which potentially could influence bidding behavior, and this variable was also used in Lundberg et al. (2015) when analyzing the number of bids. Were an EMAT scoring system to be regarded as more complex or less transparent, this would make bidders less inclined to participate. Finally, two indicator variables are included for contracts where the PTA is paying the operator not only depending on the distance driven, but also for some performance measure(s). One is for passenger incentives, and one is for quality incentives. While the former is aimed at attracting more passengers, the latter is rather to enhance (or retain) the quality of the service. The direction of the estimated coefficients is not straightforward; operators might see an opportunity to earn more revenue than in a pure production contract by having effective tools to enhance performance, but they would also be taking risks because their revenue stream would be less secure.

Three operator-restricting variables are included. REQFUEL, a green criterion, indicates whether the PTA has demanded that a specific fuel for some or all vehicles must be used. A less restrictive criterion would be to instead define functional requirements, which do not require a specific technique to be implemented but still achieve the intended goal. DEPOT.FORCE is a dummy variable denoting cases where a depot owned by the PTA is included in the contract and the operator is forced to use the same. While this could be an opportunity for operators that do not have a depot in the area, it might serve as an inconvenience for those with existing depots because, in the worst case, two depots would need to be maintained. For completeness, a dummy indicating cases where a depot is included, but optional to use (DEPOT.OPT), is included, which should be insignificant in line with this reasoning. Finally, TAKEOVER indicates contracts where the operator is forced to take over some of the previous operator's vehicles. This could potentially save costs, but to coordinate, for example, purchases or maintenance knowledge, the vehicles taken over might impose restrictions on the operator's vehicle stock to be purchased. Presumably, there are still several additional ways in which the bidders can be restricted by contract design. However, the effect of the three variables included in this study should indicate the impact of restrictions in general. If only one coefficient becomes negatively significant, it could be argued that it is only that specific measure that affects the number of bidders negatively. However, if all coefficients are negative, a broader conclusion might be that restrictions overall have negative impacts on bidders. For more on this subject, see, for example, Lidestam (2013). For readability, the estimates from including one variable at a time, and all simultaneously, are provided in separate tables in the results section.

Finally, w_{ij} is a set of variables capturing the operational environment for the specific tender, including the number of potential bidders (POTENTIAL), the number of simultaneous tenders (SIMUL), and population density (POPDENS). The first is a standard variable to include according to the procurement literature, and it measures the local competitiveness based on the number of potential bidders in the region, or contract area, where more operators in the contract area would imply more potential bidders for a contract. Similarly, SIMUL also measures competitiveness, but on a national level. Because the PTAs are 21 independent entities, they often carry out tenders at the same time as other PTAs. Arguably, because operators have capacity constraints in their planning resources (irrespective of them being small or large), the more simultaneous tenders the fewer resources can be dedicated to each tender. Operators need to prioritize, causing the number of unique bidders to decrease. Finally, POPDENS is intended to capture differences in the operating environment in a similar way as MEDLINE previously. Among other things, Vigren (2016) shows that contracts run in a more densely populated operating area are associated with reduced cost efficiency. Consequently, it is likely that the same effect is present here.

3.1. Data

The main data source for this paper is the enquiry and awarding documents from the PTAs' tenders, here called the "*contract data*". Data from Statistic Sweden's Business register and population information, and Samtrafiken's timetable data (GTFS, General Transit Feed Specification) are also important sources, and the use of these will be discussed in turn.

Starting with the contract data, documents related to tenders should be publicly available by the Principle of Public Access (PPA) in accordance with the Swedish constitution (grundlag)[9], which the PTAs sort under. Information is only subject to confidentiality if certain paragraphs apply as specified in SFS 2009:400, for example, company information that reveals trade secrets. The overall principle is, however, openness. Using the PPA, each of the PTAs[10] were contacted and asked to provide enquiry and awarding documents for the active public transport contracts by bus in the county as of December 2015. Similar efforts have been made by Nilsson (2011) and Hultén (2015), but obstacles similar to the ones encountered in this paper were met, which limited their analyses.

The reason not to collect documents for more than active contracts is entirely due to time constraints in the collection process, which in turn is because the PTAs have this information available to varying extents. While there are some PTAs that deliver the complete requested documents immediately or within a couple of days, the majority is either slow in handling the request (the PPA states that requests must be handled in a timely manner (skyndsamt)), deliver incomplete documentation, claim the documents are lost, or some combination of these. In short, many PTAs fail to comply with the PPA. Through persistent requests over one year's time, a more or less complete set of tendering and awarding documentation was, however, obtained, and this was supposed to cover all tenders for the currently active public transport contracts in Sweden. That is, contracts tendered over the years 2007-2015. Some complementary documentation was retrieved using the commercial tendering database Visma Opic in which many recent tenders and the corresponding documentation have been announced.

The acquired documents cover all tendering PTAs and their active contracts. The exception is for the county of Norrbotten where digitized documents are only available from 2012 and later. The collected information contains a total of 102 tenders with 565 individual contracts (contract areas). For this paper, observations for the counties of Norrbotten, Västerbotten, and Kronoberg are excluded. The reason for the exclusion of Västerbotten and Norrbotten is the high number of single contracts for the two counties. While the average county has nine contracts, Västerbotten has 71 contracts. Although the sample for Norrbotten is not complete, the number of contracts is similar. Further, while the size of the median contract nationwide is 1,520,000 vehicle kilometers, the median size in Västerbotten is 121,000 vehicle kilometers. The median bid nationwide is 41 million SEK, and the corresponding figure for Västerbotten is 2 million SEK. Finally, Västerbotten has a median of 1 line per contract, while the rest of Sweden has a median of 10 lines. Because the bus operations in the two counties differ substantially from the rest of Sweden, they are excluded from

[9] Tryckfrihetsförordningen in Swedish. The Freedom of the Press Act includes the Principle of public access (Offentlighetsprincipen, SFS 1949:105 ch. 2).)

[10] The county of Västmanland does not tender its public transport services and has thus not been contacted.

the estimations. The two counties have been included as a trial in the models, but when including one at a time the results change. The fact that the inclusion of a single county substantially changes the inferences is, arguably, a further motivation for exclusion.

The third county, Kronoberg, is excluded because their evaluation model is not easily comparable to those of the rest of the PTAs. While other PTAs tender a contract area and award the same to an operator, Kronoberg has a model where bids are placed on the vehicle level, and the PTA allocates a certain number of vehicles within an area to several operators. That, and the fact that the vehicle allocation seems not to be determined on beforehand, makes it hard to compare Kronoberg to the rest of the country. To summarize, in the rest of the paper all analysis and discussion excludes the counties of Kronoberg, Norrbotten, and Västerbotten, which gives a final sample of 17 counties with 72 tenders and 268 individual contracts. This also affects the number of operators in the sample, which is now lowered to around 75 operators.

The sample used in the analysis contains, to the author's knowledge and excluding the counties mentioned above, all active tendered bus contracts in Sweden as of December 2015. The data are on the contract level, thus representing single contract areas. Table 1 shows descriptive statistics on the national level. On average, 3.41 operators placed bids for a contract area in the PTAs' tenders. Four contracts stand out with 6 or more bids, as shown in Figure 1. The average number of bidders seems roughly in line with experiences in other European counties with an average of 2.83 bidders in France (Amaral et al., 2013) and 5.14 bidders in Germany (Augustin and Walter, 2010). However, it is important to note that the time periods of those studies are not the same as the data used in this paper. For the average number of bidders across PTAs (or counties), illustrated in Figure 2, there is a general that the average number of bids decrease the more north one looks.

The contracts vary in size, ranging from 4,000 to 23.7 million vehicle kilometers. The larger contracts tend to be for traffic in urban areas, while the smallest one are on islands such as Ven. The distribution is skewed to the left, indicating that the PTAs structure their contracts into relatively small units.

The use of combinatory bidding differs across PTAs. Of the contracts included in the sample, four PTAs allow for combining contract areas in all of their tenders. However, this does not necessarily mean combining the whole county into one area because the whole county is not always tendered at the same time. Five PTAs have not allowed any combinations in any of their tenders. Thus, all bids for areas are placed independently. Consequently, the remaining PTAs sometimes allow for combinatory bidding. It is also noteworthy that the size of each of the contract areas that are allowed to be combined is smaller than the average contract size in the sample.

As awarding criteria, the lowest bid is used in just over 50 percent of the contracts. In the rest, various forms of the EMAT are used.

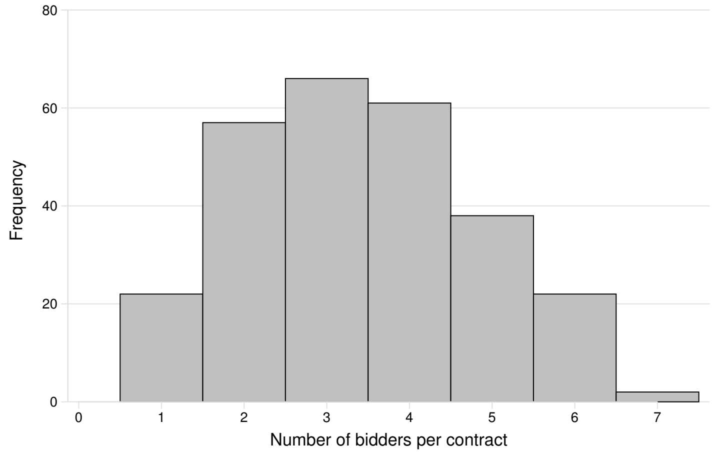

Figure 1: Distribution of the total number of bidders

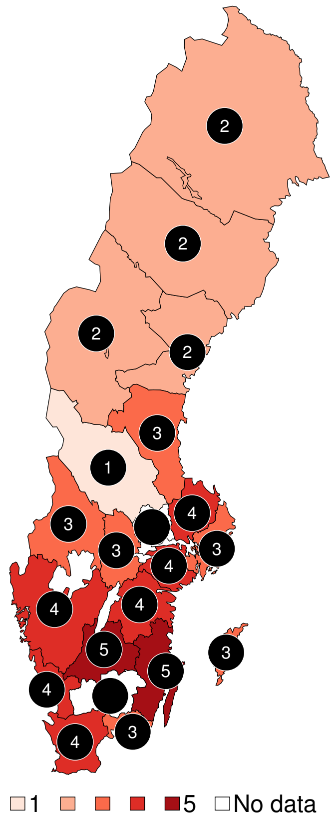

Figure 2: Average number of bidders per county (the two northernmost counties are not included in the analysis)

	Mean	Median	SD	Min	Max
Number of bidders per contract	3.41	3	1.43	1	7
VKM (-000 km)	1845.3	896.0	2945.7	4.00	23700.6
ln(VKM)	13.6	13.7	1.32	8.30	17.0
LINES (#)	11.5	8	12.3	1	80
MEDLINE (km)	26.8	25.0	14.6	1.68	110.3
ln(MEDLINE)	3.13	3.22	0.59	0.52	4.70
POTENTIAL (#)	23.7	23	11.5	6	58
SIMUL (#)	7.69	8	3.11	2	15
POPDENS (pop./-000km^2)	1563.1	1295.7	773.5	561.4	4226.5
ln(POPDENS)	7.25	7.17	0.44	6.33	8.35
LENGTH (#)	7.29	8.01	1.67	2	10.5
Indicator variables					
EMAT (#)	0.46	0	0.50	0	1
COMB	0.54	1	0.50	0	1
INC.QUAL	0.36	0	0.48	0	1
INC.PASS	0.51	1	0.50	0	1
REQFUEL	0.19	0	0.40	0	1
DEPOT.OPT	0.082	0	0.28	0	1
DEPOT.FORCE	0.17	0	0.37	0	1
TAKEOVER	0.11	0	0.32	0	1
Observations	268				

Table 1: Descriptive statistics, aggregated on the national level

The duration of the contracts varies, although most are around 7 to 8 years long, excluding option clauses. The shorter contracts are found in the counties of Östergötland and Skåne, while the longest duration, ten years, is found in several counties. This is the longest duration allowed by the EU's public transport act.

The number of simultaneous tenders, SIMUL, was constructed by counting the number of tenders that were also occurring (overlapping) at some point in the time range of a specific tender. A tender's time range is the time from tender announcement to the last day for placing a bid. No matter if the tender includes one or more contracts, all contract observations in a specific tender will have the same value for SIMUL. On average, 8 tenders were overlapping with the own tender(Table 1), with one tender having an extreme value of 15 other tenders occurring at the same time.

The contract data almost always contain information on which lines are run in the contract, and often have detailed timetable specifications of the same. However, the length of the lines is not always reported. To achieve a measure of the median line length, MEDLINE, of a contract, the Swedish GTFS data, which contain information about all stops and the frequency of every line run, were used to map the lines within a contract to the routes of the same. By grouping the stops for each line and, in the case of multiple variants of the line, using the longest line variant, the line length could be calculated. The length of all lines run in a contract can then be inferred to construct the median line length, which is arguably a more robust measure than taking the average. In Table 1, the median length ranges between 2 and 110 kilometers, while the average is 27 kilometers. Most shorter lines are found in contracts run in smaller cities, with Arvika and Kristinehamn at the extremes. Analogously, the longer lines are run in more rural contracts or contracts with express buses serving multiple cities. This is in line with the motivation for the variable given in the previous section.

The variables discussed up until now have not been related to geography, which some of the variables included in the model indeed are. To measure the number of potential bidders and population density, one needs to have information about where the contract is located. This becomes even more challenging due to the nature of public transport; operations are not run at one point, but rather over an area with different lines. To create the area in which a contract is operated, the contract area, the routes of the lines included in the contract is utilized as discussed in the previous paragraph. By using the point position of each stop along a line included in a contract, buffers (circles) can be created around these points. By increasing the radius of the buffers, all (or most) buffers will at some point intersect and overlap each other, thus forming a contract area. Which radius to use, however, is not straightforward because it should capture both the demand for transport services and the operators' preferences for a contract. Six radiuses are defined and used differently depending on the variable: 25, 50, 75, 100, 150, and 200 km. Multiple regressions were run with these six radiuses to test whether the results are sensitive to the radius chosen. If the estimated coefficients related to geography does not change substantially or switches to and from significance, the outlined strategy is regarded as valid. These estimates are presented in the results section.

The second variable related to geography is the number of potential bidders for a contract. The previous literature has often calculated this based on the number of companies requesting the enquiry documentation (De Silva et al., 2009; Li and Zheng, 2009; Krasnokutskaya and Seim, 2011), or as the number of companies placing bids in previous tenders (auctions) in the same area (Amaral et al., 2013). Neither of these approaches was directly implementable in this paper. For the first, the data used do not always document the companies requesting the enquiry documentation. Also, because requesting this information is cheap, one could argue that this approach would not indicate whether a company is a potential bidder or not. Such requests might only be to gather market information. The second approach was not implementable because only active contracts are observed and say nothing about previous tenders. However, even if they did, the market environment in an area could have changed substantially during the lifespan of a single contract, which can stretch up to ten years. A more viable strategy for this paper was to define a potential bidder as an operator with a workplace, for example a depot, in a certain contract area the year before the tender. This approach is similar to what was done in Jofre-Bonet and Pesendorfer (2003), Cantillon and Pesendorfer (2006), and Lundberg et al. (2015), with the exception that these studies only defined a potential bidder as a company that has actually placed a bid during the data time period or has placed a bid in a certain region over the time period. As a complement analysis, the more restrictive definition of only considering actual bidders is used to see whether the results are sensitive to the definition of a potential bidder. In constructing the variable, time-series data over companies' workplaces are utilized. These are accessible through Statistic Sweden's Business register, from which companies with registered SNI-code 49.31 and 49.39 were filtered out. Companies (operators) were filtered further based on whether the data show that they have participated in bidding or in other ways can be identified as running public transport services. The latter criterion is foremost based on the company being active in annual reports and if any relevant activity can be found in, for example, acquiring vehicles or having vehicles appearing in newspapers, photographs, or other media. In total, 220 operators with 572 workplaces were kept (including operators in counties excluded from the analysis). Knowing the visiting address of each workplace using Statistics Sweden's business registry , coordinates were calculated using an API for Google Maps. The number of operators having workplaces within a contract area before the tender formed the number of potential bidders for the same. Large operators and co-ops were treated specially. As was argued previously, large operators have the capacity to bid anywhere in the country. Consequently, the four largest operators were regarded as potential bidders in all contracts. From the same section, remember that co-op members place bids as a single unit. Thus, workplaces of co-op members were counted as if owned by the co-op, reducing the number of unique operators.

In the following results section, the results will be discussed based on the 100-km measure if not stated otherwise. The reason for choosing this distance is not based on any economic theory, but the discussion benefits from focusing on one distance. In the results section, the results from varying the distance are also discussed.

Finally, the population density in the contract areas, DENSITY, was constructed using Statistics Sweden's population statistics for the year 2012, which contain 100 x 100 meter squares with the number of people living there. The total population within the defined contract area divided by this area in square kilometers gives the density measure. There are reasons to believe that DENSITY should have a small radius because it somewhat mirrors the demand for transport services, which is probably more local. Consequently, the radius used for this variable will be the smallest one, 25 km.

3.2. Estimation equation

The dependent variables in this paper have non-negative integer values, also known as count data. Consequently, the probability mass of the distribution is limited to a non-negative range (Cameron and Trivedi, 2005), which the normal distribution is not as it allows for negative values. Thus, a standard ordinary least squares (OLS) approach would potentially fail. Instead, regression methods utilizing discrete probability distributions are turned to when dealing with count data, and the natural starting point is the Poisson regression model. Following Greene (2003), this model takes it departure in a Poisson distribution with a probability mass function

$$Pr[Y = y_i|\mathbf{x}_i] = \frac{\exp(-\lambda_i)\lambda_i^{y_i}}{y_i!}, \qquad y_i = 0, 1, 2, \ldots, \tag{2}$$

with dependent variable y_i, parameters λ_i, regressors $\mathbf{x}$, and moments

$$E[Y] = V[Y] = \lambda_i. \tag{3}$$

That is, the mean and the variance of the variable are equal, or equidispersed. The expected value of the dependent variable is thus

$$E[y_i|\mathbf{x}_i] = \lambda_i = \exp(\mathbf{x}_i')\beta, \tag{4}$$

which is an exponential parameterization of Y. Because of its non-linearity, it is estimated using a maximum likelihood technique and a corresponding log-likelihood function.

A common, and relevant, critique of the Poisson model is the requirement of equidispersion. If the moments do not hold, the Poisson model risks misestimating standard errors (Cameron and Trivedi, 2005) and thus leading to potentially wrong inferences. Investigating the dependent variable is necessary in order to choose the appropriate modeling framework, which in Table 1 shows signs of underdispersion because the variance (2.05) is smaller than the mean number of bidders (3.41). This would mean that the standard errors risk being overestimated resulting in false insignificant estimates (Hilbe, 2014). Winkelmann (2013) discusses the Generalized Poisson distribution, as found in Consul (1989). The distribution allows for both over- and underdispersion by introducing a parameter γ that extends the probability mass function of the Poisson distribution in (2) to

$$Pr[Y = y_i|\mathbf{x}_i] = \begin{cases} \frac{\lambda_i \exp(-\lambda_i - y_i\lambda_i)(\lambda_i + y_i\gamma)^{y_i - 1}}{y_i!}, & y_i = 0, 1, 2, \ldots, \\ 0, & \text{for } y_i > m, \text{ when } \gamma < 0. \end{cases} \tag{5}$$

where γ is a dispersion parameter that lies in the range $\max[-1, -\lambda_i/m] < \gamma \leq 1$. A negative (positive) value of γ would indicate underdispersion (overdispersion), while $\gamma = 0$ reduces the distribution to the standard Poisson distribution. As noted in (5), the Generalized Poisson distribution is restricted in parameter space at m for the underdispersed case. The restriction is the largest positive integer that satisfies $\lambda_i + m\gamma > 0$. Although the consequence of this is that probabilities do not sum exactly to unity, Consul and Famoye (2006) note that this truncation error is small and makes no practical difference in applications. It is therefore deemed appropriate for use in this paper. The moments are

$$E[Y] = \frac{\lambda_i}{1-\gamma}, \tag{6}$$

$$V[Y] = \frac{\lambda_i}{(1-\gamma)^3}, \tag{7}$$

which collapse to the Poisson regression case if $\gamma = 0$.

The coefficients from the estimated models are transformed by taking the exponents of the same. This allows the coefficients to be interpreted as a percentage change in the actual number of counts (number of bids) following an X change in the independent variable instead of a "log-change" as would be the case without the transformation (Hilbe, 2014). That is, increasing X by 1 gives a percentage increase by $\exp(\widehat{\beta}) - 1$ in the number of bids[11]. For log-transformed independent variables, the interpretation is not as straightforward. Although the direction of an increase is determined (as in the non-transformed case) in terms of whether the coefficient is larger (positive effect) or smaller (negative effect) than unity, the size is less easy to interpret directly from the coefficient. In those cases where the coefficient of a log-transformed variable is statistically significant, the marginal effects of the estimate will instead be plotted in order to interpret the result more accurately.

The fact that the dependent variable has no zero counts needs to be addressed. The empirical model is extended with truncation at zero, thus restricting the model not to predict zero outcomes. In Table C.8 (Appendix C), in addition to the zero-truncated generalized Poisson model, results from the standard OLS, Poisson, zero-truncated Poisson, and non-truncated generalized Poisson models are presented to allow the model to also have zero counts, which, although not observed, is a possible outcome.

4. Results

This section presents results from the estimating model in Equation (1). Table 2 presents the results from four variants of the model with the gradual inclusion of fixed effects. Along with these results, some of the estimated coefficients are plotted and the results from the operator-restricting measures are given. Following this, some sensitivity analyses are presented on model choice, radius distance, and the definitions of SIMUL and POTENTIAL. As noted in Section 3, the model introduces non-linearity in interpreting the coefficients, which in all results tables are transformed with $\exp(\widehat{\beta}_i) = X$. All standard errors are clustered

[11] Analogously, an estimate in the results tables of $\exp(\beta) > 1$ indicates an increase and an estimate of $\exp(\beta) < 1$ indicates a decrease.

at the county level. Finally, as discussed in the previous section, the results use a radius distance of 100 km. As discussed below, it turns out that varying the radius did not matter much for most of the results discussed in the beginning.

In the results in Table 2, Models I to IV show a sequential build-up with county and year fixed effects up to the final Model IV, which is the model in the main focus of this section. All models used a zero-truncated generalized Poisson model.

When including the county and year fixed effects, no major changes seemed to occur. However, the perhaps most notable changes were the coefficients of LINES, POTENTIAL, and POPDENS, which all became insignificant. The opposite held for EMAT, and INC.PASS, which turned significant. The fact that some significant effects disappeared illustrates the need to control for heterogeneity, both across PTAs (counties), because they might have different approaches in tendering, and across years, because the tendering environment might change.

Focusing on the main model, Model IV, eight of the variables had significant coefficients at the 5 percent level or lower, including VKM, SIMUL, EMAT, LENGTH (and its higher-order forms), INC.PASS, and INC.QUAL. In general, the model predicted the number of bidders to change by around 0.1-0.5 bidders depending on which coefficient was considered. Starting with the logged VKM coefficient, this value was positive and significant, implying that larger contracts result in more bidders. A 10 percent increase in VKM would, on average, give a 0.75 percent increase in the number of bids, which is a rather modest effect relative to the number of bids. Figure 3 shows the predicted number of bidders for different levels of VKM with $\ln(VKM)$ on the x-axis and a positive effect of size of production on bidders. Although the model predicts one more bid on the largest contracts compared to the smallest contracts, marginal movements along the line are the most probable (for example, from 20,000 to 25,000 kilometers), and these do not yield much of an effect. A higher number of simultaneous tenders, SIMUL, implies fewer bidders for the tendered contract. The relationship with the number of bidders is plotted in Figure 4 and shows a clear downward slope. The difference between point estimates at the two extremes (having two versus 15 simultaneous tenders) is about 1.8 bids. Turning to EMAT, evaluating tenders with this method lowered the number of bids slightly. For the three coefficients on LENGTH, a non-linear relationship was found, which is most easily described by consulting Figure 5. It can thus be inferred that contract duration seems not to yield any difference in bidders for most contract terms (years) except for very short durations. That is, the only significant difference[12] in the figure is when comparing the number of bidders for contracts with a 2-3 year duration with contracts of four years or longer. Including higher-order forms of the variable did not change this result. Finally, turning to the remaining significant coefficients, including passenger and

[12] For clarity, note that overlapping confidence intervals do not imply that the estimated means are the same per sé (Schenker and Gentleman, 2001).

	I	II	III	IV
Production variables				
ln(VKM)	1.049	1.085**	1.071**	1.075**
	(0.025)	(0.022)	(0.022)	(0.025)
LINES	0.993**	0.991**	0.992**	0.996
	(0.003)	(0.003)	(0.002)	(0.003)
ln(MEDLINE)	1.006	0.985	0.986	0.972
	(0.043)	(0.045)	(0.037)	(0.045)
Operational environment				
POTENTIAL	1.009**	1.013*	1.013**	1.005
	(0.003)	(0.006)	(0.004)	(0.005)
SIMUL	0.954**	0.978**	0.989	0.962**
	(0.011)	(0.008)	(0.020)	(0.006)
ln(POPDENS)	1.187**	1.190*	1.152*	1.083
	(0.064)	(0.069)	(0.071)	(0.047)
Contract characteristics				
EMAT	1.043	0.903	0.914	0.894**
	(0.053)	(0.063)	(0.086)	(0.040)
COMB	1.021	0.945	0.944	0.931
	(0.057)	(0.047)	(0.065)	(0.061)
LENGTH	7.114**	4.407**	3.980**	2.769**
	(0.211)	(0.230)	(0.234)	(0.121)
LENGTH × LENGTH	0.745**	0.810**	0.817**	0.855**
	(0.032)	(0.041)	(0.034)	(0.020)
LENGTH × LENGTH × LENGTH	1.014**	1.010**	1.009**	1.008**
	(0.002)	(0.002)	(0.002)	(0.001)
INC.PASS	0.977	0.967	1.008	0.896**
	(0.069)	(0.050)	(0.060)	(0.035)
INC.QUAL	1.174**	1.233*	1.208**	1.194*
	(0.058)	(0.101)	(0.062)	(0.079)
Constant	0.011**	0.011**	0.043**	0.056**
	(0.969)	(0.985)	(1.014)	(0.591)
County fixed effects	No	Yes	No	Yes
Year fixed effects	No	No	Yes	Yes
AIC	854.259	770.582	811.062	723.428
BIC	908.124	820.856	868.518	784.475
Observations	268	268	268	268

** $p < 0.01$, * $p < 0.05$.

Standard errors in paretheses are robust to within county clustering and heteroscedasticity

Table 2: Results

quality incentives gave opposite effects on the number of bids. Including passenger incentives was predicted to reduce the number of bidders by $(0.896 - 1) * 100 = -10.4$ percent, while quality incentives increased the predicted number of bids by 19.4 percent. With the average numbers of bidders being 3.41, the average effect would be 0.36 fewer and 0.66 more bids, respectively.

As described in Section 3, three variables capturing different sorts of special requirements that restrict the operator's operations were added to Model IV. For presentation purposes, the coefficient estimates are presented in Table 3, and the full results are given in Table B.7 in Appendix B. The last three columns in Table B.7 include the gradual addition of fixed effects to Model IV.R.ALL. All of the included requirements had negative significant estimates when included separately, which means that putting requirements on fuel, forcing an operator to use a depot should it win, and having to take over existing vehicles reduced the number of bids. One could note that offering access to a depot, but not forcing the operator to use it, did not have any effect. The magnitudes of the coefficients were not substantial, but they were nonetheless different from zero. In general, the special requirements reduced the number of bidders by approximately 0.4 bidders.

In Model IV.R.ALL, all four requirement variables are included, giving lower point estimates and higher standard errors for all estimated variables. All four variables were insignificant. However, when testing the joint significance, a point estimate of 0.770 and a p-value below 0.01 confirmed the findings when testing the variables separately.

4.1. Sensitivity analysis

4.1.1. Model choice

Table C.8 provides estimates for Model IV in Table 2, but for different distributions and truncations. The compared setups are, from the left, a standard OLS model, a Poisson model, a zero-truncated Poisson, a generalized Poisson, and a zero-truncated generalized Poisson model.

Starting with the OLS, the estimates often differ substantially. However, this is not unexpected given the different distributional assumptions of the Poisson and OLS models. Predicting the effects of the OLS and Poisson models yields roughly the same sizes, but lower precision is seen with the former. However, because the number of bids is a count variable, a count data model is arguably the better way to go. Comparing the four count data models, some differences between the Poisson and generalized Poisson cases exist as well, although these are not as large as in the OLS case. Note that the GPOIS (generalized Poisson) model did not manage to converge, which all other estimated model in the paper have. The coefficients are often larger (in absolute values) in the T.POIS (truncated Poisson) model, most notably the estimates of the LENGTH variables. However, the same pattern as in Figure 5 is predicted from the coefficients. One difference is that LINES is significant at the 5 percent level in the T.POIS model, while EMAT and INC.QUAL are not. The latter could be a consequence of the underdispersed dependent variable (Hilbe, 2014), which is dealt with

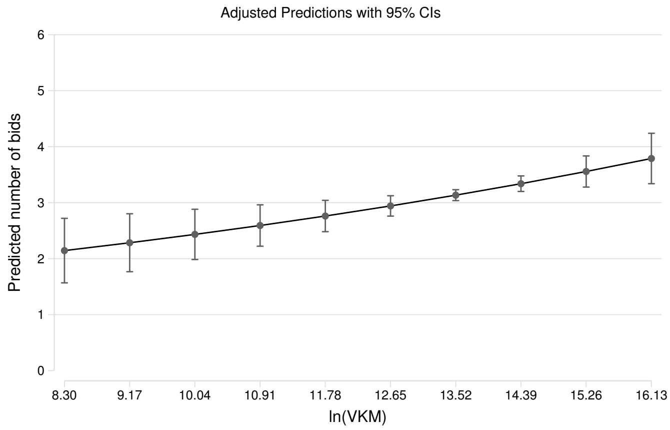

Figure 3: Varying ln(VKM)

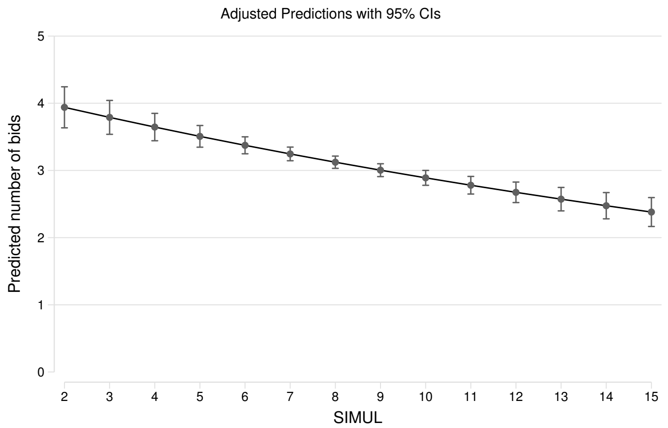

Figure 4: Varying SIMUL

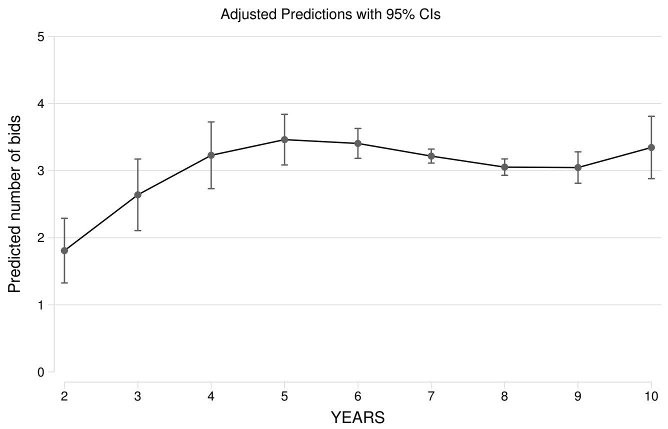

Figure 5: Varying LENGTH

	IV.R.I	IV.R.II	IV.R.III	IV.R.IV	IV.R.ALL
REQFUEL	0.881**				0.906
	(0.043)				(0.052)
DEPOT.OPT		1.055			
		(0.074)			
DEPOT.FORCE		0.874**	0.871**		0.934
		(0.051)	(0.050)		(0.064)
TAKEOVER				0.879*	0.911
				(0.061)	(0.066)
Controls from IV	Yes	Yes	Yes	Yes	Yes
County fixed effects	Yes	Yes	Yes	Yes	Yes
Year fixed effects	Yes	Yes	Yes	Yes	Yes
Joint sig.					0.770**
					(0.066)
AIC	717.868	719.997	720.329	720.167	715.195
BIC	778.915	781.044	781.376	781.214	776.241
Observations	268	268	268	268	268

** $p < 0.01$, * $p < 0.05$.

Standard errors in paretheses are robust to within county clustering and heteroscedasticity

Table 3: Results of operator-restricting measures

using the generalized Poisson model. Further, because the BIC statistic is clearly lower for the T.GPOIS (truncated generalized Poisson) model compared to the T.POIS model, the former model was chosen as more appropriate for the analysis.

4.1.2. Contract area size

In the analysis, the variable POTENTIAL was created using the geographical area of a contract, which was created by drawing 100 km buffers around the lines belonging to the contract. Thus, this measure could be regarded as arbitrary. To determine whether the chosen area size would affect the results, Model IV was re-run for different radiuses of 25, 50, 75, 100, 150, and 200 km. It is expected that the coefficients for variables not based on area size will not change substantially and that their significance will not be lost. The results of the sensitivity analysis are shown in Table D.9, and the models are ordered by distance.

The coefficient on POTENTIAL did depend on the radius chosen. While a statistically significant effect was found for distances smaller than 100 km, this was not true for the larger radiuses. This would imply that POTENTIAL is dependent on which radius is chosen, and this should be taken into consideration when making inferences and conclusions.

For the other non-distance related variables, the estimates were robust and generally differed by less than 0.01 points. The exceptions were the first and second levels of LENGTH, but given the non-linearity imposed on the variable this was not regarded to be a problem, and the inferences did not change.

4.1.3. Simultaneous tenders

Because the current definition of SIMUL can sometimes mark tenders overlapping by just single days as simultaneous, two narrower definitions of the variable were also used to see whether the results would change. The redefinition was made by shortening the time range, that is, the number of days between tender announcement and the last day of making a bid, by 10, 20, and 30 percent (proportionally on the start and end of the time range). This reduced the number of tenders that were only slightly overlapping.

The results in Table 4 indicate that the results did not change much and were therefore robust to the definition. The coefficients on SIMUL were at least significant at the five percent level and were around the same size as in Model IV. The level of significance decreased the narrower the time range was defined.

	IV	-10%	-20%	-30%
SIMUL	0.972**	0.961**	0.979*	0.973*
	(0.011)	(0.012)	(0.010)	(0.013)
Controls from IV	Yes	Yes	Yes	Yes
County fixed effects	Yes	Yes	Yes	Yes
Year fixed effects	Yes	Yes	Yes	Yes
AIC	725.883	725.452	724.727	724.401
BIC	786.930	786.499	782.183	781.856
Observations	268	268	268	268

** $p < 0.01$, * $p < 0.05$.

Standard errors in paretheses are robust to within county clustering and heteroscedasticity

Table 4: Sensitivity test SIMUL

4.1.4. Potential bidders

As noted in Section 3.1, the number of potential bidders can be defined in various ways. The definition in this paper used the number of operators with workplaces within a certain contract area (buffer), irrespective of them having placed a bid in any tender. A more restrictive definition would be to only consider those having placed a bid in the sample period, and this was used as the variable POTENTIAL in the results shown in Table 5 (to be compared with results in Table D.9).

The estimations from the more restrictive definition of POTENTIAL had coefficients of roughly the same magnitude as those in Table D.9. The one difference is that the coefficient on the 50 km radius buffer was no longer significant. This somewhat reduced the strength of the result that the local competitive environment affected the number of bidders. However, the significant effect at 25 and 75 kilometers was still intact and in line with the results presented earlier.

	25 km	50 km	75 km	100 km	150 km	200 km
POTENTIAL	1.013**	1.013	1.016*	1.004	0.999	1.004
	(0.004)	(0.008)	(0.007)	(0.007)	(0.007)	(0.006)
Controls from IV	Yes	Yes	Yes	Yes	Yes	Yes
County fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Year fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
AIC	723.227	723.062	720.001	724.398	724.883	723.966
BIC	784.274	784.108	781.048	785.444	785.880	785.013
Observations	268	268	268	268	268	268

** $p < 0.01$, * $p < 0.05$.
Standard errors in paretheses are robust to within county clustering and heteroscedasticity

Table 5: Sensitivity test POTENTIAL

5. Results discussion

In Swedish tenders for public transport bus contracts, PTAs see on average just over three bidders per contract as shown in the descriptive statistics in Table 1, and there is also variation across counties, ranging on average from 1 to 5 bidders per contract. The overall result from the previous section, that the estimates do not give scope for substantial increases in the number of bidders, is perhaps not surprising. One interpretation is that PTAs have few tools to enhance competition in their tenders, other than to adjust contract conditions in order to change the number of bidders by around 0.2-0.5 bidders. The PTAs are therefore often left out to the operator market. The results in this paper show that streamlining contracts fosters competition (as measured by the number of bidders), but not by a large amount. Over the data sample period, the number of companies involved in the sector was constant, while compared with the year 2003, some 100 fewer companies were registered in 2015 (The Swedish Bus and Coach Federation, 2016). Expanding the time horizon to the last three decades, Nilsson (2011) notes that, compared to 1989, three out of four operators no longer existed in 2011, a development like the one in Norway (Mathisen and Solvoll, 2008). Although the decrease was not as large as before, an important question is whether the more concentrated market should be a worry for the PTAs. That is, is the possible competition high enough for competitive tendering to function as intended? A perhaps naïve interpretation of economic theory would suggest that only two bidders are enough for a competitive price. Because most of the contracts see more than two bidders, as shown in Figure 1, the general answer would, if anything, lean towards a yes. However, in practice, complicated dynamics are in place in terms of scale economies, private and common costs, local presence, and multiple simultaneous tenders. The map in Figure 2 does raise concerns for some counties (mostly the northernmost) with few bidders and a strong presence of co-ops. Too small contracts, which is often the case here, and colluding small operators in the same county might deter participation from other operators (mostly larger operators) that might have a hard time competing with a centralizing strategy. The issue is complex and calls for an analysis itself.

One of the more influential factors is the number of other tenders that coincide in time with a specific tender. In line with expectations, when the number of simultaneous tenders is high, the contract put to tender receives fewer bidders. As illustrated in Figure 4, this differs by almost two bidders between the two extremes. One plausible explanation would be that all operators, irrespective of size, must prioritize when too many tenders coincide. The focus is shifted either to tenders where there is a high probability for the operator to win or those where it can seek high profits. Also, some tenders are extensive, for example, Stockholm's "E22-tender" comprising the Stockholm inner city traffic with over 1,100 pages in documentation (excluding timetable specifications), and these require more resources to prepare a bid. However, it is not necessarily straightforward to suggest which contracts are more complex; small, large, urban traffic, or high-powered incentive contracts. All have varying levels of complexity. A straightforward policy suggestion would be for the PTAs to spread out their tenders more evenly across time, something that could be coordinated through the PTAs' trade organization Svensk Kollektivtrafik (in English, Swedish Public Transport). Such coordination could benefit from using option clauses in existing contracts, which would allow space for maneuver in the planning process. If not possible for all contracts, at least large contracts should avoid being tendered simultaneously due to the amount of work needed to prepare a bid.

Although most contract duration times yielded no difference in the number of bidders, the shortest durations, did. It is noteworthy that these short contracts do not seem to be "*emergency tenders*" (that is, unplanned tenders that have to be carried out quickly because a previous contract was, for example, canceled), but are for regular traffic. Thus, such short contracts should not be favored in tendering. Although the PTA can change the contract settings more rapidly in shorter contracts, such contracts give rise to uncertainty for the operator in terms of revenue, provide less time for an operator to establish itself, and provide short write-off times. Thus, it is important that the PTA not put special requirements that are too strict on the vehicles used here so that the existing buses can be used in the contract (or so that buses can be re-used from other areas).

Special requirements, which are a form of operator-restricting measures, were also found to, in themselves, affect the number of bidders negatively. However, in the analysis, the measures (REQFUEL, DEPOT.FORCE, and TAKEOVER) were included not necessarily to assess their individual impacts on bidders, but rather to indicate whether actions by the PTAs (whether they were aware of it or not) restrict the degrees of freedom an operator might have. Because all three coefficients were negative and significant on their own, there is some evidence for this. That would mean that PTAs need to be careful with what requirements or demands they request in their tenders and should think through whether the demands are necessary and if there are less restricting ways in which the demands might be met. The industry has worked with these questions for many years in the collaboration "*Partnersamverkan för Förbättrad Kollektivtrafik*" and has already standardized many requirements into the Buss 2014 (and earlier) manuals. That work is validated by the findings in this paper and should be developed further. However, compliance by PTAs with these guidelines is not always high.

County and locally specific conditions seem to be an important aspect of Swedish public transport by bus because varying the contract area radius makes the coefficient significant only for radiuses under 100 km. That is, the number of operators in a more narrow geographical area affects the number of bidders. One interpretation of this would be that the locality of the operators plays a role in participation, which is perhaps not unexpected. Some input factors such as fuel are directly dependent on distance driven, while others, for example, labor and capital depreciation, depend indirectly on such distances. Given identical operators, the one with the shortest distance from the depot to the starting point of the line(s) will be expected to place the lowest bid. A simple extension with more heterogeneous operators would be for those farther away to try to compensate for the distance disadvantage by producing services more efficiently or by accepting lower profits. If depots were easy to establish, this would not a problem. However, this is not necessarily the case due to various factors such as land availability, environmental standards on washing and maintenance, and not the least the expense of building them. A second option would be to rent an existing depot, but the possibility of doing this is not known by the author, although similar problems as when building one should be present. A third option could be for the PTA to offer a depot for the winning operator. As noted previously in the paper, this is done by some PTAs, although only in fewer than 10 percent of the contracts in the sample. In short, non-availability of a depot is an entry barrier. But should PTAs build depots to use in all contract areas? A not very constructive answer would be yes if the long-term profits from increased competition by building a depot are higher than the cost of building and maintaining the depot. However, this is probably hard for the PTA to infer exactly. A starting point would be for the PTAs to investigate the situation and create a dialog with operators in areas with few bidders to see whether a lack of depot is the reason for the lack of bidders. This might be of extra importance for the northernmost counties. One must also remember the result from this paper that forcing operators to use depots lowers the number of bidders, and a possible explanation for this might be that some operators already have their own depots to use and do not want to be forced to use another one. Another suggestion could be to not pre-define which contract areas contain which lines, but rather let the tender be on the line level. However, the awarding mechanism of such a situation might prove overly complex. The essence of the last suggestion is, however, that the definition of contract areas plays a role in the number of operators that submit bids.

Finally, given today's regime with competitive tendering, the PTAs cannot stop trying to enhance competition. This does not primarily mean they should enter into the market with their own operators, but rather, as they have done, they should collaborate with the industry to create more standardized contracts and nationwide standards, for example, vehicle standards that would allow for vehicles to easily move between counties. But they also need to think carefully about the contract and area design when putting out tenders. Packaging lines into the same combinations as 10-20 years ago might not be the best thing to do if the operator market has changed. Reducing entry barriers by offering depots in relevant cases might also be fruitful, and this has been done in some counties in recent years, as would pre-tender talks with operators to hear their views and potential suggestions for the upcoming tender. Although not in line with the competitive tendering paradigm, negotiated performance-based contracts might also be a viable way for the PTAs to enhance the transport services as suggested by Hensher and Stanley (2008), given that current legislation allows for it. Competitive tendering would therefore serve as a threat to the operators if the negotiations were not favorable enough to the PTAs.

6. Conclusions

This paper has examined how different factors relating to contract characteristics and the operational and tender environment affect the number of unique bidders placing bids in tenders for bus contracts in Sweden. A generalized Poisson model was used along with a comprehensive data set containing recently tendered bus contracts in Sweden spanning the period 2007-2015 and 17 counties.

The main finding from the analysis was that most contract characteristics could change participation by around 0.1-0.5 bidders on average. Operator-restricting measures, such as special requirements on buses, generally lowered participation by around 0.4 bidders. Further, the number of tenders going on at the same time as a specific tender reduced participation by almost 2 bidders. Finally, there was evidence that the local competitive environment is of importance and that the PTAs therefore need to be concerned with entry barriers in their tenders.

This paper has also discussed the competitive environment in Sweden and how the presence of co-ops can affect this. Also discussed was the work made by the industry to streamline tenders, and that this work should continue, and how the PTAs and operators should comply and cooperate on entry barriers such as depot availability or industry agreements on special requirements. The latter relates to the finding that the local competitive environment matters. Finally, it is noted that the PTAs need to coordinate their tenders in order not to overlap any more than is necessary because such overlaps have a negative effect on the number of bids received.

References

Alexandersson, G. and Pyddoke, R. (2010). Bus Deregulation in Sweden Revisited: Experiences from 15 Years of Competitive Tendering. In *The accidental deregulation : essays on reforms in the Swedish bus and railway industries 1979-2009*, pages 113–126. PhD Thesis, Stockholm School of Economics.

Amaral, M., Saussier, S., and Yvrande-Billon, A. (2013). Expected number of bidders and winning bids: Evidence from the london bus tendering model. *Journal of Transport Economics and Policy*, 47(1):17–34.

Athey, S., Levin, J., and Seira, E. (2011). Comparing open and sealed bid auctions: Evidence from timber auctions. *The Quarterly Journal of Economics*, 126(1):207–257.

Augustin, K. and Walter, M. (2010). Operator changes through competitive tendering: Empirical evidence from german local bus transport. *Research in Transportation Economics*, 29(1):36–44.

Beck, A. (2011). Experiences with competitive tendering of bus services in germany. *Transport Reviews*, 31(3):313–339.

Bergman, M. A. and Lundberg, S. (2013). Tender evaluation and supplier selection methods in public procurement. *Journal of Purchasing and Supply Management*, 19(2):73–83.

Cameron, A. C. and Trivedi, P. K. (2005). *Microeconometrics: methods and applications*. Cambridge university press.

Camén, C. and Fellesson, M. (2015). Appeals against public transport procurement processes: an empirical study of complainants' arguments and court decisions. In *Proc. 14th International Conference on Competition and Ownership in Land Passenger Transport (Thredbo 14)*, Santiago de Chile, Chile.

Cantillon, E. and Pesendorfer, M. (2006). Auctioning bus routes: The London experience. In Cramton, P., Shoham, Y., and Steinberg, R., editors, *Combinatorial Auctions*, chapter 23. MIT Press.

Consul, P. C. (1989). *Generalized Poisson Distributions*. Dekker New York.

Consul, P. C. and Famoye, F. (2006). *Lagrangian probability distributions*. Springer.

De Silva, D. G., Kosmopoulou, G., and Lamarche, C. (2009). The effect of information on the bidding and survival of entrants in procurement auctions. *Journal of Public Economics*, 93(1):56–72.

Greene, W. H. (2003). *Econometric analysis*. Pearson Education India.

Hart, O. and Moore, J. (1988). Incomplete contracts and renegotiation. *Econometrica: Journal of the Econometric Society*, 56:755–785.

Hensher, D. A. and Stanley, J. (2008). Transacting under a performance-based contract: The role of negotiation and competitive tendering. *Transportation Research Part A: Policy and Practice*, 42(9):1143–1151.

Hensher, D. A. and Wallis, I. P. (2005). Competitive Tendering as a Contracting Mechanism for Subsidising Transport: The Bus Experience. *Journal of Transport Economics and Policy*, 39(3):295–322.

Hensher, D. A., Yvrande-Billon, A., Macário, R., Preston, J., White, P., Tyson, B., Van de Velde, D., van Wee, B., de Aragão, G., dos Santos, E. M., et al. (2007). Delivering value for money to government through efficient and effective public transit service continuity: Some thoughts. *Transport Reviews*, 27(4):411–448.

Hilbe, J. M. (2014). Modeling count data. *Cambridge Books*.

Hong, H. and Shum, M. (2002). Increasing competition and the winner's curse: Evidence from procurement. *The Review of Economic Studies*, 69(4):871–898.

Hultén, S. (2015). Kontrakt och konkurrens i den regionala kollektiva busstrafiken. Uppdragsforskningsrapport 2015:7, Swedish Competition Authority.

Jansson, K. and Wallin, B. (1991). Deregulation of Public Transport in Sweden. *Journal of Transport Economics and Policy*, 25(1):97–107.

Jofre-Bonet, M. and Pesendorfer, M. (2003). Estimation of a dynamic auction game. *Econometrica*, 71(5):1443–1489.

Krasnokutskaya, E. and Seim, K. (2011). Bid preference programs and participation in highway procurement auctions. *The American Economic Review*, 101(6):2653–2686.

Li, T. and Zheng, X. (2009). Entry and competition effects in first-price auctions: theory and evidence from procurement auctions. *The Review of Economic Studies*, 76(4):1397–1429.

Lidestam, H. (2013). Factors reflecting bids in procurement of bus transports. *Management of Environmental Quality: An International Journal*, 24(4):526–537.

Lundberg, S., Marklund, P.-O., Strömbäck, E., and Sundström, D. (2015). Using public procurement to implement environmental policy: an empirical analysis. *Environmental Economics and Policy Studies*, 17(4):487–520.

Mathisen, T. A. and Solvoll, G. (2008). Competitive tendering and structural changes: An example from the bus industry. *Transport Policy*, 15(1):1–11.

Nilsson, J.-E. (2011). Kollektivtrafik utan styrning. ESO Report 2011:6.

Schenker, N. and Gentleman, J. F. (2001). On judging the significance of differences by examining the overlap between confidence intervals. *The American Statistician*, 55(3):182–186.

The Swedish Bus and Coach Federation (2016). Statistik om Bussbranschen November 2016. Report (in swedish).

Transport Analysis (2014). En förbättrad kollektivtrafik? – utvärdering av två reformer. Report 2014:13.

Transport Analysis (2017). Local and regional public transport 2016. Retrieved from tables at `http://www.trafa.se/kollektivtrafik/kollektivtrafik/`.

Vigren, A. (2016). Cost efficiency in swedish public transport. *Research in Transportation Economics*, 59:123–132.

Williamson, O. E. (1976). Franchise bidding for natural monopolies-in general and with respect to CATV. *The Bell Journal of Economics*, 7:73–104.

Winkelmann, R. (2013). *Econometric analysis of count data*. Springer Science & Business Media.

Appendix A. Correlation matrix

	Number of bidders	VKM	ln(VKM)	LINES	MEDLINE	ln(MEDLINE)	POTENTIAL	SIMUL	POPDENS	ln(POPDENS)
Number of bidders	1.000									
VKM	-0.088	1.000								
ln(VKM)	0.035	0.710	1.000							
LINES	-0.113	0.819	0.631	1.000						
MEDLINE	-0.045	-0.168	-0.149	-0.140	1.000					
ln(MEDLINE)	0.014	-0.169	-0.137	-0.107	0.904	1.000				
POTENTIAL	0.169	0.037	0.191	0.034	0.073	0.100	1.000			
SIMUL	-0.296	0.195	0.229	0.111	0.005	-0.045	0.247	1.000		
POPDENS	0.077	0.525	0.382	0.271	-0.258	-0.278	0.036	0.258	1.000	
ln(POPDENS)	0.111	0.444	0.358	0.200	-0.223	-0.244	0.110	0.281	0.972	1.000
LENGTH	-0.129	0.290	0.409	0.257	-0.143	-0.207	-0.006	-0.010	0.079	0.036
COMB	0.087	-0.256	-0.310	-0.145	0.151	0.178	-0.109	-0.331	-0.213	-0.224
EMAT	0.212	0.194	0.273	0.090	-0.046	-0.076	-0.189	-0.240	0.154	0.111
INC.QUAL	0.199	0.052	0.215	-0.176	-0.133	-0.192	0.303	0.038	0.260	0.263
INC.PASS	0.025	0.366	0.551	0.163	-0.105	-0.157	0.153	0.192	0.335	0.319
REQFUEL	-0.016	0.257	0.294	0.094	-0.228	-0.285	0.092	0.133	0.210	0.236
DEPOT.OPT	-0.063	-0.023	0.078	-0.045	0.002	-0.059	-0.105	0.256	-0.059	-0.044
DEPOT.FORCE	-0.118	0.393	0.387	0.409	-0.125	-0.126	0.113	0.126	0.221	0.198
TAKEOVER	-0.040	0.442	0.395	0.309	-0.229	-0.252	0.026	0.162	0.322	0.284

	LENGTH	COMB	EMAT	INC.QUAL	INC.PASS	REQFUEL	DEPOT.OPT	DEPOT.FORCE	TAKEOVER
LENGTH	1.000								
COMB	-0.026	1.000							
EMAT	0.205	-0.113	1.000						
INC.QUAL	0.242	-0.049	0.351	1.000					
INC.PASS	0.412	-0.308	0.336	0.435	1.000				
REQFUEL	0.028	-0.339	0.113	0.256	0.253	1.000			
DEPOT.OPT	0.293	-0.230	0.226	0.026	0.173	-0.076	1.000		
DEPOT.FORCE	-0.033	-0.294	0.035	-0.157	0.075	0.237	-0.129	1.000	
TAKEOVER	0.065	-0.303	0.161	0.122	0.266	0.412	-0.022	0.373	1.000

Table A.6: Correlation matrix

Appendix B. Full results table for operator-restricting measures

	IV	IV.R.I	IV.R.II	IV.R.III	IV.R.IV	IV.R.ALL	IV.R.ALL	IV.R.ALL	IV.R.ALL
Production variables									
ln(VKM)	1.075**	1.080**	1.086**	1.086**	1.080**	1.087**	1.080**	1.098**	1.103**
	(0.025)	(0.025)	(0.027)	(0.027)	(0.026)	(0.027)	(0.023)	(0.029)	(0.027)
LINES	0.996	0.997	0.996	0.996	0.997	0.997	0.995*	0.993*	0.994**
	(0.003)	(0.003)	(0.003)	(0.003)	(0.003)	(0.003)	(0.003)	(0.003)	(0.002)
ln(MEDLINE)	0.972	0.954	0.963	0.964	0.962	0.947	0.972	0.959	0.947
	(0.045)	(0.041)	(0.043)	(0.044)	(0.039)	(0.037)	(0.038)	(0.035)	(0.033)
Operational environment									
POTENTIAL	1.005	1.006	1.006	1.005	1.005	1.006	1.010**	1.013**	1.012**
	(0.005)	(0.005)	(0.005)	(0.005)	(0.005)	(0.004)	(0.003)	(0.005)	(0.004)
SIMUL	0.962**	0.956**	0.965**	0.965**	0.959**	0.956**	0.955**	0.983**	0.982
	(0.006)	(0.007)	(0.007)	(0.007)	(0.004)	(0.007)	(0.012)	(0.006)	(0.021)
ln(POPDENS)	1.083	1.088	1.092	1.088	1.088	1.093	1.199**	1.203**	1.157*
	(0.047)	(0.050)	(0.047)	(0.048)	(0.048)	(0.051)	(0.058)	(0.069)	(0.069)
Contract characteristics									
EMAT	0.894**	0.916*	0.881**	0.896**	0.917*	0.929	1.054	0.881*	0.954
	(0.040)	(0.044)	(0.046)	(0.042)	(0.036)	(0.046)	(0.054)	(0.060)	(0.103)
COMB	0.931	0.926	0.917	0.914	0.920	0.912	0.966	0.928	0.902
	(0.061)	(0.055)	(0.066)	(0.064)	(0.061)	(0.058)	(0.041)	(0.041)	(0.063)
LENGTH	2.769**	2.583**	2.838**	2.857**	2.626**	2.563**	7.682**	4.174**	3.696**
	(0.121)	(0.111)	(0.125)	(0.134)	(0.110)	(0.107)	(0.183)	(0.226)	(0.225)
LENGTH × LENGTH	0.855**	0.867**	0.853**	0.851**	0.862**	0.867**	0.738**	0.821**	0.828**
	(0.020)	(0.018)	(0.022)	(0.022)	(0.019)	(0.017)	(0.028)	(0.041)	(0.034)
LENGTH × LENGTH × LENGTH	1.008**	1.007**	1.008**	1.008**	1.007**	1.007**	1.014**	1.009**	1.008**
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.002)	(0.002)
INC.PASS	0.896**	0.905*	0.896**	0.898**	0.910**	0.914**	0.953	0.989	0.978
	(0.035)	(0.039)	(0.035)	(0.035)	(0.029)	(0.032)	(0.054)	(0.055)	(0.061)
INC.QUAL	1.194*	1.174*	1.171*	1.165*	1.178*	1.153*	1.147*	1.204	1.148
	(0.079)	(0.073)	(0.071)	(0.071)	(0.074)	(0.069)	(0.054)	(0.102)	(0.072)
Special Requirements									
REQFUEL		0.881**				0.906	0.905	0.869*	0.937
		(0.043)				(0.052)	(0.089)	(0.070)	(0.082)
DEPOT.OPT			1.055						
			(0.074)						
DEPOT.FORCE			0.874**	0.871**		0.934	0.794**	0.915	0.780**
			(0.051)	(0.050)		(0.064)	(0.068)	(0.065)	(0.086)
TAKEOVER					0.879*	0.911	0.943	0.931	0.914
					(0.061)	(0.066)	(0.096)	(0.105)	(0.071)
Constant	0.056**	0.057**	0.052**	0.052**	0.063**	0.060**	0.007**	0.010**	0.038**
	(0.591)	(0.642)	(0.603)	(0.613)	(0.582)	(0.610)	(0.832)	(0.999)	(0.939)
County fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	No	Yes	No
Year fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	No	No	Yes
Joint sig.						0.770**	0.678**	0.740**	0.668**
						(0.066)	(0.148)	(0.139)	(0.086)
AIC	723.428	717.868	719.997	720.329	720.167	715.195	839.365	763.409	792.420
BIC	784.475	778.915	781.044	781.376	781.214	776.241	896.821	820.865	849.876
Observations	268	268	268	268	268	268	268	268	268

** $p < 0.01$, * $p < 0.05$.
Standard errors in paretheses are robust to within county clustering and heteroscedasticity

Table B.7: Full results table, special requirements

Appendix C. Test of Distributions

	OLS	POIS	T.POIS	GPOIS	T.GPOIS
Production variables					
ln(VKM)	1.346**	1.093**	1.109**	1.075**	1.075**
	(0.092)	(0.028)	(0.035)	(0.025)	(0.025)
LINES	0.984*	0.995*	0.994*	0.996	0.996
	(0.008)	(0.002)	(0.003)	(0.002)	(0.003)
ln(MEDLINE)	0.904	0.970	0.966	0.973	0.972
	(0.149)	(0.045)	(0.055)	(0.045)	(0.045)
Operational environment					
POTENTIAL	1.015	1.005	1.007	1.005	1.005
	(0.019)	(0.005)	(0.006)	(0.005)	(0.005)
SIMUL	0.889**	0.964**	0.957**	0.962**	0.962**
	(0.031)	(0.007)	(0.008)	(0.006)	(0.006)
ln(POPDENS)	1.321	1.084	1.095	1.082	1.083
	(0.148)	(0.042)	(0.050)	(0.046)	(0.047)
Contract characteristics					
EMAT	0.727	0.948	0.970	0.893**	0.894**
	(0.161)	(0.038)	(0.046)	(0.040)	(0.040)
COMB	0.834	0.946	0.935	0.931	0.931
	(0.271)	(0.066)	(0.074)	(0.061)	(0.061)
LENGTH	9.994**	2.805**	5.134**	2.703**	2.770**
	(0.411)	(0.151)	(0.258)	(0.118)	(0.121)
LENGTH × LENGTH	0.697**	0.853**	0.780**	0.858**	0.855**
	(0.064)	(0.022)	(0.036)	(0.020)	(0.020)
LENGTH × LENGTH × LENGTH	1.018**	1.008**	1.012**	1.007**	1.008**
	(0.004)	(0.001)	(0.002)	(0.001)	(0.001)
INC.PASS	0.723	0.899*	0.876*	0.897**	0.896**
	(0.178)	(0.050)	(0.059)	(0.034)	(0.035)
INC.QUAL	1.660	1.157	1.180	1.192*	1.194*
	(0.342)	(0.088)	(0.099)	(0.078)	(0.079)
Constant	0.000**	0.054**	0.009**	0.061**	0.056**
	(1.618)	(0.552)	(0.849)	(0.588)	(0.591)
County fixed effects	Yes	Yes	Yes	Yes	Yes
Year fixed effects	Yes	Yes	Yes	Yes	Yes
AIC	753.953	911.530	871.671	727.901	723.428
BIC	811.409	968.985	932.718	788.948	784.475
Observations	268	268	268	268	268
Converged		1	1	0	1

** $p < 0.01$, * $p < 0.05$.
Standard errors in paretheses are robust to within county clustering and heteroscedasticity

Table C.8: Results from the distribution tests

Appendix D. Sensitivity test on contract area size

	25 km	50 km	75 km	100 km	150 km	200 km
Production variables						
ln(VKM)	1.076**	1.075**	1.073**	1.076**	1.082**	1.079**
	(0.021)	(0.022)	(0.021)	(0.025)	(0.022)	(0.022)
LINES	0.996	0.996	0.995*	0.996	0.996	0.996
	(0.003)	(0.002)	(0.002)	(0.003)	(0.003)	(0.002)
ln(MEDLINE)	0.967	0.971	0.965	0.972	0.977	0.976
	(0.043)	(0.043)	(0.040)	(0.045)	(0.046)	(0.045)
Operational environment						
POTENTIAL	1.014**	1.010*	1.014**	1.005	1.002	1.003
	(0.005)	(0.005)	(0.005)	(0.005)	(0.004)	(0.003)
SIMUL	0.964**	0.962**	0.964**	0.962**	0.960**	0.960**
	(0.008)	(0.007)	(0.005)	(0.006)	(0.007)	(0.007)
ln(POPDENS)	1.045	1.065	1.069	1.083	1.081	1.087
	(0.046)	(0.043)	(0.043)	(0.046)	(0.049)	(0.053)
Contract characteristics						
EMAT	0.886**	0.895**	0.896**	0.893**	0.888**	0.884**
	(0.039)	(0.040)	(0.038)	(0.041)	(0.039)	(0.038)
COMB	0.931	0.934	0.922	0.931	0.930	0.928
	(0.060)	(0.061)	(0.061)	(0.061)	(0.057)	(0.057)
LENGTH	3.139**	2.998**	2.894**	2.776**	2.821**	2.821**
	(0.102)	(0.102)	(0.108)	(0.121)	(0.122)	(0.116)
LENGTH × LENGTH	0.838**	0.845**	0.851**	0.855**	0.852**	0.852**
	(0.017)	(0.018)	(0.018)	(0.020)	(0.021)	(0.020)
LENGTH × LENGTH × LENGTH	1.009**	1.008**	1.008**	1.008**	1.008**	1.008**
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
INC.PASS	0.894**	0.901**	0.896**	0.896**	0.894**	0.890**
	(0.034)	(0.034)	(0.033)	(0.035)	(0.033)	(0.031)
INC.QUAL	1.200*	1.195*	1.206*	1.194*	1.193*	1.203*
	(0.081)	(0.078)	(0.074)	(0.079)	(0.076)	(0.078)
Constant	0.057**	0.056**	0.062**	0.056**	0.050**	0.051**
	(0.512)	(0.525)	(0.583)	(0.592)	(0.534)	(0.534)
County fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Year fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
AIC	722.099	722.359	717.030	723.337	724.400	723.812
BIC	783.145	783.406	778.077	784.384	785.446	784.858
Observations	268	268	268	268	268	268

** $p < 0.01$, * $p < 0.05$.
Standard errors in paretheses are robust to within county clustering and heteroscedasticity

Table D.9: Results of varying the size of the contract area