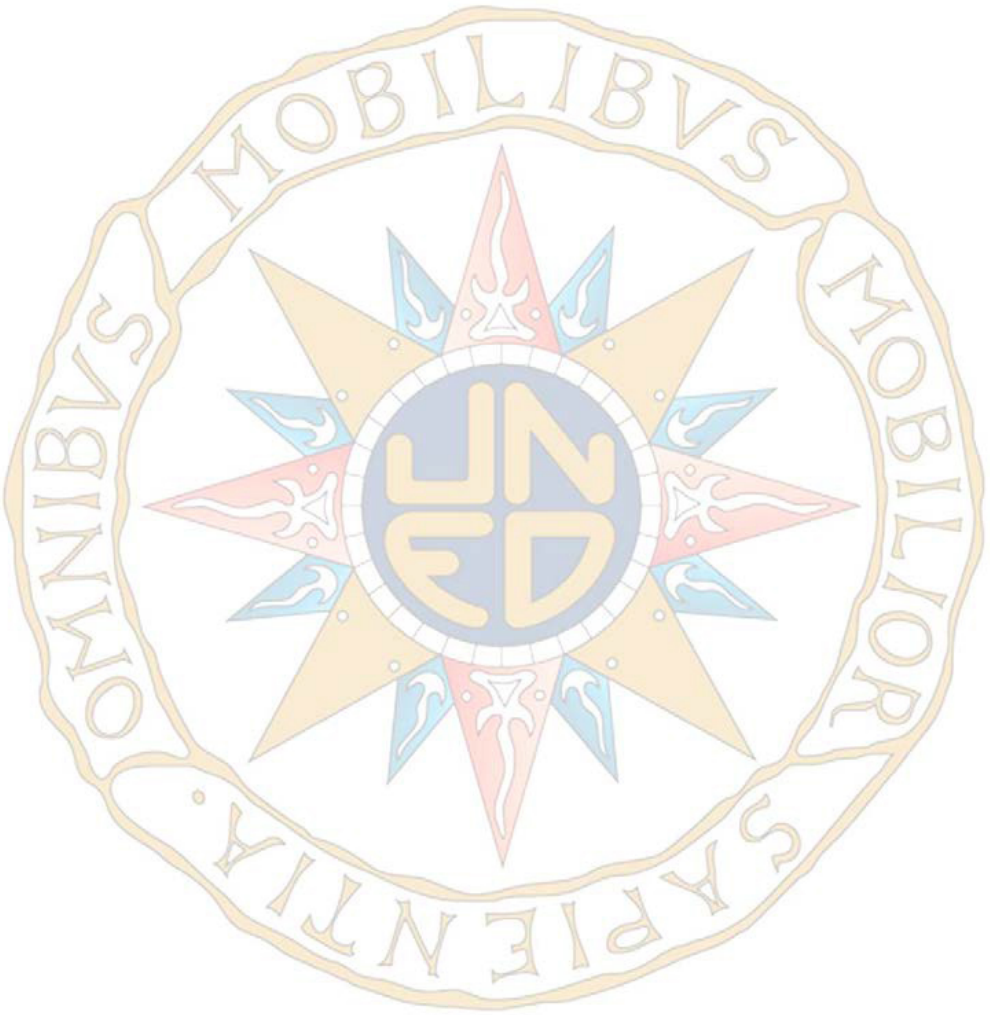
TESIS DOCTORAL
AÑO 2022



Competition effects in EU external aid. A case study for supply tenders

LUIS MARIO GARCÍA LAFUENTE

PROGRAMA DE DOCTORADO EN ECONOMÍA Y EMPRESA
Directora de Tesis: Asunción Mochón Sáez

Dedicado a mis padres, Luis & María Luisa.

AGRADECIMIENTOS

Quiero reconocer el inestimable apoyo que he recibido por parte de mi directora de tesis, la profesora Asunción Mochón, para la elaboración de este documento que culmina un trabajo de varios años de profundización en un campo de investigación apasionante.

También quiero hacer extensivo el reconocimiento a los profesores del Máster en Investigación en Economía de la UNED, quienes, sin duda, contribuyeron a la decisión de cursar el doctorado. Y, en particular, a quienes concibieron dicho máster, por la variedad de asignaturas optativas, que permiten encauzar la investigación a terrenos menos frecuentes del campo de la Economía.

Por último, quiero expresar también un enorme agradecimiento a tres revisores científicos que con sus críticas constructivas me ayudaron a perfilar el artículo que ha servido como aplicación práctica del trabajo de investigación desarrollado en esta tesis. Muy especialmente, a uno de los revisores de la revista Empirica, quien me ayudó a abrir los ojos sobre aspectos relevantes e innovadores de la investigación.

ACKNOWLEDGMENTS

I would like to acknowledge the invaluable support that I have received from my supervisor, Prof. Asunción Mochón, for the elaboration of this thesis that culminates the work of several years deepening in an exciting field of research.

I would also like to extend this gratitude to the college of professors of the UNED Master in Economic Research, who, no doubt, contributed to my decision to follow the PhD course. And, particularly, to those who conceived the said master course, with a variety of optional subjects allowing to focus the research on less frequent fields of Economy of high interest.

Finally, I want to express as well my acknowledgement to three referees, who helped me to profile better with their criticism the scientific article that became a practical application of the research work conducted in this thesis. This acknowledgement is very special for the Empirica's referee, who opened my eyes on relevant and innovative aspects of my research.

SINOPSIS

Esta investigación analiza empíricamente los efectos de la competencia en los costes de licitación de contratos de suministros financiados por la Agencia de Cooperación *Europe Aid* a los países beneficiarios de los instrumentos financieros de Asistencia para la Preadhesión (IPA) y de Vecindad (ENI). El volumen de los fondos de ayuda oficial al desarrollo, donde se encuadran estos instrumentos, excedió los 160 mil millones de dólares en 2020. Es por tanto un sector de enorme relevancia económica con externalidades positivas para el desarrollo de los países beneficiarios, aunque los estudios empíricos sobre él son muy limitados.
El propósito de la tesis es evaluar el funcionamiento del mecanismo de asignación de los contratos analizados, que se basa en una subasta a sobre cerrado de primer precio, y proponer sugerencias de mejora. Para ello, la investigación incluye datos de 220 procedimientos de licitación correspondientes a maquinaria, hardware y software, vehículos, material médico y químico, y mobiliario, publicados entre 2014 y 2017 en los países beneficiarios. Uno de los resultados relevantes de la investigación corresponde a la obtención del conjunto de datos a partir de las publicaciones de *Europe Aid*. El argumento más frecuente para los escasos trabajos empíricos en este sector es precisamente la ausencia de datos públicos.
En la investigación, estimo un precio de referencia para cada lote licitado basándome en el requerimiento de la autoridad contratante de establecer un aval bancario de participación en la licitación. Posteriormente, calculo una tasa de ahorro sobre el coste de los lotes licitados indexada a ese precio de referencia, y mido su evolución con el nivel de competencia, controlando la heterogeneidad de este mercado. Dicha tasa indica un ahorro limitado debido a un nivel bajo de competencia en las licitaciones. Propongo mejoras en el mecanismo de asignación a través de diseños con puja dinámica de subasta inglesa, que estimulan la competencia revelando información sobre la valoración del lote, y del establecimiento de reglas de acceso más flexibles al procedimiento de licitación.

Palabras Clave: Subasta de Adquisición - Efectos de la Competencia - Señalización de Precio - Ayuda Oficial al Desarrollo

Clasificación JEL: D44 - D82 - F35 - H57

Aspectos relevantes de esta tesis aparecen publicados en la revista Empirica, en el artículo titulado: *Competition effects in EU external aid supply tenders funded with the Pre-accession and Neighbourhood instruments*. DOI:10.1007/s10663-021-09518-5, de Luis Mario García Lafuente y Asunción Mochón Sáez, en agosto de 2021.

La tesis está organizada en tres partes:
La parte I contiene un resumen completo en español y en inglés.
La parte II incluye el cuerpo central de la tesis, estructurado en 8 capítulos.
La parte III es un Apéndice con 4 anexos.

ABSTRACT

This research analyzes empirically the competition effects on procurement costs for Europe Aid funded supply tenders in countries benefiting from the EU Pre-accession Assistance (IPA) and Neighbourhood (ENI) financial instruments. The volume of official development assistance funds, where these instruments are framed, exceeded USD 160 billion in 2020. Thus, this a sector of high economic relevance with positive externalities for the development of beneficiary countries, although the empirical studies on it are limited.
The ultimate aim of the thesis is to assess the performance of the allocation mechanism of the tenders, which is based on a sealed-bid first-price reverse auction, and to propose suggestions for improvement. For this purpose, the research includes data from 220 supply tendering procedures regarding machinery, hardware and software, vehicles, medical and chemical products, and furniture, published between 2014 and 2017 in the beneficiary countries. One of the relevant results of the research corresponds to the dataset creation from Europe Aid publications. The most frequent argument for the few empirical works in this sector is precisely the absence of public data.
In the research, I estimate a reference price for each procured lot based on the contracting authority's requirement to establish a participation tender guarantee. Subsequently, I calculate a savings rate for the cost of the procured goods, indexed to that reference price, and I measure the evolution with the level of competition, controlling for the heterogeneity of the market. The said rate indicates limited savings owing to a low level of competition in the tenders. I propose improvements in the allocation mechanism for these contracts through dynamic bidding designs of English auction, which stimulate competition by revealing information on the lot valuation, and through the establishment of more flexible access rules to the tendering procedure.

Keywords: Procurement Auction - Competition Effects - Price Signaling - Official Development Assistance

JEL classification D44 - D82 - F35 - H57

Relevant aspects of this research have been published in Empirica, in the article entitled: *Competition effects in EU external aid supply tenders funded with the Pre-accession and Neighbourhood instruments*. DOI:10.1007/s10663-021-09518-5, by Luis Mario García Lafuente and Asunción Mochón Sáez, in August 2021.

The thesis is organized in three parts:
Part I contains a comprehensive summary in Spanish and English.
Part II includes the full body of the thesis structured in 8 chapters.
Part III is an Appendix with 4 annexes.

CONTENTS

LIST OF FIGURES

LIST OF TABLES

ACRONYMS

2SLS Two Stage Least Squares
(Mínimos Cuadrados en Dos Etapas)

AVP Affiliated Value Paradigm
(Paradigma del Valor Afiliado)

CPV Common Procurement Vocabulary
(Vocabulario Común de Contratación Pública)

CVP Common Value Paradigm
(Paradigma del Valor Común)

DAC Development Assistance Code
(Código de Ayuda al Desarrollo)

DTF Distance to Frontier Index
(Índice de Distancia a Frontera)

EC European Commission
(Comisión Europea, CE)

ENI European Neighbourhood Instrument
(Instrumento Europeo de Vecindad)

EU European Union
(Unión Europea, UE)

EULEX European Union Rule of Law Mission in Kosovo
(Misión Europea para el Estado de Derecho en Kosovo)

FOB Free on Board
(Franco a Bordo)

GDP Gross Domestic Product
(Producto Interior Bruto, PIB)

GMM Generalized Method of Moments
(Método Generalizado de los Momentos)

IPA Instrument for Pre-accession Assistance
(Instrumento de Ayuda a la Preadhesión)

IPVP Independent Private Value Paradigm
(Paradigma del Valor Independiente Privado)

IV Instrumental Variable
(Variable Instrumental)

NDICI Neighbourhood, Development and International Cooperation Instrument
(Instrumento de Vecindad, Desarrollo y Cooperación Internacional)

ODA Official Development Aid
(Ayuda Oficial al Desarollo)

OECD Organization for Economic Co-operation and Development
(Organización para la Cooperación y el Desarrollo Económicos, OCDE)

OLS Ordinary Least Squares
(Mínimos Cuadrados Ordinarios)

PRAG Practical Guide on EU External Action Contract Procedures
(Guía Práctica para los Procedimientos Contractuales de la Acción Exterior de la UE)

RET Revenue Equivalence Theorem
(Teorema de Equivalencia de Ingresos)

USD United States Dollar
(Dólares Estadounidenses)

WB World Bank
(Banco Mundial)

IADB Inter-American Development Bank
(Banco Interamericano, BID)

EBRD European Bank for Reconstruction and Development
(Banco Europeo de Reconstrucción y Desarrollo, BERD)

JICA Japan International Cooperation Agency
(Agencia Japonesa de Cooperación Internacional)

UNDP United Nations Development Programme
(Programa de las Naciones Unidas para el Desarrollo)

UN United Nations
(Naciones Unidas)

Part I

RESUMEN / SUMMARY

Esta primera parte de la tesis incluye un resumen de la investigación, organizado de la siguiente manera.

En primer lugar, presento una breve motivación en la sección R.1, donde describo la envergadura y relevancia del mercado económico derivado de la ayuda oficial al desarrollo y, en particular, de la financiada por la Unión Europea. Explico también el mecanismo de asignación utilizado: la licitación pública internacional, que es una aplicación de la subasta de adquisición.

Posteriormente, en la sección R.2 delimito el ámbito geográfico y los bienes comercializados en el contexto de la investigación y defino los objetivos de la tesis. Éstos están orientados inicialmente a evaluar el nivel de competencia de este mercado y el ahorro que proporciona el mecanismo de adquisición utilizado; el propósito final es elaborar potenciales mejoras en el diseño de tal mecanismo para lograr una asignación más eficiente y un mayor ahorro de gasto público.

La sección R.3 sintetiza algunos conceptos teóricos fundamentales que utilizo, a continuación, en la sección R.4, donde describo la metodología aplicada para la obtención de las conclusiones finales, con cuatro hitos o fases intermedias diferenciadas: la obtención del conjunto de datos, la transformación de los datos en variables de estudio, la especificación de modelos compatibles con los conceptos teóricos y, finalmente, la estimación empírica de los modelos, identificando los que tienen mejor ajuste econométrico.

En la sección R.5 presento los resultados empíricos, que se basan en tres modelos consistentes complementarios. Éstos determinan de manera robusta una tasa de ahorro promedio para las licitaciones analizadas.

Por último, en la sección R.6 extraigo las conclusiones más relevantes de la investigación, en particular la posibilidad de obtener una tasa de ahorro más elevada fomentando una mayor competencia en el procedimiento de licitación, y recomiendo para ese fin la introducción de mejoras potenciales en el mecanismo de adquisición, incluyendo aspectos dinámicos de puja y estableciendo reglas de acceso que favorezcan un mayor número de licitadores incumbentes, en especial proveedores locales y pequeñas empresas.

This first part of the thesis includes a summary of the research, organized as follows.

In the first place, I present a brief motivation in section S.1, where I describe the relevance and magnitude of the economic market originated from the official development assistance and, particularly, the assistance funded by the European Union. I explain the allocation mechanism as well: the international tender, which is one of the applications of the procurement auction mechanism.

Subsequently, in section S.2, I establish the geographic scope and the goods exchanged in the context of the research, and I define the objectives of this thesis. They are oriented initially to estimate the level of competition in this market and the savings introduced by the allocation mechanism; the ultimate purpose is to elaborate potential improvements in the mechanism design in order to achieve a more efficient allocation and higher savings of public funds.

Section S.3 synthesizes some of the theoretical fundamental concepts that I then use in section S.4, where I describe the research methodology to obtain the final conclusions, with four milestones, or intermediate phases: dataset creation, data transformation into the relevant variables for the research, specification of compatible models with the theoretical concepts and, finally, empirical estimation of the models, identifying those ones with the best goodness of fit.

In section S.5 I present the empirical results, which are based on three complementary consistent models. These models determine with robustness an average savings rate for the analyzed tenders.

Finally, in section S.6 I draw the most relevant conclusions of the research, in particular the possibility to obtain a higher savings rate by promoting competition in the tender procedure, and I recommend to that end introducing potential improvements in the allocation mechanism, by including bidding dynamic features and establishing access rules favoring a higher number of incumbent bidders, specially local providers and small enterprises.

R

RESUMEN, RESULTADOS Y CONCLUSIONES DE LA INVESTIGACIÓN

R.1 MOTIVACIÓN

La subasta de adquisición es un mecanismo extendido de asignación de mercados públicos con una gran relevancia en el comercio internacional. En particular, la subasta de adquisición es el mecanismo dominante utilizado en la gestión de la ayuda oficial al desarrollo (ODA, en inglés[1]). El volumen de los fondos ODA destinados a los países en desarrollo por los países miembros del Comité de Ayuda al Desarrollo de la OECD excedió los 160 mil millones de dólares estadounidenses en 2020. En términos reales esta cifra se incrementó en un 3.5% respecto al año 2019 y alcanzó el mayor nivel de financiación jamás alcanzado (OECD, 2021a).

Una parte significativa de estos fondos proviene de las instituciones de la Unión Europea. La Acción Externa de la Unión Europea viene de aprobar en 2021 la base legal para sus nuevos instrumentos financieros ODA. Estos incluyen: la tercera fase del Instrumento de Ayuda a la Preadhesión (IPA) y el nuevo Instrumento de Vecindad, Desarrollo y Cooperación Internacional - Europa Global (NDICI). IPA III está dotado con un presupuesto de más de 14 mil millones de EUR y NDICI con más de 79 mil millones de EUR. Estos instrumentos suponen la mayor parte de la Acción Externa de la UE y, en combinación con el instrumento de Ayuda Humanitaria y otros instrumentos específicos de menor envergadura, hacen que su asignación supere más de los 100 mil millones de EUR en el periodo 2021-2027. Este montante supone un incremento substancial en relación con el presupuesto para el periodo 2014-2020.

Una de las características de la ayuda al desarrollo de las instituciones de la Unión Europea es la modalidad de apoyo presupuestario no reembolsable que aplica en la mayoría de sus instrumentos financieros. De hecho, la UE se convirtió en el mayor donante mundial de ODA en esta modalidad de financiación en el periodo 2014-2020 (OECD, 2018).

Dos de los instrumentos financieros de la Unión Europea de mayor relevancia en ODA bajo la modalidad de apoyo presupuestario no reembolsable durante el periodo 2014-2020 fueron la segunda fase del instrumento IPA, y el Instrumento de Vecindad, ENI. Ambos instrumentos beneficiaron a países geográficamente muy próximos a la Unión Europea, o a países fronterizos. Por lo tanto, estos países constituyen una prioridad estratégica para las políticas de cooperación europeas. Los instrumentos de apoyo presupuestario no reembolsable tienen una larga trayectoria en la ayuda al desarrollo de la Unión Europea para estos países.

1 Los acrónimos que aparecen en esta tesis están recogidos en una lista ordenada alfabéticamente al final de la sección de contenidos, incluyendo su definición en inglés y en español.

La figura R.1 representa la situación geográfica y el nombre de los países beneficiarios de los instrumentos IPA y ENI, que son objeto de la investigación en esta tesis. Su denominación y estatus corresponde a la situación vigente en el periodo que abarca la investigación, 2014-2020[2].

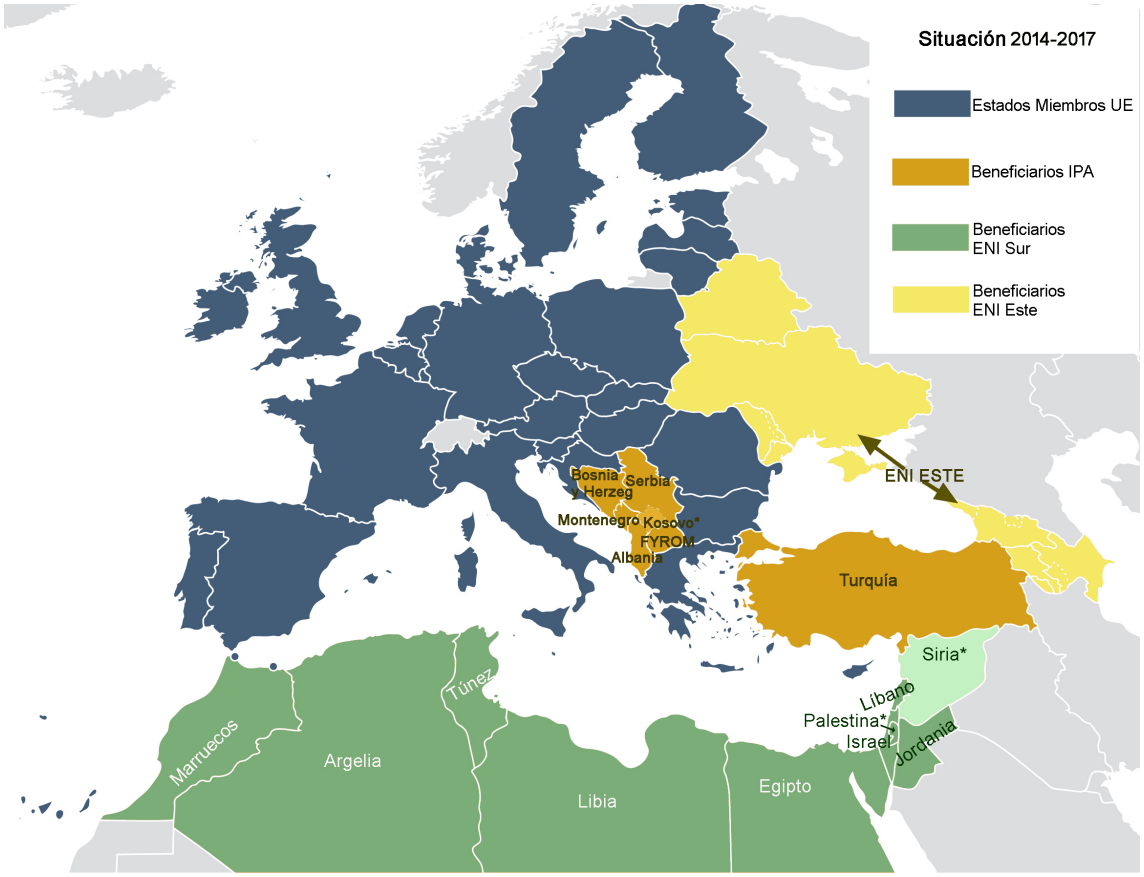


Figura R.1: Representación geográfica de los países beneficiarios de los instrumentos financieros IPA y ENI de la Unión Europea. Situación 2014-2017

A pesar de la relevancia económica, y del valor instrumental de estos fondos para el desarrollo del comercio local y la mejora de la gobernanza, el número de estudios empíricos desarrollados para estimar el coste de los productos y servicios suministrados por la ayuda oficial al desarrollo a los países beneficiarios es muy limitado. El argumento más frecuente en la literatura es la ausencia de datos públicos en los procesos de licitación de países en desarrollo. Otros autores mencionan argumentos que pueden estar relacionados con aspectos sensibles de la ODA, de carácter político (Iimi, 2006). Datos limitados e implicación política de la financiación de la UE aparecen también en las consideraciones de otros estudios empíricos, por ejemplo (Tsanana and Katrakilidis, 2014), quien investiga sobre la convergencia de ingresos de ciertos países beneficiarios de estos fondos con los países de la UE.

2 Los países cuyo nombre aparece con un asterisco son territorios con estatus excepcional. Kosovo de acuerdo con la resolución 1244 del Consejo de Seguridad de Naciones Unidas, y Palestina de acuerdo con la resolución 67/19 de la Asamblea General de Naciones Unidas. La participación de Siria en el instrumento ENI fue suspendida a partir de 2011, a causa del conflicto bélico interior.

Además del valor añadido de estos bienes para el desarrollo de los países beneficiarios, su adquisición a un precio competitivo contribuye a optimizar el despliegue de sus propios recursos y a lograr un uso eficiente de los fondos asignados por los donantes europeos.

R.2 OBJETIVOS

El objetivo inicial de esta tesis es estimar el efecto de la competencia en los costes de adquisición dentro de un mercado multilateral de distintos bienes. A partir de la consecución de ese objetivo, el propósito principal es determinar hasta qué punto el mecanismo de asignación proporciona un precio adecuado a la autoridad de contratación pública que adquiere los bienes, y qué medidas serían necesarias para obtener una asignación más eficiente y un mayor ahorro de los fondos públicos que financian la adquisición.

Los bienes se suministran a países beneficiarios de los fondos de los instrumentos de Preadhesión (IPA) y de Vecindad (ENI) de la Agencia de Cooperación Europea, *Europe Aid*, después de concluir un procedimiento de licitación pública abierta a la participación internacional. Estos instrumentos financieros de ayuda al desarrollo han estado vigentes durante un largo periodo, y forman parte de la Acción Externa de la UE actualmente; el IPA lo hace como instrumento independiente y el ENI como parte de los programas geográficos del NDICI. La tesis incluye una visión general de ellos en las secciones 1.1.2 y 1.1.3.

Los bienes que se adquieren con mayor frecuencia en estas licitaciones de suministro son equipo tecnológico y maquinaria para distintas industrias. En la investigación se han considerado cinco categorías específicas de bienes para agrupar toda la variedad de productos licitados. Además de las dos categorías mencionadas, vehículos, material médico y de laboratorio, y mobiliario completan este mercado.

Para cumplir el propósito de la tesis, he necesitado establecer cuatro hitos sucesivos relacionados con los retos principales de la investigación.

1. Obtener el conjunto de datos y definir a partir de ellos aquellas variables relevantes para la investigación.

2. Especificar los modelos empíricos de la investigación utilizando conceptos de teoría de subastas bien establecidos aplicados al procedimiento de licitación internacional.

3. Estimar los modelos empíricos especificados de manera consistente con respecto a las características del conjunto de datos, utilizando métodos econométricos adecuados.

4. Identificar posibles mejoras del diseño del mecanismo de licitación de *Europe Aid*, utilizando predicciones de teoría de subastas aplicadas a los resultados empíricos de la investigación.

R.3 MARCO TEÓRICO

En esta tesis, las licitaciones de suministros de *Europe Aid* se han modelado como un tipo de subasta inversa. La autoridad contratante (el comprador, en lo sucesivo) demanda abiertamente un producto. Un conjunto de licitadores (los vendedores) presentan sus ofertas económicas de manera privada (subasta de *sobre cerrado*) siguiendo cada uno su estrategia de puja. El licitador con la puja de menor precio resulta adjudicatario y vende su producto al comprador por ese precio (subasta de *primer precio*).

En el contexto de este modelo de subasta, he considerado que los licitadores no cooperan entre sí. Esto significa que descarto comportamientos colusorios. Además, he considerado que el mercado de las licitaciones de suministros de *Europe Aid* se encuentra en equilibrio, y que los licitadores se comportan con una estrategia de maximización de beneficios. Esto implica que asumo un comportamiento racional de los licitadores neutral ante el riesgo.

Con las hipótesis descritas en el párrafo anterior, la investigación ha utilizado conceptos bien establecidos de la teoría de subastas de adquisición, que influyen en el efecto de la competencia sobre el precio de los bienes adquiridos. Entre otros conceptos se incluyen:

1. La influencia del paradigma de coste que utilizan los licitadores para formar sus pujas.
2. La influencia de la información revelada en el procedimiento de licitación.
3. La influencia de la asimetría de los licitadores.

En este resumen, me limito a describir aspectos generales básicos de los conceptos mencionados, estrictamente relevantes para la investigación. Estos conceptos se desarrollan en el capítulo 2 de la tesis con detalles y consideraciones más específicas del estado del arte.

R.3.1 *Influencia del paradigma de coste*

De acuerdo con la teoría de subastas, el efecto de la competencia en el precio del bien adquirido está directamente relacionado con la estimación del valor de su coste (Paarsch, 1992).

Cuando el coste tiene la misma valoración para todos los licitadores (Paradigma del Valor Común, CVP), aunque este valor no sea conocido, existe un límite al efecto de la competencia sobre el precio. Es decir, a partir de un cierto número de licitadores, el efecto de la entrada de nuevos licitadores sobre el precio de adjudicación no varía significativamente. Esta aversión a pujar por debajo de un cierto precio, en contextos de información incompleta, se conoce como la propensión a evitar *la maldición del ganador* de la subasta.

Cuando el valor del coste del bien es privado para cada licitador (Paradigma del Valor Privado Independiente, IPVP), el efecto de la competencia sobre la

reducción del precio de adjudicación se acentúa con la entrada de cada nuevo licitador. Es decir, el precio de adjudicación se ve reducido de manera continuada.

Finalmente, cuando se considera que el coste se deriva de una valoración con un paradigma más amplio (Paradigma del Valor Afiliado, AVP), el efecto es tal que los casos CVP e IPVP son los dos casos especiales extremos. Es decir, podemos esperar un efecto intermedio entre ambos más complejo de interpretar (Pinkse and Tan, 2005).

En el contexto de las licitaciones de la investigación no asumo ninguna restricción sobre el paradigma de coste subyacente. La razón es que los expedientes de licitación públicos no revelan los datos de todos los licitadores y de sus pujas, sino la del adjudicatario únicamente. Por ello, he seguido un enfoque comparativo de modelos que responden a la solución de la puja de equilibrio para todos los diferentes tipos de paradigma de coste que se pueden presentar. De esta manera, las conclusiones comunes para todos los modelos son robustas e independientes del paradigma de coste subyacente, aunque éste sea desconocido *a priori*.

Este enfoque comparativo, además, permite sacar conclusiones adicionales razonando a la inversa. Es decir, en función de la bondad de ajuste de los modelos empíricos seleccionados podemos inferir a partir de qué nivel de competencia la influencia del paradigma de coste es más relevante, y encontrar explicaciones razonables del paradigma más probable utilizando argumentos económicos.

R.3.2 *Influencia de la información revelada*

Bajo una serie de consideraciones bastante generales, la revelación de información sobre el precio del bien por parte del comprador, en el tipo de subasta considerado en este estudio, incrementa la participación y, por tanto, el nivel de competencia (Milgrom and Weber, 1982b). Siempre que el paradigma de coste no sea un CVP puro, el efecto de la información revelada será, pues, una reducción del precio de adquisición del lote con respecto a un contexto sin señal de precio. La reducción del precio de adquisición viene motivada por el incremento en el nivel de competencia que induce la señal del comprador.

En las licitaciones de la investigación, el comprador revela indirectamente parte de la información sobre el precio esperado del bien, o precio de referencia, a través de la cuantía de un aval bancario de participación, que es exigido en la mayor parte de los procedimientos de licitación. La utilización de esa señal de precio en los modelos empíricos es uno de los aspectos innovadores de esta tesis. Dicha señal fija también límites al precio de reserva del comprador, es decir, el precio máximo que puede pagar de acuerdo con el presupuesto asignado por el instrumento financiero que sufraga la adquisición, que es una información privada.

Los resultados empíricos obtenidos para el conjunto de datos de la investigación se corresponden con la predicción de la teoría porque, utilizando esa señal de precio de manera homogénea para todas las licitaciones, observamos una tendencia de reducción del precio de adquisición con la entrada de nuevos licitadores respecto al precio de referencia.

R.3.3 *Influencia de la asimetría de los licitadores*

Cuando la tipología de los licitadores es tal que hay grandes diferencias entre ellos, las estrategias de valoración del coste generalmente difieren por la asimetría entre los distintos tipos. En el contexto de las licitaciones de suministro de *Europe Aid*, el origen internacional de los licitadores, su tamaño y la posibilidad de participar formando parte de un consorcio son razones para que se produzca esta asimetría. En estas condiciones, la solución de equilibrio de mercado no tiene una forma cerrada (Campo et al., 2003). Es decir, no contamos con un modelo teórico estructural identificado de antemano, sino que tenemos que utilizar modelos empíricos más flexibles que nos permitan sacar conclusiones para el contexto específico de nuestra investigación.

Este aspecto está interrelacionado con el paradigma de coste, y complica su interpretación. La posibilidad de que haya grupos asimétricos de licitadores respondiendo a paradigmas diferentes de coste apoya el enfoque comparativo de la investigación. El análisis conjunto de los modelos estadísticamente consistentes obtenidos en la investigación permite obtener interpretaciones coherentes con fundamento económico sobre estas posibles asimetrías.

R.4 METODOLOGÍA

En esta sección presento las etapas con las que he abordado los objetivos de la investigación hasta obtener las conclusiones. La figura R.2 sintetiza todo el proceso metodológico de la investigación.

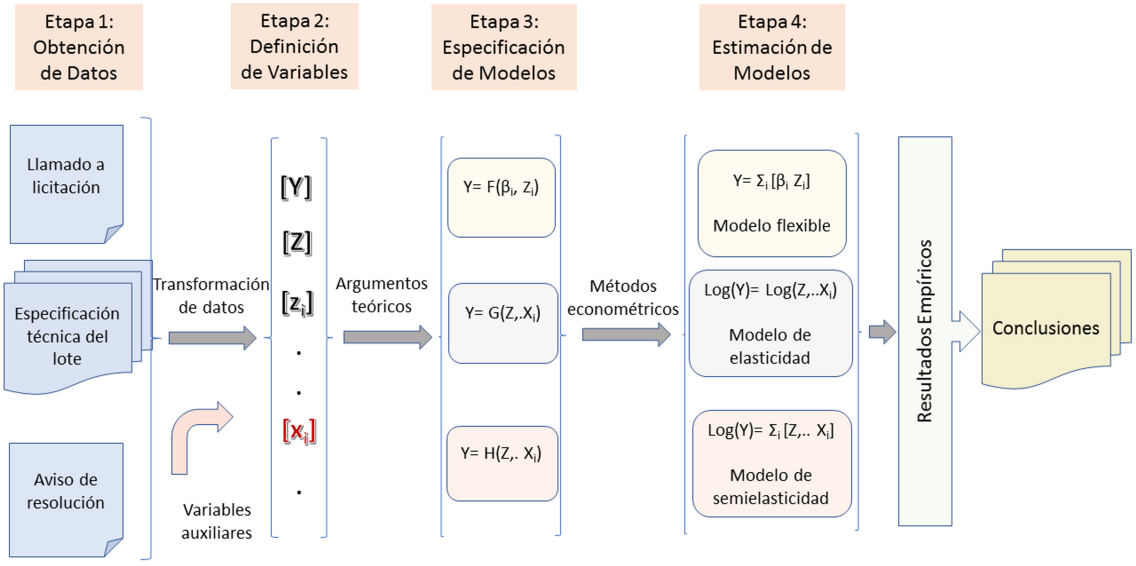


Figura R.2: Representación gráfica del proceso metodológico de la investigación.

Las secciones R.4.1, sobre la obtención de los datos; R.4.2, sobre la definición de las variables; R.4.3, sobre la especificación de los modelos; y R.4.4, sobre la

estimación de los modelos seleccionados, describen las cuatro primeras etapas, y se desarrollan en los capítulos 4, 5 y 6 de esta tesis.

Los resultados empíricos y las conclusiones se describen específicamente en las secciones R.5 y R.6 que completan este resumen, y se amplían en los capítulos 7 y 8 de la tesis.

R.4.1 *Obtención del conjunto de datos*

El conjunto de datos se creó a partir de las publicaciones realizadas por *Europe Aid*[3]. El proceso de obtención y registro de datos implicó consultar y clasificar toda la información relevante procedente de 220 expedientes de licitación de suministros de distintos bienes, publicados entre 2014 y 2017, y recogidos en el anexo B del Apéndice.

Los expedientes de licitación constan típicamente de dos documentos principales: el *llamado a licitación*, cuyo formato oficial se presenta en anexo en la sección A.1 del Apéndice, y la *resolución de la licitación*, que se presenta también en el Apéndice, en las secciones A.2 y A.3.

El llamado a licitación incluye entre otros detalles generales: el título del contrato financiado por *Europe Aid*, la región y el país o países donde se ejecutará el contrato, un código de referencia de seis dígitos unívoco para el contrato, la línea presupuestaria del programa o instrumento financiero a la que se adscribe el contrato y el nombre de la autoridad de contratación.

Las licitaciones de la investigación fueron financiadas con los instrumentos financieros de: Vecindad (ENI), con procedimientos de licitación en Marruecos, Egipto, Túnez, Jordania, Líbano y Argelia; y Preadhesión a la UE (IPA), con procedimientos de licitación en Albania, Bosnia, FYROM (Antigua República Yugoslava de Macedonia, actualmente Macedonia del Norte[4]), Serbia, Montenegro y Turquía. Además, en los datos se incluye Kosovo, bajo su estatus según la resolución 1244 del Consejo de Seguridad de Naciones Unidas[5] como un mercado geográfico singular, debido al hecho de que Kosovo se benefició tanto de los fondos IPA como de los fondos del instrumento EULEX.

A continuación, el llamado a licitación incluye las especificaciones del contrato, en particular: la descripción del objeto del contrato (es decir, los bienes a suministrar), y el número y título de cada lote que será licitado. Los expedientes de licitación de la investigación incluyen uno o varios lotes. En general, los lotes se adjudican de manera simultánea. Cada lote produce una observación independiente en el conjunto de datos, porque corresponde a un bien indivisible específico adjudicado a un precio independiente del precio del resto de lotes.

3 Accedí a dichas publicaciones desde finales del año 2017 hasta comienzos del año 2019 a través de esta página web: https://ec.europa.eu/europeaid/home_en

4 Se incluye el término FYROM por razones de consistencia con la denominación existente en el periodo que abarcan los datos.

5 En la tesis, cualquier mención a Kosovo debe ser interpretada en relación con el referido estatus de Naciones Unidas.

La muestra consta de 587 observaciones. La mayoría de los bienes licitados en la investigación son equipamiento y maquinaria para diferentes industrias (alrededor del 35% del total). Hardware y Software es también una categoría dominante de los bienes de la muestra (alrededor de 29 % del total). El resto de los bienes son diferentes clases de vehículos, materiales químicos y médicos, y mobiliario.

La figura R.3 representa la proporción de lotes licitados para cada categoría de productos recogidos en el conjunto de datos. Cada categoría constituye una variable en la especificación de los modelos tal como se describe en la sección R.4.2.

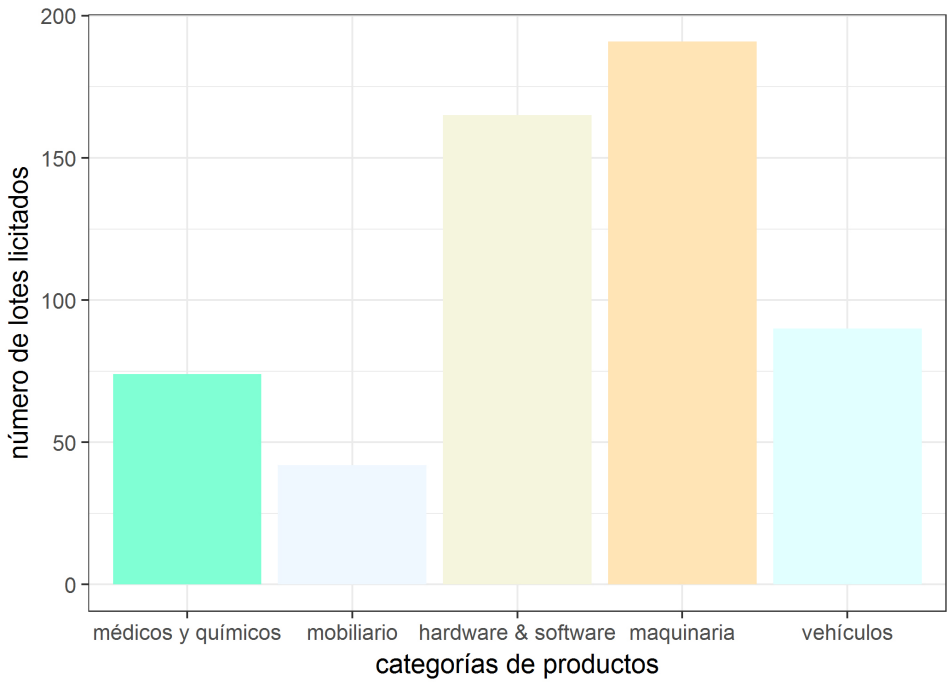


Figura R.3: Distribución del número de lotes por categoría de productos para todos los lotes donde la resolución indica el número de participantes en la licitación.

Posteriormente, el llamado especifica los términos de participación, que incluyen entre otros: las reglas de elegibilidad y origen de los licitadores y los bienes, los motivos de exclusión, la cuantía del aval bancario de participación (si se requiere), la cuantía del aval bancario de ejecución (si se requiere), el periodo de validez de la oferta o puja presentada, y el periodo de ejecución del contrato. El conjunto de datos de la investigación incluye 457 lotes en los que el comprador requirió un aval bancario para acceder a la licitación, y 130 lotes en que tal aval no fue requerido.

La siguiente sección del llamado a licitación incluye los criterios de selección y adjudicación. Los criterios de selección se basan en: la capacidad económica y financiera del licitador; la capacidad profesional del licitador; y la capacidad técnica del licitador. El criterio de adjudicación para los procedimientos de licitación de la investigación es el criterio de mejor precio.

Finalmente, el llamado establece las instrucciones de puja, en particular: cómo obtener el expediente de licitación, la fecha límite de puja, la fecha y el lugar de la sesión de apertura de pujas, el idioma del procedimiento de licitación, y la base legal que regula dicho procedimiento.

La resolución de la licitación incluye detalles comunes al llamado a licitación como: el título del contrato, la región y país o países donde se ejecutará el contrato, el código de referencia, la autoridad de contratación y la base legal. Además, incluye la información específica sobre la resolución, en particular: el tipo de procedimiento; el número y el título de lote adjudicado; el número asignado al contrato y el valor de dicho contrato; la fecha de adjudicación; el número de ofertas recibidas; el nombre, la dirección y la nacionalidad del adjudicatario; la duración del contrato; y el código DAC del lote licitado (si aplica).

Algunos lotes se adjudican una vez transcurridos varios meses después de la publicación del llamado a licitación inicial, y la publicación de la resolución oficial lleva también un cierto tiempo. Por ello, la investigación utiliza la fecha del 31/05/2018 como fecha de corte para recopilar los datos de los expedientes de licitación publicados por *Europe Aid*[6].

En la muestra hay 479 lotes adjudicados con un precio especificado, que es público, y 108 procedimientos desiertos.

Varios lotes desiertos tras la licitación han originado procedimientos relanzados dentro del período de selección de la muestra. En estos casos, el conjunto de datos incluye dos registros diferentes: el primero incluye el lote desierto inicial (un registro con cero pujas). El segundo registro incluye los datos de la adjudicación del lote relanzado[7]. Cuando el procedimiento resulta desierto y el lote es cancelado, la muestra incluye solamente un registro con cero pujas.

Hay un número reducido de 25 licitaciones en las cuales el número de licitadores incluido en la resolución es el número global de licitadores para todos los lotes adjudicados del mismo procedimiento.

En la estimación de los modelos empíricos de la investigación descarto aquellos registros donde no se puede averiguar el número real de licitadores que compiten por cada lote individual. Además, utilizo solamente aquellos registros donde la autoridad de contratación establece la constitución de un aval bancario como requisito para participar en la licitación, pues esta información permite estimar un precio de referencia del bien que desea adquirir. El precio de reserva real del comprador no es público y, por tanto, sin estimar un precio de referencia, no se podría llevar a cabo la investigación.

6 Esta fecha límite se ha tomado teniendo en consideración el período medio de 7 a 8 meses del procedimiento completo estimado en la normativa de *Europe Aid*.

7 El lote licitado en el procedimiento relanzado puede cambiar sus especificaciones. Por ejemplo, las cantidades del bien, sus características o la cantidad del aval de participación. Por lo tanto, es razonable mantener dos registros diferentes en la muestra, porque son estrictamente dos licitaciones diferentes.

R.4.2 *Descripción de las variables principales*

La variable dependiente de los modelos es una variable compuesta, que está estrictamente asociada a aquellos lotes que han sido adjudicados. La defino de la manera siguiente:

• *Coste de la licitación normalizado*. Esta variable la he nombrado *indpago* en los modelos especificados en la investigación, y representa la razón entre el precio de adjudicación de cada lote, P^*, que identifico con coste de la licitación, y el precio de referencia del lote, *Pref*.

$$indpago_k = P_k^*/Pref_k \qquad k = 1, 2, ..., K \tag{R.1}$$

donde *k* representa cada uno de los *K* lotes adjudicados incluidos en el conjunto de datos de la investigación que requirieron la aportación de un aval bancario para participar en la licitación.

Tal como indico en la sección R.3.2, el precio de reserva del comprador es privado y, por tanto, es preciso estimar un precio de referencia. Las reglas del procedimiento de licitación bajo estudio establecen que el aval bancario debe tener una cuantía de entre el 1% y el 2% del valor máximo estimado del contrato, siguiendo un estudio de mercado[8]. Por lo tanto, podemos inferir el precio de referencia, P_{ref}, a partir de la señal proporcionada por el aval bancario.

Este precio de referencia puede ser calculado por todos los licitadores de acuerdo con sus propios criterios, y puede ser considerado como un indicador del valor común del lote, si dicho valor común existiera. En la investigación he calculado el precio de referencia con la ecuación (R.2), utilizando el valor medio entre los dos umbrales por razones de simetría.

$$P_{ref} = A/0.015 \tag{R.2}$$

Donde *A* es la cuantía del aval bancario.

En la sección 4.2.5 profundizo en los conceptos de precio de reserva y precio de referencia, y justifico la elección del precio de referencia calculado con la ecuación (R.2). También detallo en la sección 8.2.2 los aspectos innovadores de este enfoque metodológico y la relevancia de su aplicación para el objetivo de la investigación.

La elección de la variable dependiente como una variable relativa al precio de referencia estimado es útil para interpretar directamente el efecto marginal de la competencia en el coste de la licitación, controlando el resto de los atributos específicos de la licitación que son estadísticamente significativos. La ausencia de información sobre las características de los licitadores en la muestra de estudio está parcialmente integrada en el estudio de mercado que proporciona el precio de referencia. Una consecuencia de la ausencia de esta información es la potencial endogeneidad de la variable que representa el número de licitadores en los modelos empíricos.

8 Véase el punto 11 del modelo del llamado a licitación en la sección A.1, donde también se especifican estos umbrales.

Hay una fuerte correlación entre el coste de la licitación y el precio de referencia[9] de los lotes. Referir el coste de la licitación a este precio deducido, que se calcula de manera homogénea para todas las licitaciones, permite aislar el efecto de la competencia, basándonos exclusivamente en los datos accesibles de la puja ganadora. También limita los efectos intertemporales de los precios. Los pocos estudios sobre este asunto que cuentan con un precio de referencia para los lotes licitados hacen el mismo tratamiento de esta variable. Véase, por ejemplo, (Onur and Özcam, 2012).

Finalmente, este enfoque normalizado permite calcular de manera inmediata la tasa de ahorro, SR, que es el objetivo fundamental de la investigación:

$$SR_k = \frac{Pref_k - P_k^*}{Pref_k} = 1 - indpago_k \qquad k = 1, 2, ..., K \tag{R.3}$$

Donde k y K tienen la misma interpretación que en la ecuación (R.1).

A continuación, analizo los regresores de los modelos identificados en la investigación.

• *Número de licitadores*. Este es el regresor principal. Indica el nivel de competencia en el procedimiento de licitación. Lo represento como un conjunto de variables discretas para cada valor, o como una aproximación a una variable continua.

Cuando lo represento como un conjunto de variables discretas, defino categorías individuales con subíndices. Por ejemplo, *BIDS3* es una variable binaria que toma el valor 1 cuando el número de licitadores que participa en la licitación es 3, y el valor nulo en cualquier otro caso. Cuando lo represento como una variable continua, lo llamo *bids*. Esta variable toma el valor nulo cuando la licitación resulta desierta y el valor del número de pujas válidas que recibe la autoridad de contratación en el resto de los casos.

La metodología de la investigación considera todas las características que la variable que representa el número de licitadores puede exhibir, tomando en consideración:

- su tratamiento como variable en categorías (efectos individuales no lineales) o como una variable continua incluida en una forma funcional cerrada.
- su comportamiento endógeno o exógeno en el modelo.

Cuando el número de licitadores se representa como una variable en categorías (que es esencialmente su naturaleza, puesto que el número de licitadores es siempre un número entero), los modelos empíricos permiten estimar efectos diferenciados con la entrada de cada nuevo licitador en el procedimiento de puja. En los modelos que utilizan el número de licitadores como aproximación a una variable continua, obtenemos un efecto más suave con la entrada de cada nuevo licitador.

9 El coeficiente de correlación de la regresión lineal entre ambas variables es superior a 0.90.

En estos modelos que aproximan el número de licitadores a una variable continua, si la variable resulta endógena, el efecto de la competencia en el coste de la licitación está sesgado cuando aplicamos una estimación directa del modelo. Por tanto, además de controlar la heterogeneidad del mercado, hay que corregir el sesgo de endogeneidad con métodos instrumentales.

La figura R.4 presenta la distribución del número de licitadores en el conjunto de datos utilizado en la investigación.

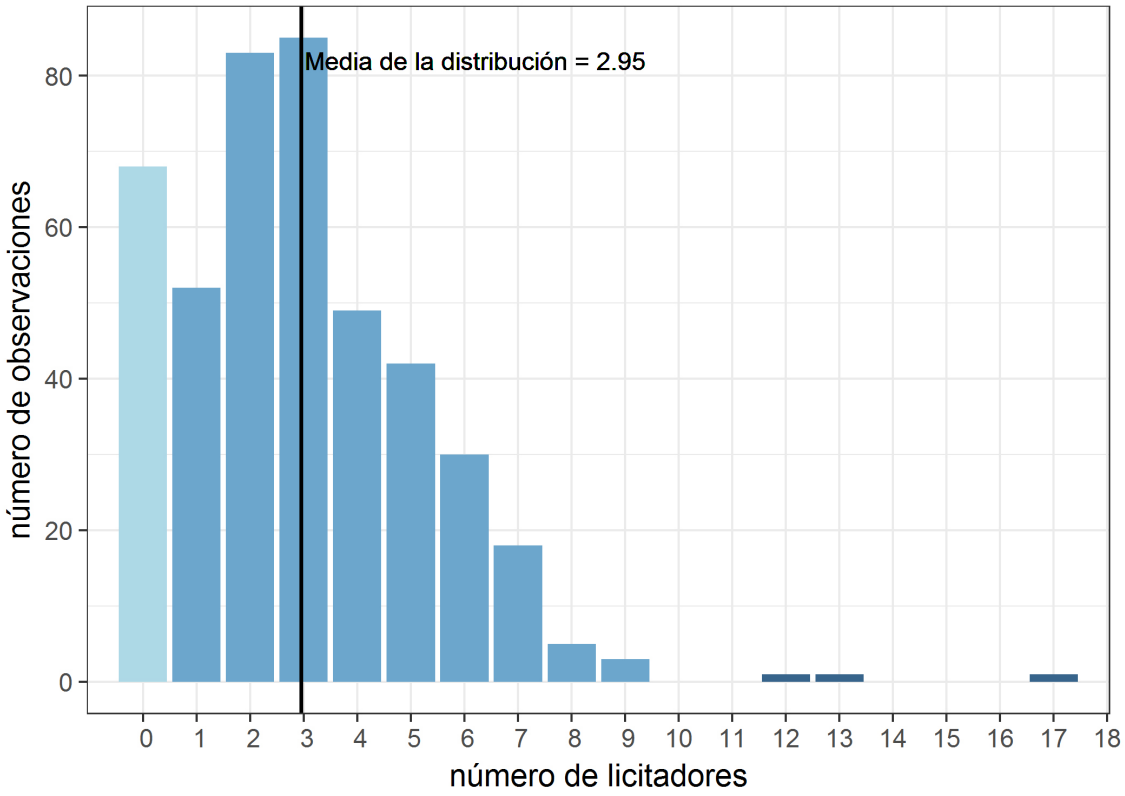


Figura R.4: Distribución del número de licitadores para licitaciones con requerimiento de garantía bancaria

La investigación utiliza el siguiente conjunto de regresores para controlar la heterogeneidad del mercado:

• *Ubicación del mercado*. Los datos sobre la ubicación del mercado se modelan con un conjunto de categorías. Estas categorías se han creado tomando en consideración el instrumento financiero de *Europe Aid* que proporciona los fondos para la licitación, y la localización geográfica de los países como factores diferenciales. Represento las categorías de ubicación del mercado en los modelos de la investigación con las siguientes variables binarias:

a) *DCATMAR1*. Esta variable toma el valor 1 para las licitaciones que tienen lugar en Turquía, que es el país con el mayor número de licitaciones de suministros en la muestra.

b) *DCATMAR2*. Esta variable toma el valor 1 para las licitaciones convocadas en los países que se benefician del instrumento IPA, excluyendo a Turquía y a Kosovo, que también se benefician de este instrumento.

c) *DCATMAR3*. Esta variable toma el valor 1 para las licitaciones convocadas en Kosovo, que es beneficiario tanto del instrumento IPA como del instrumento EULEX.

d) Los países beneficiarios del instrumento ENI conforman el grupo base de los modelos aplicados en la investigación.

• *Producto*. Los productos que constituyen los bienes suministrados son heterogéneos. Para la investigación, he clasificado los datos en categorías tradicionalmente reconocibles para los licitadores que compiten por contratos de suministros de *Europe Aid*[10]. Las categorías incluidas en los modelos de la investigación están representadas con las siguientes variables binarias:

a) *DCATPRO1*. Esta variable toma el valor 1 para los lotes de la categoría general de *mobiliario*. Esta categoría incluye predominantemente elementos de mobiliario para equipar oficinas e instalaciones de diferentes organizaciones.

b) *DCATPRO2*. Esta variable toma el valor 1 para lotes de la categoría general de *hardware and software*. Esta categoría incluye ordenadores, periféricos y aplicaciones de software para diferentes fines.

c) *DCATPRO3*. Esta variable toma el valor 1 para los lotes de la categoría general de *equipamiento y maquinaria mecánica e industrial*. Esta categoría es amplia porque abarca equipamiento para industrias diversas.

d) *DCATPRO4*. Esta categoría toma el valor 1 para lotes de la categoría general de *vehículos*. Los productos predominantes en esta categoría son vehículos de carretera, tales como coches, furgonetas y autobuses. En algunos casos, el contrato se refiere a piezas de recambio para estos vehículos.

e) *Equipamiento médico, forense y de laboratorio* . Esta categoría incluye medicamentos, vacunas, instrumentos de laboratorio y materiales de naturaleza química. Esta categoría constituye el grupo base en los modelos de la investigación.

Otros datos han sido modelados también con variables binarias. Estas variables se han incluido en la estimación de los modelos empíricos sin resultar estadísticamente significativas. Incluyen una variable que indica si la adjudicación se

10 Los expedientes de licitación utilizados como fuente de datos incluyen por lo general varios códigos de clasificación para los bienes de cada lote. Estos códigos siguen el estándar CPV (Vocabulario Común de Contratos Públicos). La investigación utiliza una clasificación en categorías generales de acuerdo con estos códigos y con la descripción de los bienes de los expedientes de licitación. He seleccionado la naturaleza dominante del lote cuando hay varios códigos CPV que caracterizan los bienes en dicho lote.

refiere a un procedimiento negociado tras un procedimiento abierto desierto, una variable que indica si el ámbito de la licitación es local[11] y otra variable que indica si la licitación incluía uno o más lotes.

Por último, para comprobar la endogeneidad de la variable *bids* en los modelos utilizados en la investigación he utilizado variables instrumentales. Los instrumentos en el contexto de estas licitaciones son difíciles de encontrar por tres razones fundamentales:

- También pueden ser variables endógenas en el modelo empírico utilizado.
- Pueden no tener suficiente valor instrumental para la variable *bids*.
- Puede no existir una fuente de datos de confianza para obtener la variable instrumental en todos los países incluidos en el conjunto de datos.

En la investigación, selecciono los siguientes instrumentos que cumplen los criterios de validez, relevancia y suficiente valor instrumental:

• *Producto Interior Bruto retardado un año (GDP_1)*. El GDP caracteriza el desarrollo de cada país beneficiario. Por tanto, puede tener una influencia razonable en la decisión de los licitadores de pujar en la licitación. Los países con un mayor GDP pueden despertar un mayor interés en el procedimiento de licitación tanto por competidores nacionales como internacionales. En la investigación se utiliza el GDP anual en miles de millones de dólares, a precios constantes de 2000.

• *DTF retardado un año (DTF_1)*. El índice DTF (*Distancia a Frontera*) captura la diferencia entre el desempeño de un país y una medida del mejor desempeño de un conjunto de 41 indicadores relacionados con el contexto regulatorio económico[12]. No tiene un comportamiento necesariamente igual al GDP. El argumento para elegir este segundo instrumento es similar al argumento utilizado para el GDP en relación con el potencial interés de licitadores extranjeros. Un mayor desempeño en este índice macroeconómico podría estimular la participación de licitadores extranjeros.

• *Exportaciones a la Unión Europea retardadas un año (EXPORTS_1)*. Las cifras de exportación son un indicador de la actividad comercial internacional de los países beneficiarios, y pueden tener una influencia en el número de licitadores recurrentes para los bienes solicitados en la muestra de la investigación. Considero las exportaciones a los países de la UE para tener en cuenta el hecho de que las licitaciones de *Europe Aid* involucran mayoritariamente[13] comercio directo entre los países de la UE y los países beneficiarios de los fondos.

11 Las licitaciones locales están abiertas a licitadores internacionales, pero pueden establecer reglas específicas que dificulten una mayor competencia, como la existencia de publicidad local solamente; procedimientos administrativos locales complementarios; pujas y pagos en moneda local; y otras restricciones que pueden influir en la decisión de los licitadores de tomar parte en la licitación. Una licitación con ámbito local implica siempre un contrato por debajo de un cierto umbral. En el periodo que abarca la investigación, este umbral es de 300.000.- EUR.

12 La Fuente de datos macroeconómica para el GDP_{-1} y el DTF_{-1} es la página web http://www.doingbusiness.org/en/methodology del Banco Mundial, que proporciona información detallada sobre la metodología para la elaboración de las variables mencionadas.

13 Esto es debido a las reglas de nacionalidad y origen de los bienes. Estas reglas se establecen en el punto 8 del llamado a licitación. Véase la sección A.1 del Apéndice.

Esta variable se ha construido a partir de los datos de la Dirección de Estadísticas de Comercio del Fondo Monetario Internacional[14]. Esta fuente presenta Exportaciones FOB en millones de dólares estadounidenses corrientes. De cara a hacer las cifras de exportaciones consistentes con los instrumentos previos, las he convertido a millones de dólares estadounidenses, a precios constantes[15].

GDP, *DTF* y *EXPORTS* son variables retardadas un año en los modelos, porque esa es la información accesible a los licitadores cuando establecen su puja.

En el Apéndice, anexo C, incluyo un descriptor resumido de las variables, que es el que corresponde a la base de datos creada y utilizada en la investigación.

R.4.3 *Especificación de los modelos empíricos*

Como he expuesto en la sección R.4.1, en el contexto de las licitaciones de suministros de *Europe Aid* el comprador exige a menudo un aval bancario de participación para acceder al procedimiento de puja. El importe de este aval proporciona una señal del precio de referencia del bien que desea adquirir.

Una vez definido el precio de referencia aplicando la ecuación (R.2) a cada uno de los lotes licitados que exigen aval bancario, estudio tres modelos empíricos utilizados de manera dominante en la literatura de subastas de adquisición.

En los tres modelos estudiados, un número aleatorio de n licitadores accede a cada procedimiento de licitación. Las licitaciones incluyen diferentes productos en diferentes países. Por ello, controlo esta heterogeneidad con varios regresores que caracterizan los mercados específicos, y que detallo en la sección R.4.2.

Cada licitador estima un coste para el lote licitado y define su estrategia de puja basándose en el coste que ha estimado. Como he indicado en la sección R.3.1, la estimación de este coste puede provenir de un valor que es el mismo para todos los licitadores (CVP); de un valor del coste que es privado para cada licitador (IPVP); o de un valor del coste derivado de un paradigma de estimación más amplio, con un cierto grado de afiliación entre los licitadores (AVP), donde CVP y IPVP son los casos extremos especiales.

En la investigación, asumo que los licitadores no cooperan entre sí y que utilizan una estrategia de optimización de beneficios. También asumo un mercado en equilibrio, en línea con los principios que permiten construir modelos estructurales. Por ejemplo, (Paarsch, 1992) aplica estas hipótesis para construir modelos estructurales teóricos para los casos CVP y IPVP.

Sin embargo, yo no asumo *a priori* ningún paradigma de distribución de la estimación del coste entre los licitadores, u otra hipótesis simplificadora que defina un modelo privilegiado con solución en forma cerrada. Como señalo en la sección R.3.3, la razón es que las licitaciones de este entorno se ven probablemente afectadas por asimetrías causadas por el origen internacional de los licitadores, su

14 En la página data.imf.org

15 Para realizar esta transformación he deflactado los valores de las exportaciones utilizando el indicador del Índice de Precios al Consumo proporcionado por el Banco Mundial data.worldbank.org. Este indicador utiliza 2010 como año de referencia para el índice.

diferente tamaño y la posibilidad de participar formando parte de un consorcio, entre otras circunstancias.

Las subastas con asimetría de licitadores tienen soluciones en forma no cerrada a las ecuaciones que caracterizan el equilibrio de las estrategias de puja, y son propias de situaciones generales como las analizadas en esta tesis (Campo et al., 2003).

Por otro lado, incluso aplicando las mencionadas hipótesis restrictivas sobre el paradigma de coste, la estimación de los modelos simplificados que resultan en soluciones cerradas requiere a menudo el conjunto completo de pujas, y no sólo la puja ganadora, lo cual es una limitación de la fuente de datos utilizada para la investigación.

Teniendo en cuenta los argumentos mencionados, considero inicialmente un modelo con una relación no cerrada entre el coste de la licitación normalizado al precio de referencia estimado y el número de licitadores en la solución de equilibrio. Puesto que las licitaciones incluyen un número limitado de licitadores, la especificación de un modelo empírico discreto puede abordar de manera flexible esta situación.

Además, si asumiéramos que las características de nuestro entorno de licitación se aproximan a las condiciones de una solución en forma cerrada, al menos en un rango de valores típicos, esperaríamos que esta forma cerrada fuera no lineal, en general. Por ello, además del modelo discreto con forma no cerrada, analizo otros dos modelos continuos con formas funcionales no lineales como modelos aproximativos que utilizan el coste de la licitación normalizado al precio de referencia en la variable dependiente y el número de licitadores como regresor, controlando los factores de heterogeneidad del mercado.

Los tres modelos resultantes especificados en la investigación son estadísticamente consistentes y convergen relativamente entre sí, al menos en un número amplio de valores del regresor que incluye el número promedio de licitadores. Este enfoque comparativo es un aspecto innovador de la investigación, puesto que los trabajos previos en la literatura imponen hipótesis restrictivas para identificar de antemano formas funcionales privilegiadas para el modelo elegido.

R.4.4 *Estimación de los modelos empíricos*

En el enfoque empírico de la investigación, primero estimo modelos que asumen el número de licitadores como una variable discreta en categorías y modelos que la asumen como una variable continua, expresada en diferentes formas funcionales, de acuerdo con lo expuesto en la sección R.4.3; posteriormente, selecciono aquéllos con mejor ajuste estadístico y, finalmente, comparo los resultados.

Para la selección del modelo discreto, pruebo a estimar diferentes modelos regresando varias formas funcionales de la variable que representa el coste de la licitación sobre variables binarias que representan cada valor del número de licitadores (es decir, toman el valor 1 para cada número específico de licitadores, y 0 en cualquier otro caso) y sobre otros regresores que representan el entorno de la licitación (básicamente las características del mercado definidas en la sección

R.4.2). El modelo seleccionado es el de mejor ajuste estadístico de acuerdo con criterios econométricos.

La estimación de este primer modelo, donde la variable del número de licitadores se trata como discreta, no presenta dificultades técnicas. Tal como se ha explicado en la sección R.4.3, este es el modelo más flexible y el que se adapta mejor a las soluciones no cerradas de equilibrio, que serían de esperar en el entorno de las licitaciones bajo estudio. La principal desventaja de este modelo reside en la poca representatividad de las categorías correspondientes a un número elevado de licitadores, porque la muestra obtenida siguiendo lo expuesto en la sección R.4.1 contiene un número limitado de observaciones para dichas categorías.

De un modo similar, para la selección del modelo donde el número de licitadores está representado por una variable continua, pruebo a estimar modelos con diferentes formas funcionales de la variable dependiente que representa el coste de la licitación, y con diferentes formas funcionales también para el regresor que corresponde al número de licitadores. Asimismo, incluyo otros regresores que representan el entorno de la licitación, tal como hago para la selección del modelo discreto.

Los modelos con la aproximación continua del número de licitadores con un mejor ajuste estadístico proporcionan una elasticidad y semielasticidad competencia del coste de la licitación. La mayor ventaja de la estimación de ambos modelos es que pueden ser directamente comparados con resultados previos en este campo. La mayor desventaja desde un punto de vista técnico es que debemos considerar la endogeneidad potencial de la variable número de licitadores en los modelos y, por tanto, he precisado tratarla de manera consistente en los métodos de estimación, utilizando los instrumentos adecuados mencionados en la sección R.4.2.

Es importante reiterar que los modelos descritos en el último párrafo, con una relación cerrada entre coste de la licitación y número de licitadores, deben ser considerados como aproximativos debido a las condiciones expuestas para el entorno de las licitaciones bajo estudio.

R.5 RESULTADOS

En esta sección identifico y describo brevemente los resultados de los modelos con mejor ajuste encontrados en la investigación. Al final de la sección represento gráficamente los tres modelos seleccionados e interpreto en mayor extensión los resultados de manera agregada apoyándome en dicha representación gráfica.

Los resultados de estos modelos son importantes para extraer las conclusiones fundamentales de esta tesis. En particular, todos ellos convergen en un rango de niveles de competencia que incluye el valor medio de licitadores en el conjunto de procedimientos analizados, lo cual permite obtener una tasa de ahorro promedio robusta. A partir de esta tasa de ahorro promedio, en el apartado final de conclusiones R.6, analizo la eficiencia del procedimiento de licitación y elaboro sugerencias de mejora en el diseño de este procedimiento.

• Modelo flexible no lineal.

$$\begin{aligned} indpago = {} & 1.151 - 0.154DCATPRO1 - 0.132BIDS_2 - 0.166BIDS_3 - 0.192BIDS_4 - \\ & - 0.277BIDS_5 - 0.236BIDS_6 - 0.242BIDS_7 - 0.409BIDS_8 - 0.209BIDS_9 - 0.205BIDS_{10} + \nu \end{aligned} \tag{R.4}$$

Este modelo flexible no lineal apunta hacia un límite en el efecto de la competencia sobre el precio de la adjudicación a partir de los ocho licitadores. Este sería el comportamiento típico en un contexto de subasta que satisficiera el paradigma de valor común (CVP) del bien para los licitadores, donde los licitadores intentan evitar la *maldición del ganador*. Este resultado es consistente con las discusiones que se encuentran en trabajos previos que utilizan un modelo similar, como (Brannman et al., 1987).

• Modelo de semielasticidad.

$$log(indpago) = -0.172DCATPRO1 - 0.027bids + u \tag{R.5}$$

Este modelo proporciona una semielasticidad de -0.027 para bienes que no se encuentran en la categoría de mobiliario. El mismo modelo aplicado exclusivamente a bienes de mobiliario proporciona una semielasticidad de -0.098 para esta categoría de productos. La media ponderada para todos los bienes es de -0.031. Este resultado es comparable con el que aporta (Onur and Özcam, 2012), quien obtiene una semielasticidad media de -0.039 con un modelo similar para una muestra sin restricciones para todo tipo de subastas públicas en Turquía. La menor elasticidad (en valor absoluto) indicada por el modelo de esta investigación puede corresponder a una mayor proporción de productos tecnológicos en el contexto de las licitaciones de *Europe Aid*.

• Modelo de elasticidad (instrumentado).

$$log(indpago) = -0.179DCATPRO1 - 0.076log(bids) + \epsilon \tag{R.6}$$

El modelo de elasticidad es el modelo con un mejor ajuste de acuerdo con los criterios de consistencia estadística. En este modelo, los efectos de la competencia cesarían rápidamente con la entrada de nuevos competidores. El valor estimado por los licitadores no sería puramente privado, sino que esperaríamos un cierto grado de afiliación entre ellos. Una vez controlada la endogeneidad, el modelo proporciona una elasticidad de -0.08 para los bienes que no pertenecen a la categoría de mobiliario. El mismo modelo aplicado exclusivamente a bienes de mobiliario proporciona una elasticidad de -0.28. La media ponderada esta cercana a -0.10. Este resultado es comparable a (Iimi, 2006), quién obtiene una elasticidad media de -0.2 en un modelo con una muestra internacional de licitaciones ODA con contratos de precio elevado sobre los 7 millones de EUR, bajo hipótesis simplificadoras de paradigma IPVP. El menor valor de la elasticidad del modelo presentado en esta tesis puede corresponder a una mayor proporción de productos tecnológicos y a la ausencia de sesgo de selección potencial de muestra, asociado a contratos de alto precio.

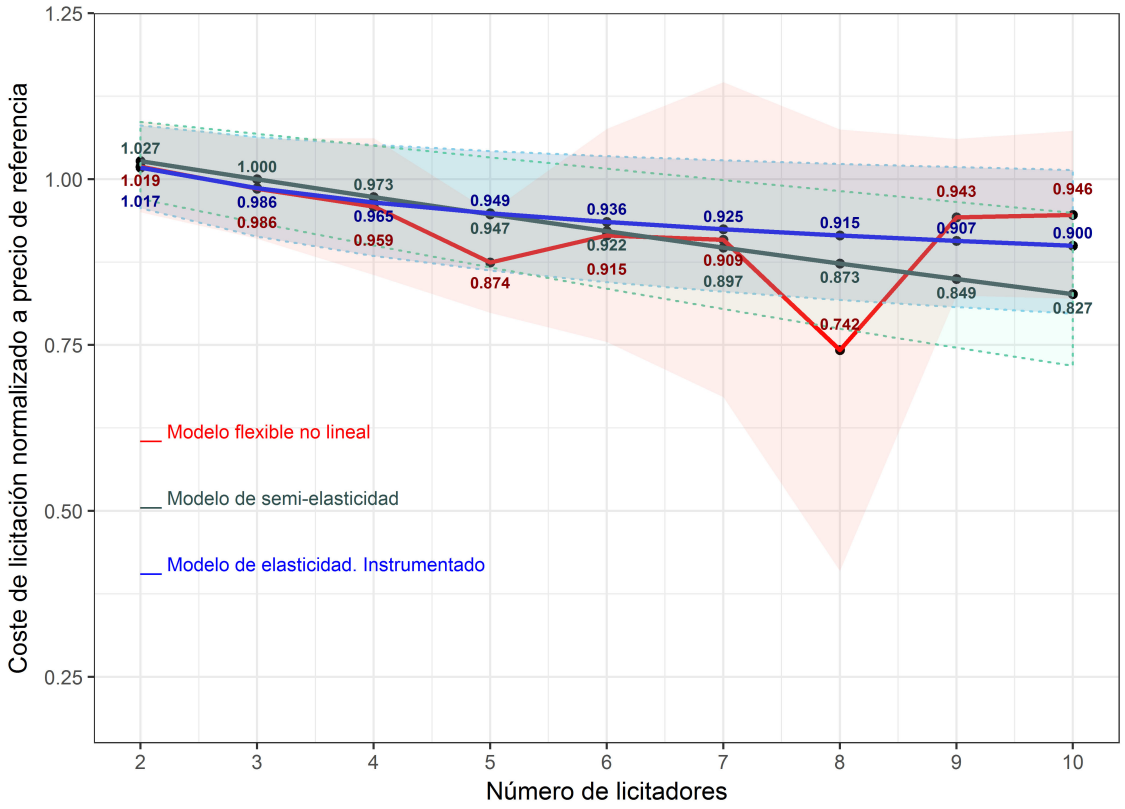


Figura R.5: Representación de los modelos con mejor ajuste estadístico para determinar la influencia de la competencia en los costes de licitación. El gráfico muestra los predictores del coste de licitación normalizado con las bandas de confianza de error para cada número de licitadores. Incluye todo tipo de productos excepto los de la categoría de mobiliario, que tienen un comportamiento diferente.

Los resultados empíricos de los tres modelos seleccionados comparten las siguientes características relevantes para las conclusiones de la investigación, y que pueden interpretarse directamente de la figura R.5, considerando que la tasa de ahorro es simplemente la diferencia de las curvas representadas respecto a la unidad, tal como expresa la ecuación (R.3):

1. Los tres modelos son consistentes estadísticamente, es decir, su ajuste estadístico es adecuado para realizar inferencia dentro de los márgenes de confianza comúnmente aceptados.

2. Como consecuencia de la característica anterior, existe entre los tres modelos un amplio margen de convergencia. En particular, en licitaciones con participación de entre dos y cuatro licitadores los tres modelos hacen una predicción muy similar de la tasa de ahorro. Este comportamiento es lógico, al ser las categorías de nivel de competencia más habituales de la muestra de datos. Con niveles de competencia entre cinco y ocho licitadores las predicciones empíricas sobre la tasa de ahorro varían, aunque la tendencia creciente de dicha tasa con el nivel de competencia se mantiene.

3. Para niveles de competencia representados por nueve o más licitadores los modelos divergen significativamente, lo cual impide no sólo estimar el comportamiento de la tasa de ahorro, sino también interpretar los atributos subyacentes de los licitadores en el contexto de estas licitaciones. Esto es razonable con respecto al enfoque comparativo de la investigación, puesto que los tres modelos son consistentes, y cada uno responde a una solución a la puja de equilibrio bajo hipótesis diferentes sobre los atributos de los licitadores.

R.6 CONCLUSIONES

Esta investigación ilustra el efecto positivo de una mayor competencia en el ahorro en los costes de licitación asociados a los contratos de adquisición de suministros de *Europe Aid*, financiados con los instrumentos de Ayuda a la Preadhesión (IPA) y de Vecindad (ENI).

En la investigación identifico tres modelos empíricos consistentes con características clave de la teoría de subastas de adquisición, como es el hecho de que la relación entre el coste de la licitación y el número de los licitadores sea no lineal. Los resultados empíricos son compatibles con los de otros trabajos previos en el campo de la ayuda oficial al desarrollo.

Los aspectos más innovadores de la investigación son: la creación y el tratamiento del conjunto de datos; la estimación de un precio de referencia homogéneamente calculado para todos los lotes licitados que exigen una garantía bancaria de participación, y la utilización de este precio de referencia estimado como indicador del precio de reserva desconocido del comprador; la definición de una tasa de ahorro referida al precio de referencia estimado, y la predicción de la evolución de esta tasa de ahorro con niveles progresivos de competencia; y el enfoque multipaís, multiproducto y comparativo de la investigación basado en los tres modelos empíricos identificados.

Los modelos empíricos identificados responden a una caracterización amplia de los licitadores, cuyos atributos son desconocidos. Los aspectos innovadores de la investigación inciden en solventar dificultades relacionadas con la ausencia de datos públicos en el sector de las subastas de adquisición de ayuda oficial al desarrollo, y contribuyen al objetivo de analizar la eficiencia de este mecanismo de asignación de mercado. Consecuentemente con ello, los resultados de la investigación permiten proponer eventuales mejoras en el diseño de este mecanismo para su aplicación futura.

En esta sección incluyo un breve resumen de las conclusiones de la investigación estructurada en tres apartados. El apartado R.6.1 va encaminado a describir los resultados relacionados con el objetivo inicial, es decir, la estimación cuantitativa del efecto de la competencia en los costes de adquisición de los productos licitados. El apartado R.6.2 describe las medidas sugeridas para una asignación más eficiente, y un mayor ahorro en los costes da adquisición. Finalmente, el apartado R.6.3 indica brevemente qué líneas de investigación futura considero más interesantes como complemento y extensión de los resultados de mi investigación.

Todas ellas son convenientemente ampliadas y descritas en mayor detalle en el capítulo 8 de esta tesis.

R.6.1 *Nivel de competencia y costes de adquisición*

Los resultados de la predicción de la tasa de ahorro con los tres modelos identificados convergen hasta un número de cuatro licitadores y divergen a partir de ocho licitadores. El número promedio de los licitadores en la muestra utilizada en la investigación es tres, incluyendo también los procedimientos desiertos. Puesto que este valor promedio está dentro del rango de convergencia de los modelos, los resultados empíricos ofrecen un valor robusto de la tasa media de ahorro.

Los resultados de la investigación no muestran diferencias entre los efectos de la competencia originados en las licitaciones con financiación de IPA y de ENI. Sin embargo, la categoría de bienes de mobiliario muestra un comportamiento más competitivo que el resto de los bienes que se licitan en los tres modelos seleccionados. Este efecto es razonable en términos económicos, porque los bienes de mobiliario no precisarían procesos de producción muy sofisticados, y podrían ser suministrados por diversos proveedores locales a precios más reducidos.

Para el número promedio de licitadores los tres modelos predicen una tasa de ahorro reducida no superior al 1.5% respecto al precio de referencia para todos los mercados geográficos y todos los productos, exceptuando los bienes de mobiliario.

La caracterización de los licitadores en el contexto de las licitaciones analizadas en esta investigación no se puede determinar completamente. En primer lugar, no disponemos de información relevante sobre ellos, porque dicha información no aparece en los expedientes públicos de licitación (sólo se reflejan los datos del adjudicatario). Por otro lado, el hecho de que los tres modelos empíricos identificados en la investigación sean todos ellos consistentes estadísticamente indica implícitamente que los licitadores pueden ser caracterizados de varias maneras compatibles con los resultados empíricos.

El modelo con mejor ajuste a los datos de la muestra es el modelo de elasticidad, que proporciona una elasticidad competencia precio de -0.08 para todos los bienes, exceptuando la categoría de mobiliario. La estimación de ese valor requiere corrección de endogeneidad para la variable que representa el número de licitadores. El signo negativo de la elasticidad indica que un mayor nivel de competencia estimula un ahorro en el coste de la licitación, de acuerdo con la predicción teórica. Un modelo de elasticidad para el coste de la licitación describe una curva con una pendiente que se suaviza con la entrada de nuevos licitadores, que se correspondería con un entorno con cierto nivel de afiliación entre los licitadores.

A pesar de que todos los modelos seleccionados son empíricamente consistentes con los datos, desde el punto de vista económico, el modelo de elasticidad caracteriza de una manera razonable el entorno competitivo. De una parte, la endogeneidad del nivel de competencia observado en este modelo podría venir inducida por asimetrías entre los licitadores. He justificado en la sección R.3.3

que estas asimetrías serían comunes en entornos con licitadores de diferente nacionalidad, diferente tamaño y que pueden optar por estrategias de participación consorciada, situaciones todas ellas presentes en las licitaciones de suministros de *Europe Aid* objeto de esta investigación. De otra parte, la iteración de estos mercados con licitaciones regulares de productos semejantes justificaría un cierto nivel de afiliación, es decir, una cierta propensión común a pujar con mayor o menor agresividad por un mismo lote, en especial para los licitadores incumbentes.

La reducida tasa de ahorro obtenida para el número promedio de licitadores en la muestra, cuyo valor es robusto por la convergencia de los tres modelos seleccionados, indica que medidas que fomenten la competencia en las licitaciones de suministros de *Europe Aid* ayudarían a lograr unos ahorros más significativos, abriendo pues el camino a la acción política en este campo. Ofrezco algunas sugerencias de medidas posibles en la siguiente sección.

R.6.2 *Sugerencias de mejora basadas en el diseño del mecanismo de asignación*

Dos tipos de acciones políticas se han considerado como propuesta en las conclusiones de este trabajo expuestas en la sección 8.1.2.1.

Las acciones del primer tipo atañen a las reglas de la licitación. Basándonos en las predicciones de la teoría de subastas, y considerando que las implicaciones del modelo empírico de mejor ajuste estadístico respecto a la caracterización de los licitadores: asimetría (al menos parcial) y un cierto grado de afiliación, son también las más razonables en términos económicos, la subasta inglesa de primer precio sería el formato de subasta que ofrecería un mayor beneficio al comprador. En la subasta inglesa los licitadores pujan sucesivamente mejorando su oferta, hasta que ninguno puede superar la puja final, que resulta ganadora.

Esta propuesta implica introducir elementos dinámicos en la subasta que revelen señales de valoración de precio por parte de los licitadores. En un contexto práctico tal modificación puede enfrentar retos significativos dada la descentralización de los procedimientos a los países beneficiarios, y la complejidad en los mecanismos de ejecución de la licitación y de control de la gestión de los fondos. La factibilidad de la implantación de esta mejora vendría asociada a la introducción de modelos de puja online, que simplificarían el proceso de llevar a cabo múltiples rondas de puja. Un ahorro significativo en los costes de adquisición de los lotes por efecto de la mayor competencia obtenida financiaría la inversión en el sistema tecnológico requerido para implantación de la mejora.

Las acciones del segundo tipo atañen a favorecer la participación de un mayor número de licitadores potenciales mediante la reducción las exigencias de acceso a la subasta. En particular, se pueden abordar las exigencias de solvencia técnica y económica en la práctica actual, que se consideren desproporcionadas. Limitando dichas exigencias y adaptando los criterios de solvencia a la realidad de licitadores locales y, en general, a licitadores de menor envergadura tales como pequeñas empresas, se puede estimular una mayor participación en el procedimiento y, por lo tanto, un mayor ahorro en el coste de adquisición por efecto del aumento en la competencia.

Los resultados empíricos de la investigación apoyarían esta medida, puesto que detectan cómo categorías de producto menos sofisticadas, en particular artículos de mobiliario, presentan un patrón de mayor competencia y un número muy significativo de adjudicatarios locales.

Otras medidas incentivadoras a la participación de licitadores locales, o de pequeñas empresas, actuando por ejemplo en la regla de adjudicación con bonificación a la participación local, serían alternativas a estudiar dentro de esta categoría. Aparte de contribuir a las externalidades positivas asociadas a los fines de la ODA, como la de favorecer los mercados interiores de los países en desarrollo, la mayor competencia promovida en los procesos de licitación compensaría razonablemente el coste de dichos incentivos.

R.6.3 *Líneas de investigación futuras*

La investigación puede ampliarse en el futuro a otro tipo de contratos financiados por *Europe Aid*, como los que se refieren a obras y servicios, lo cual ofrecería una caracterización más completa del comportamiento competitivo de este sector para todo el rango de bienes intercambiados.

Otro campo de investigación interesante, y directamente relacionado con el expuesto en esta tesis, es el análisis de datos semejantes en el periodo presupuestario comunitario actual (2021-2027), que permitiría extraer una estimación del impacto de la aplicación de la nueva fase del instrumento de Ayuda a la Preadhesión (IPA III) y del programa de Vecindad dentro del instrumento Europa Global (NDICI) en la reducción de los costes de adquisición para contratos de suministro. Ese enfoque comparativo temporal sería innovador en el sector de la ODA, y es un enfoque frecuente en otros campos económicos relacionados, como la convergencia económica de estos países en desarrollo respecto a los estándares de la UE.

Dotar la investigación de un contexto geográfico más amplio es también una línea de estudio interesante. Por ejemplo, extenderla a regiones más distantes de Europa donde se aplican fondos oficiales de ayuda al desarrollo, como África Subsahariana y América Latina. El mayor reto a enfrentar en este caso sería la posible falta de representatividad de la muestra de datos, tanto por el menor número de procedimientos y su influencia en el tratamiento estadístico, como la posible mayor heterogeneidad de los mercados. Ese reto de carácter técnico se vería compensado por la obtención de una visión más global de la eficacia y la eficiencia del mecanismo de asignación de estos mercados.

Finalmente, una línea de investigación relevante corresponde a la caracterización de aspectos del entorno de estas subastas de adquisición públicas que conciernen a los licitadores. Este es un objetivo ambicioso que requiere implicación institucional y un acceso a un mayor conjunto de datos, que caractericen a dichos licitadores. La aplicación inmediata de esta línea de investigación sería la justificación de las posibles reformas del conjunto de reglas que gobiernan el tipo de subasta actual analizado en esta tesis.

S

SUMMARY, RESULTS AND CONCLUSIONS OF THE REARCH

S.1 MOTIVATION

Procurement auction is a widespread mechanism for the allocation of public markets with a high relevance in international trade. In particular, procurement auction is the dominant mechanism used in the management of official development assistance (ODA[1]). The volume of ODA funds provided to developing countries by OECD members of the Development Assistance Committee exceeded USD 160 billion in 2020. In real terms, total ODA in 2020 rose by 3.5 % compared to 2019 and reached its highest level(OECD, 2021a) ever.

A significant part of these funds comes from European Union institutions. The External Action of the European Union has established in 2021 the legal basis for the new ODA financial instruments. These include: the third phase of the Instrument for Pre-accession Assistance (IPA) and the new Neighbourhood, Development and International Cooperation instrument - Global Europe (NDICI). IPA III has a financial envelope of more that EUR 14 billion and NDICI has a financial envelope of more than EUR 79 billion. Both instruments amount for most of the funding of EU External Action and, in conjunction with the Humanitarian Aid instrument and other specific instruments with lower funding, make the whole allocation exceed EUR 100 billion for the period 2021-2027. This amount involves a significant increase with regards to the budget allocated in the period 2014-2020.

One of the features of the official development assistance of the EU institutions is the modality of non-reimbursable budget support that they apply in most of their financial instruments. In fact, the EU became the greatest worldwide ODA donor under this funding modality in the period 2014-2020 (OECD, 2018).

Two of the most relevant ODA financial instruments of the European Union under the modality of non-reimbursable budget support during the period 2014-2020 were the second phase of IPA instrument, and the European Neighbourhood Instrument, ENI. Both instruments benefited countries close to the European Union, or sharing borders with the European Union. Therefore, cooperation policies with these countries are a priority for Europe. Non-reimbursable budget support instruments have a long tradition in EU development assistance for these countries.

1 Acronyms included in this thesis are presented in an alphabetically ordered list at the end of the index of contents. The list includes the definition in English and Spanish.

Figure R.1 represents the geographic situation and the name of the beneficiary countries of ENI and IPA instruments, which are the object of the research in this thesis. Their denomination and political status corresponds to the situation during the period covered by the research, 2014-2020[2]

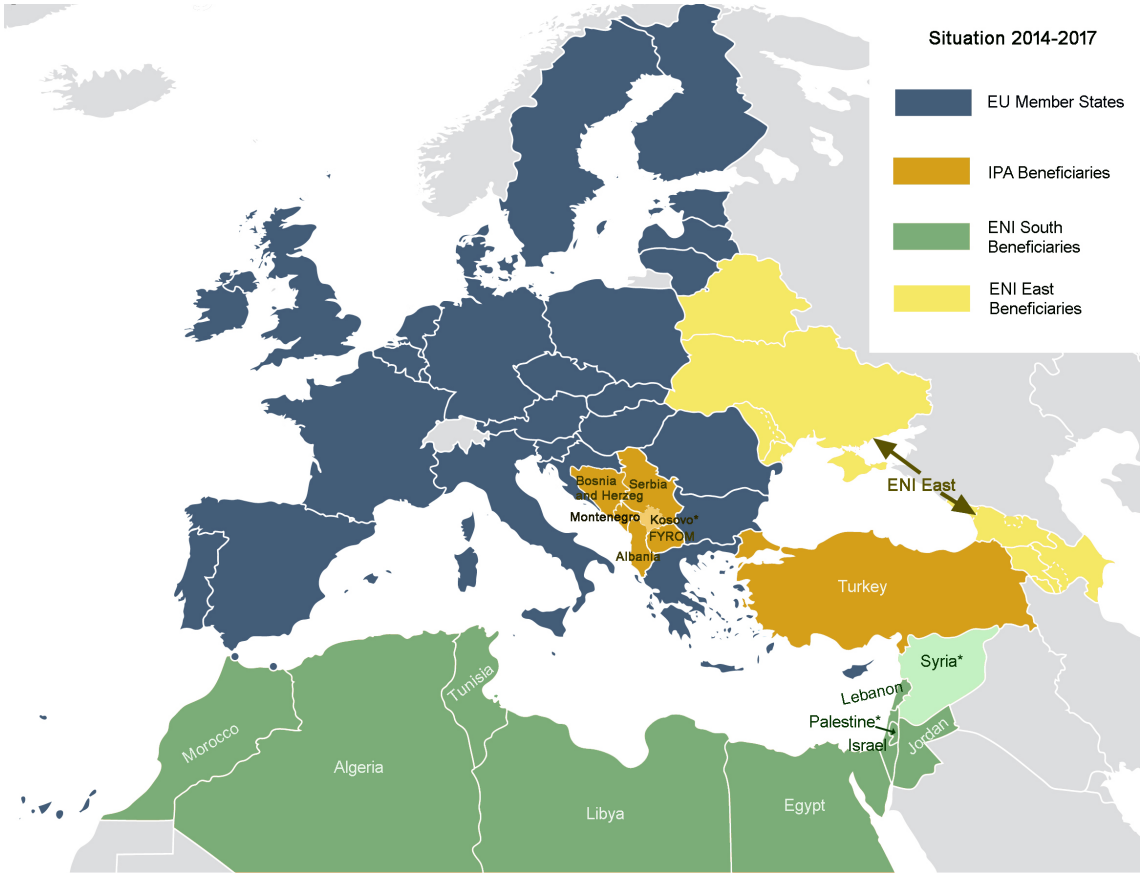


Figure S.1: Geographic representation of the countries benefiting from EU IPA and ENI financial instruments. Situation 2014-2017

Despite this economic relevance, and the instrumental value of these funds for local business development and governance improvement, the number of empirical studies carried out to estimate the cost of the goods and services provided by ODA to the beneficiary countries is very limited. The most frequent argument in the literature is the lack of public data on bidding procedures in development countries. Other authors quote arguments that may be connected to the sensitive political aspects of ODA, (Iimi, 2006). Limited data and political implications of EU funding are considered as well in the methodological approach and the context of other empirical studies, for instance (Tsanana and Katrakilidis, 2014) researching on income convergence with EU of some beneficiary countries of these funds.

2 The names followed by an asterisk are territories with exceptional status. Kosovo, according to resolution 1244 of the UN Security Council; and Palestine, according to the resolution 67/19 of the UN General Assembly. The participation of Syria in the ENI instrument was suspended as from May, 2011, owing to the internal conflict.

In addition to the added value of these goods for the development of the beneficiary countries, acquiring them at a competitive price contributes to optimize the deployment of their resources and to achieve an efficient use of the funds allocated by the European donors.

S.2 OBJECTIVES

The initial objective of this thesis is to measure the effect of competition on procurement costs in a multilateral market of different goods. Based on the achievement of that objective, the main purpose is to determine to what extent the allocation mechanism provides an adequate acquisition price to the contracting authority purchasing the goods, and what measures would be needed to obtain a more efficient allocation and higher savings of the public funds financing the acquisitions.

The goods are supplied to different beneficiary countries from Europe Aid Instrument of Pre-accession (IPA) and Neighbourhood Instrument (ENI) funds, after following a tender procedure open to international participation. These ODA financial instruments have been in force for a long period, and they are part of the EU External Action currently; IPA operates as an independent instrument, whereas ENI is a geographic programme within the NDICI instrument. The thesis provides an overview of these instruments in sections 1.1.2 and 1.1.3.

The goods that are most frequently procured in these supply tenders are technological equipment and machinery for different industries. In the research, I have considered five broad specific categories of goods to group all the variety of tendered goods. Besides the two categories already mentioned, vehicles, medical and laboratory equipment, and furniture complete this market.

To fulfill the purpose of the thesis, I needed to establish four subsequent milestones related to the main challenges of the research.

1. To create the dataset and to define based on the data the relevant variables for the research.
2. To specify the empirical models of the research by using well-established concepts of auction theory applied to the International tender procedure.
3. To estimate the specified empirical models consistently with regards to the features of the dataset, by using adequate econometric methods.
4. To identify possible improvements in the design in Europe Aid allocation mechanism, by using predictions of auction theory applied to the empirical results of the research.

S.3 THEORETICAL FRAMEWORK

In the thesis, Europe Aid supply tenders are modeled as a type of reverse auctions. The contracting authority (the buyer, henceforth) demands openly a product. A set of bidders (the sellers) present their bids privately (*sealed-bid* auction) according to their bidding strategies. The bidder with the lowest bid become the winner and sells the product at that price (*first-price* auction) to the buyer.

In this modeled auction environment I consider that the bidders are non-cooperative. This means that I rule out any collusive behavior. In addition, I consider that the market of Europe Aid supply tenders is in equilibrium, and the bidders behave with a benefit optimizing strategy. This implies the assumption of rational bidders neutral to risk.

With the hypotheses described in the previous paragraph, the research uses well-established concepts of procurement auction theory that influence the competition effects on the price of the procured goods. They include:

1. Influence of the bidders' cost paradigm used to form their bids.
2. Influence of the revealed information in the procurement procedure.
3. Influence of bidders' asymmetries.

In this summary, I restrict to describe basic general aspects on the mentioned concepts strictly relevant for the research. They are further developed in chapter 2 of the thesis with more specific details and considerations regarding the current state of the art.

S.3.1 *Influence of cost paradigm*

According to auction theory, competition effects on the price of procured goods are directly related to the bidders' estimation of the value of the cost of the goods (Paarsch, 1992).

When the estimated cost has the same value for all the bidders (Common Value Paradigm, CVP), there is a limit to the competition effect on the price, even when this common value is unknown. Thus, after the entry of a certain number of bidders into the tender procedure, the entry of new bidders does not modify the expected acquisition price significantly. This aversion to bid lower than a certain price, in situations of incomplete information, is known as the attempt to avoid the *winner's curse*.

When the estimated cost is private for each of the bidders (Independent Private Value Paradigm, IPVP), the effect of competition on reducing the price of the procured good increases with each new bidder. This means that the price of acquisition gets continuously lowered.

Finally, when the estimation of the cost derives from a broader value paradigm (Affiliated Value Paradigm, AVP) the effect of competition on the price of the good ranges from the two extreme cases CVP and IPVP. This means that we may expect an intermediate effect between the other two special cases, which has a more complex interpretation (Pinkse and Tan, 2005).

In the context of the tenders of this research I do not assume any restriction on the underlying cost paradigm. The reason is that the public tender dossiers do not reveal the data of all the bidders and their bids, just only those of the winner. Thus, I have followed a comparative approach for models that satisfy the solution to the equilibrium bid for all those different types of cost paradigm that may appear. In this way, the common conclusions for all the different models are robust and independent of the underlying cost paradigm, even when this paradigm is *a priori* unknown.

Furthermore, this comparative approach allows to draw additional conclusions by reverse reasoning. This means that, based on the goodness of fit of the selected empirical models, it is possible to infer the level of competence from which the the influence of the cost paradigm is more relevant. With this information I find reasonable explanations to the most likely cost paradigm by using economic arguments.

S.3.2 *Influence of revealed information*

Under general considerations, when the buyer reveals information on the reference price of the goods for the kind of procurement auction used in this research, participation increases and, therefore, so does the level of competition (Milgrom and Weber, 1982b). Provided that the underlying cost paradigm is not a pure CVP, the effect of revealing information on the expected price of the procured goods will contribute to reduce the acquisition price with regards to a procurement environment without a price signal. The acquisition price reduction is due to the increase in the level of competence induced by the buyer's price signal.

In the tenders studied in the research, the buyer reveals indirectly part of the information on the expected price of the good, or reference price, through the participation guarantee to enter the procurement procedure, which is required in most of the tender procedures. The use of this price signal in the empirical models is one of the innovative aspects of this research. The mentioned price signal establishes limits to the buyer's reserve price as well. This is the maximum price that the buyer can pay according to the budget allocated by the financial instrument funding the acquisition, which is a private information.

The empirical results obtained for the dataset used in the research correspond to the theoretical predictions because, by using the price signal homogeneously for all the tenders, we observe a trend of acquisition price reduction with the entry of new bidders regarding the reference price.

S.3.3 *Influence of bidders' asymmetry*

The bidders' typology influences the competition effect when there are significant differences between those types. The strategies to estimate the cost of the procured goods generally differ between the bidders owing to their asymmetries. In the auction environment of Europe Aid supply tenders, the international origin of the bidders, their size and the possibility to participate as a part of a bigger consortium are reasons to create these asymmetries. Under these conditions, the solution to market equilibrium does not have a closed form (Campo et al., 2003). This means that we do not have a structural theoretical model identified beforehand. We need to use more flexible empirical models, which allow drawing conclusions for the specific context of the research.

This aspect is interrelated with the cost paradigm and complicates its interpretation. The possibility to have asymmetric groups of bidders, who respond to different cost paradigms support the comparative approach taken in the research. The joint analysis of the statistically consistent models identified in the research enables coherent interpretations of the possible asymmetries based on economic foundations.

S.4 METHODOLOGY

In this section I present the steps followed to address the objectives of the research until drawing the conclusions. Figure S.2 synthesizes the whole methodological process of the research.

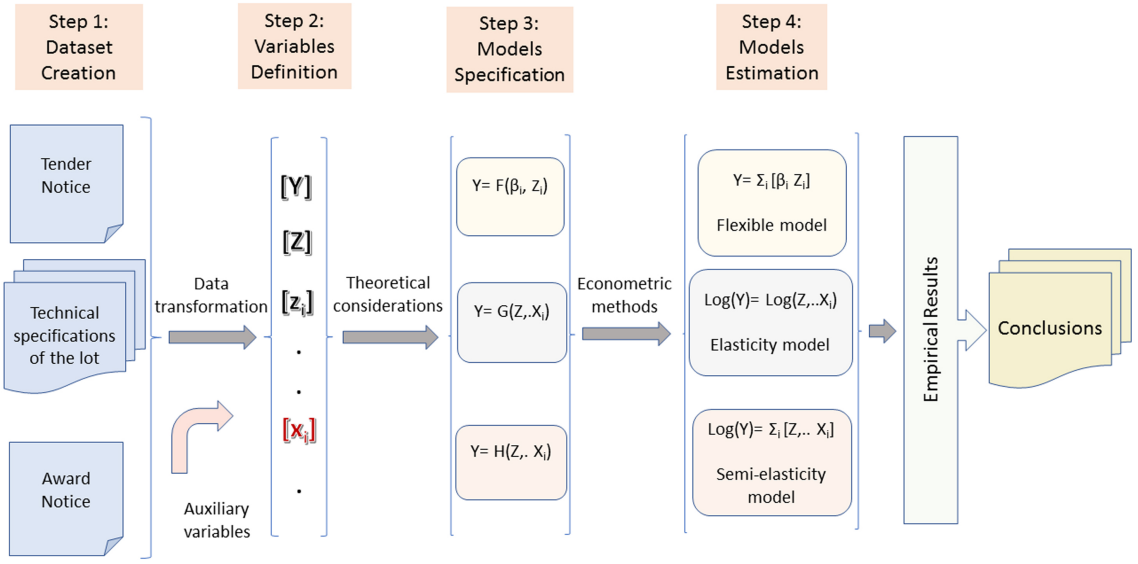


Figure S.2: Graphic representation of the methodological process of the research.

Sections S.4.1, on the dataset creation; S.4.2, on the definition of the variables; S.4.3, on the models specification; and S.4.4, on the estimation of the selected

models, describe the four initial steps, which are developed in chapters 4, 5 and 6 of this thesis.

The empirical results and the conclusions are specifically described in sections S.5 and S.6, completing this summary. They are extended in chapters 7 and 8 of the thesis.

S.4.1 *Dataset creation*

The dataset was created from the publications issued by Europe Aid[3]. The curation process involved looking up and classifying all the relevant information from 220 tender dossiers for supplies of different goods called for between 2014 and 2017. The dossiers are listed in annex B of the Appendix.

The tender dossiers are typically characterized by two main documents: the *supply contract notice*, whose official template is presented in section A.1 of the Appendix and the *supplies contract award notice*, whose official templates are also presented in the Appendix in sections A.2 and A.3.

The supply contract notice includes among other general details: the title of the contract funded by Europe Aid, the region and the country (or countries) where the contract will be implemented, a six-digit unique reference code for the contract, the budget line of the financial instrument or programme funding the contract, and the name of the contracting authority.

The supply tenders included in the dataset were funded with the financial instruments of: European Neighbourhood (ENI), with tender procedures in Morocco, Egypt, Tunisia, Jordan, Lebanon and Algeria; and EU Pre-accession Assistance (IPA), with supply procedures in Albania, Bosnia, FYROM (Former Yugoslav Republic of Macedonia, currently North Macedonia[4]), Serbia, Montenegro and Turkey. In addition, Kosovo is included in the research under the status of the resolution of the United Nations Security Council 1244[5] as a singular geographic market, owing to the fact that Kosovo benefited both from IPA funds and funds from the instrument EULEX.

Subsequently, the supply contract notice includes the contract specifications, in particular: the description of the object of the contract (that is, the goods to be acquired), and the number and title of each of the tendered lots. The tender dossiers in the research comprise one or several lots. Generally, the lots are awarded simultaneously. Each tendered lot produces an independent observation in the dataset, because it corresponds to a specific and indivisible good acquired at an independent price from the price of the rest of the lots.

3 I accessed these publications from the end of 2017 to the beginning of 2019 through this website: https://ec.europa.eu/europeaid/home_en

4 FYROM is referred to be consistent with the denomination existing in the data collection period.

5 In the thesis, any mention to Kosovo must be understood in connection with the referred United Nations status.

The sample consists of 587 observations. The majority of the procured goods are equipment and machinery for different industries (around 35% of the total). Hardware and software is also a dominant category of goods in the sample (around 29% of the total). The rest of the goods are different kind of vehicles, medical and chemical materials, and furniture.

Figure S.3 represents the proportion of tendered lots for each category of products collected in the dataset. Each category corresponds to a binary variable in the specification of the models described in section S.4.2.

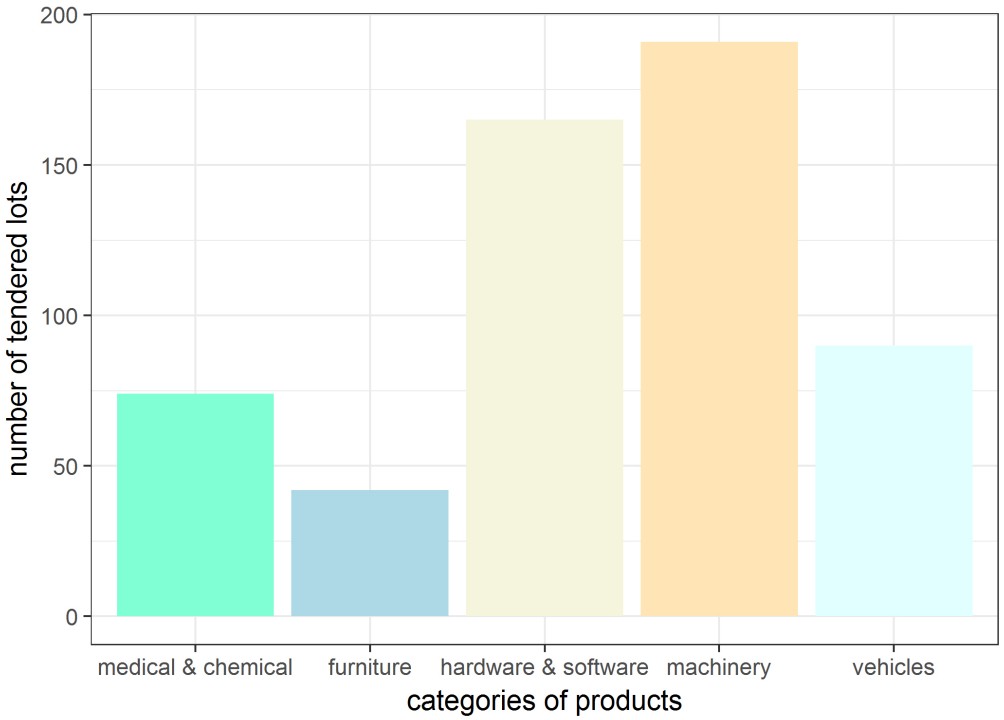


Figure S.3: Distribution of number of tendered lots per product category for all the lots where the award notice indicates the number of participants in the tender.

Afterwards, the supply contract notice specifies the terms of participation, that comprise among other: the eligibility rules and the rules of origin for the bidders and the goods, the grounds for exclusion, the amount of the participation tender guarantee (if required), the amount of the performance guarantee (if required), the submitted bid validity period, and the contract implementation period. The dataset includes 457 lots in which the buyer required a tender guarantee to enter the procurement auction and 130 in which such a guarantee was not required.

The next section in the contract notice includes the selection criteria and the award criteria. Selection criteria are based on: economic and financial capacity of the bidder; professional capacity of the bidder; and technical capacity of the bidder. The award criterion for the tender dossiers in the research is best price.

Finally, the supply contract notice establishes the tender instructions, in particular: how to obtain the tender dossier, the deadline to submit bids, the place and date of the tender opening session, the language of the tender procedure and the legal basis governing the procedure.

The contract award notice includes details that are common to the contract notice such as: the title of the contract, the region and the country or countries where the contract will be implemented, the reference code, the contracting authority and the legal basis. In addition, it includes the specific information on the awarded contract, which comprises: the type of procedure; the number and title of the awarded lot; the number and the value of the contract; the award date; the number of received tenders; the name, the address and the nationality of the winner; the duration of the contract; and the DAC code of the awarded lot (when applicable).

Some of the lots are awarded after several months from the initial call for tender, and the publication of the official resolution takes some time as well. Hence, the research uses the date of 31/05/2018 as the deadline to collect data from Europe Aid published dossiers[6].

In the dataset there are 479 awarded lots with a specific price that is public and 108 unsuccessful procedures.

Several unsuccessful tendered lots have originated relaunched procedures within the period covered in the sample. In these cases, the dataset includes two different records: the first one includes the unsuccessful initial lot (a record with no bids). The second record includes the data of the awarded relaunched lot[7]. When the procedure is unsuccessful and the lot is canceled the sample includes only one record with no bids.

There is a reduced number of 25 tenders in which the number of bidders included in the award notice is the global number of bidders for all the tendered lots.

When estimating the empirical models in the research, I discarded those records where the actual number of bidders competing for each individual lot cannot be ascertained. In addition, I use only those records where the contracting authority established the requirement of a participation tender guarantee to access the tender, because this information enables the estimation of a reference price for the tendered lot. The buyer's real reserve price is not public and, therefore, without estimating a reference price, the research could not be performed.

6 This deadline has been taken considering the average period of 7-8 months for the entire procedure estimated in Europe Aid regulations.

7 The lot that is tendered in the relaunched procedure may change its specifications. For instance, the quantities of the goods, their features or the amount for required tender guarantee may vary. Therefore, we consider that it is reasonable to keep two separated records in the sample because they are strictly different procurement auctions.

S.4.2 *Description of main variables*

The dependent variable of the models is a composite variable, which is strictly associated to the awarded lots. I define it as follows:

• *Normalized procurement cost*. This variable is named *indpago* in the models specified in the research and it represents the ratio between the awarded price of the lot, P^*, which I identify with the procurement cost, and the reference price of the lot, *Pref*.

$$indpago_k = P_k^*/Pref_k \qquad k = 1, 2, ..., K \tag{S.1}$$

where k represents each of the K awarded lots included in the sample that required the provision of a tender guarantee to participate in the tender.

As it is indicated in section S.3.2, the buyer's reserve price is private, and I need to estimate a reference price. The rules of the tendering procedure under study establish that the tender guarantee must fall between 1% and 2% of the engineered maximum value of the contract determined by a market study[8]. Therefore, it is possible to infer the reference price, P_{ref}, from the price signal of the tender guarantee.

This reference price can be calculated by all the bidders according to their own estimation criteria, and it may be interpreted as an indicator of the common value for the lot, if this exists. In the research I have calculated the reference price with equation (S.2), by using the middle point between the two thresholds for symmetry reasons.

$$P_{ref} = A/0.015 \tag{S.2}$$

Where A is the amount of the tender guarantee.

In section 4.2.5 I delve into the concepts of reserve price and reference price, and I justify the choice of the reference price calculated with equation (S.2). I also detail in section 8.2.2 the innovative aspects of this methodological approach and the relevance to use it for the purpose of the research.

The choice of the dependent variable as a variable referred to the estimated reference price is useful to interpret directly the marginal effects of competition on the procurement cost, controlling for other specific auction attributes in the procedure that are statistically significant. The lacking information on the bidders' characteristics in our dataset is partially captured by the preliminary market study yielding the reference price. One of the consequences of this lack of information is the potential endogeneity of the variable representing the number of bidders in the empirical models.

8 Point number 11 of the supply contract notice template presented in section A.1 shows these thresholds as well.

There is a strong correlation between the procurement cost and the reference price[9] of the lots. Referring procurement cost to this engineered price, which is calculated homogeneously across tenders, allows to isolate the effect of competition based on the accessible data of the winning bid only. It also limits prices intertemporal effects. The few studies on this topic counting with a reference price for the tendered lots make the same treatment for this variable. See for instance, (Onur and Özcam, 2012).

Finally, the normalized approach of the dependent variable allows to calculate immediately the savings rate, SR, which is the main objective of the research.

$$SR_k = \frac{Pref_k - P_k^*}{Pref_k} = 1 - indpago_k \qquad k = 1, 2, ..., K \tag{S.3}$$

where k and K have the same interpretation than in equation (S.1).

I analyze subsequently the regressors appearing in the models specified in the research.

• *Number of bidders*. This is the main regressor. It indicates the level of competition in the procedure. I represent the number of bidders either as a set of discrete variables or as an approximation to a continuous variable.

When I represent it as a set of discrete variables, I define individual categories with subscripts. For instance, *BIDS3* is a dummy variable taking the value 1 when the number of bidders participating in the tender is 3, and the null value otherwise. When I represent it as a continuous variable, I call it *bids*. This variable takes the null value when the procurement auction is unsuccessful and, otherwise, it takes the value of the number of valid bids received by the contracting authority.

The research methodology considers all the characteristics that the variable representing the number of bidders may exhibit, taking into consideration:

- its modeling as a categorical variable (individual non-linear effects) or as a continuous variable in a closed functional form.
- its endogenous or exogenous behavior in the model.

When the number of bidders is represented as a categorical variable (which is essentially its nature as the number of bidders is a whole number), the empirical models allow the estimation of different effects with every new bidder entering competition. When the models use the continuous variable approximation, they produce a smoother entry effect.

In these models where the number of bidders is represented with the continuous variable approximation, if this variable is endogenous, the effect of competition on procurement costs is biased when we estimate the models directly. Therefore, in addition to control for the heterogeneity of the market, I have corrected the bias with instrumental methods.

9 The coefficient of determination of the linear regression between both variables is greater than 0.90.

Figure S.4 presents the distribution of the number of bidders for the dataset used in the research.

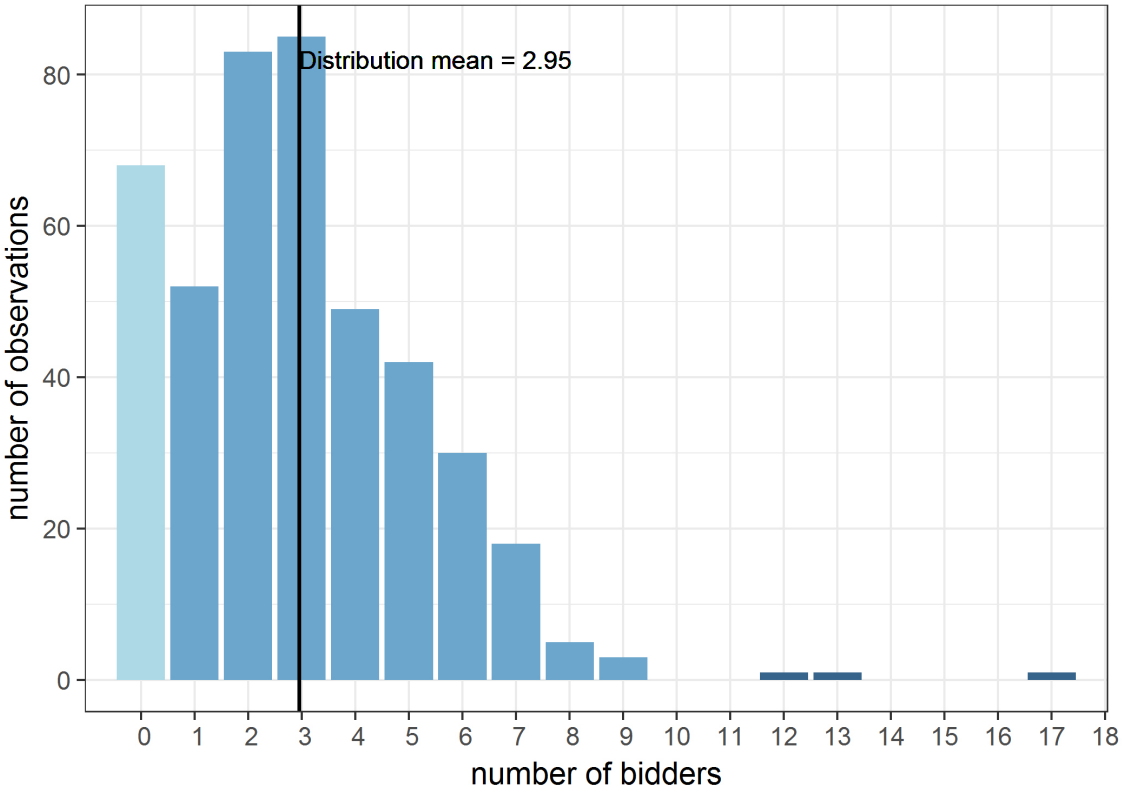


Figure S.4: Distribution of the number of bidders for tenders requiring a tender bank guarantee

The research uses the following regressors to control for the heterogeneity of the market:

• *Market place*. Data on the market place have been modeled with a set of categories. These categories have been created taking into consideration as differentiating factors the Europe Aid financial instrument funding the tender and the geographic position of the countries. I represent the categories in the models used in the research with the following dummies:

a) *DCATMAR1*. This dummy takes the value 1 for tenders in Turkey, which is the country with the highest number of supply tenders called for.

b) *DCATMAR2*. This dummy takes the value 1 for tenders in those countries benefiting from the IPA instrument, excluding Turkey and Kosovo, which benefit from IPA as well.

c) *DCATMAR3*. This dummy takes the value 1 for tenders in Kosovo, which benefits both from EULEX and IPA instruments.

d) The beneficiary countries from ENI, the Neighbourhood instrument, form the base group in the models specified in the research.

• *Product*. The tendered products in the dataset are heterogeneous. I have classified the data in general categories traditionally well recognized by the bidders competing for Europe Aid supply contracts[10]. I represent the categories in the models or the research with the following dummies:

a) *DCATPRO1*. This dummy takes the value 1 for lots in the general category of *furniture*. This category includes dominantly pieces of furniture to equip offices and premises of different organizations.

b) *DCATPRO2*. This dummy takes the value 1 for lots in the general category of *hardware and software*. This category includes computers, peripherals and software applications for different purposes.

c) *DCATPRO3*. This dummy takes the value 1 for lots in the general category of *mechanical and industrial equipment and machinery*. This category is broad because it encompasses equipment for different industries.

d) *DCATPRO4*. This dummy takes the value 1 for lots in the general category of *vehicles*. The dominant products in this category are road vehicles like cars, vans and buses. In some cases the contract relates to spare parts.

e) *Medical, forensic and laboratory equipment*. This category includes medicines, vaccines, laboratory instruments and materials of chemical nature. This category is the base group for products in the models specified in the research.

Other data have been modeled with dummies as well. These dummies have been tested in the estimation of the empirical models without resulting statistically significant. They include a dummy indicating whether the award relates to a negotiated procedure following an unsuccessful open call, a dummy indicating whether the scope of the tender is local[11] and another dummy indicating whether the tender included one or more lots.

Finally, to test the endogeneity of the variable *bids* in the models, I have used instrumental variables. Instruments in this auction environment are difficult to find for three reasons:

10 The tender dossiers used as data source include generally several classification codes of the goods for each lot. These codes follow the CPV (Common Procurement Vocabulary) standard. The research uses a classification in general categories according to these codes and to the description of the goods in the tender dossiers. I have selected the dominant nature of the lot when goods with several CPV codes are listed in it.

11 Local tenders are open to international bidders, but they may establish specific rules hampering broader competition like local publicity only, local administrative procedures, quotations and payments in local currency and other restrictions influencing bidders' decision to enter the tender. A tender with local scope involves always a contract value below a certain threshold. In the period covered by our study this threshold is 300.000.- EUR

- They can be endogenous in the empirical model as well.
- They may not have enough instrumental value for the variable *bids*.
- A trustable source of data for the instrumental variable in all the different countries included in the dataset may not exist.

In the research, I have selected the following instruments that fulfill the necessary instrumental criteria to be valid and relevant:

• *Gross domestic product lagged a year (GDP_1)*. GDP characterizes the development of each beneficiary country. Hence, it may reasonably have an influence on the bidders' decision to tender. Countries with higher GDP may trigger a higher interest in the tender procedure from domestic and foreign bidders. In the research, annual GDP in year 2000 constant USD billion has been used.

• *DTF lagged one year (DTF_1)*. The index DTF (*Distance to Frontier*) captures the gap between the country performance and a measure of the best practice performance across a sample of 41 indicators related to the regulatory economic environment[12]. It does not have necessarily the same behavior than GDP. The economic argument to choose this instrument is similar to the argument given for GDP, regarding the potential interest of foreign bidders. A better performance in this macroeconomic index may stimulate the participation of foreign bidders in the tenders.

• *Exports to the European Union lagged one year (EXPORTS_1)*. Exporting figures are an indicator of foreign trade activity of the beneficiary countries and they may have an influence on the number of incumbent bidders for the procured goods in the dataset used in the research. I consider exports to EU countries to account for the fact that Europe Aid tenders involve mostly[13] direct trade between EU countries and beneficiary countries.

I have built this variable from the data of the Directorate of Trade Statistics of the International Monetary Fund[14]. This source presents FOB Exports in current USD million. In order to make the figures retrieved from this source consistent with the previous instruments I have converted them to constant USD million[15].

GDP, *DTF* and *EXPORTS* are lagged one year in the models, because this is the information accessible to the bidders when tendering.

In the Appendix, annex C, I include a summarized descriptor of all the referred variables, which corresponds to the dataset created and used in the research.

12 The source of macroeconomic data for GDP_{-1} y DTF_{-1} is the webpage http://www.doingbusiness.org/en/methodology of the World Bank, which provides detailed information on the methodology for the elaboration of the mentioned variables.

13 This is due to the rules of nationality and origin. These rules are established in the 8th point of the tender notice. See section A.1 in the Appendix.

14 At the webpage data.imf.org

15 To accomplish that I have deflated the exports values by using the Consumer Price Index indicator of the World Bank at data.worldbank.org. This indicator uses 2010 as the reference year for the index.

S.4.3 *Empirical models specification*

As it is explained in section S.4.1, in Europe Aid supply tender environment the buyer requires often a participation guarantee to enter the procurement procedure. The guarantee amount provides a signal on the reference price of the tendered good.

Once calculated the reference price for each of the tendered lots in which the buyer requests a tender guarantee by applying equation (S.2), I study three empirical models used dominantly in public procurement auction literature.

In the three studied models, a random number of n bidders enters each tendering procedure. The tenders include different products and different countries. Hence, I control for this heterogeneity with several regressors that characterize the specific markets, and that I have detailed in section S.4.2.

Each bidder estimates a cost for the tendered lot and defines her bidding strategy based on the estimated cost. As I have introduced in section S.3.1, the estimation of this cost may come from a value of the cost that is the same for all bidders (Common Value Paradigm, CVP); from a value of the cost that is private for each bidder (Independent Private Value Paradigm, IPVP); or from a value of the cost derived from a broader paradigm (Affiliated Value Paradigm, AVP), where the CVP and the IPVP are the extreme special cases.

In the research, I assume that bidders are non-cooperative and they use a benefit optimizing strategy. I also assume market equilibrium, in line with the principles to build structural models. For example, (Paarsch, 1992) applies these assumptions to build and use structural theoretical models assuming CVP and IPVP as cost paradigms.

However, I do not assume *a priori* any cost distribution paradigm or specific simplifying assumption to define a privileged model with closed form solution. As I indicate in section S.3.3, the reason is that the tenders in this environment are likely affected by asymmetries caused by the international origin of the bidders, their different size and the possibility of joint bidding, among other circumstances.

Auctions with bidders' asymmetry result in non-closed form solutions to the equations characterizing the bidding equilibrium strategies in general situations like the one analyzed in this thesis (Campo et al., 2003).

On the other hand, even with the mentioned restrictive assumptions on the cost paradigm, the estimation of simplified models with closed solutions requires often the full set of bids, instead of the winning bid only, which is a limitation of the source of data available for this research.

Based on the referred arguments, I consider initially a model with non-closed relationship between the procurement cost normalized to the estimated reference price and the number of bidders in the equilibrium solution. As the tenders involve a restricted number of bidders, an empirical discrete model can treat flexibly this situation.

Furthermore, if we assumed that the real features of our auction environment approximate to conditions for a closed form, at least in a range of typical values, we would expect this approximated closed form to be non-linear, in general. Hence, in addition to a discrete model with non-closed form, I analyze two continuous models with closed non-linear functional forms regressing the normalized procurement cost on the number of bidders, controlling for heterogeneity market factors, as approximated models.

The three resulting models specified in the research are statically consistent and converge at least in a broad range of the regressor's values, including the average number of bidders in the dataset. This comparative approach is an innovative aspect of the research, since previous works in the literature impose restrictive assumptions to identify a privileged functional form for the selected model.

S.4.4 *Empirical models estimation*

In the empirical approach of the research, I estimate in the first place models assuming the number of bidders as a categorical variable and models assuming it as a continuous variable expressed in different functional forms, in accordance with section S.4.3; subsequently, I select those with the best goodness of fit and, finally, I compare the results.

For the selection of the discrete model, I estimate different models regressing several functional forms of the variable representing procurement costs on dummies representing each value of number of bidders (that is, taking value 1 for the specific number of bidders, and 0 otherwise) and on other regressors representing the tender environment (basically the features of the market defined in section S.4.2). The selected model is the best-fitting one according to econometric criteria.

The estimation of this first model with discrete categories for the number of bidders does not present any particular technical difficulties. As explained in section S.4.3, this is the most flexible model and the best adapted to non-closed equilibrium solutions expected for our tender environment. The main drawback of this model is the little representativeness of the categories representing a high number of bidders, because the sample described in section S.4.1 contains a limited number of observations for those categories.

Similarly, for the selection of the model where the number of bidders is represented by a continuous variable, I estimate several models with different functional forms of the dependent variable representing the procurement costs and different functional forms of the regressor representing the number of bidders. I also include other regressors representing the tender environment, as I do for the selection of the discrete model.

The best-fitting models with continuous approximation of the number of bidders provide a competition elasticity and semi-elasticity of procurement cost. The main advantage of the estimation of both models is that the results can be compared with previous results in this field. The main technical drawback in this case is the need to consider potential endogeneity of the variable number of

bidders in the models and, thus, I needed to treat endogeneity consistently in the estimation methods by using the adequate instruments described in section S.4.2.

It is important to reiterate that the models described in the last paragraph, with a closed form relating procurement costs and number of bidders, must be considered as approximations due to the conditions of the tender environment of the research.

S.5 RESULTS

I identify and briefly describe in this section the results of the best-fitting models found in the research. At the end of this section I represent graphically the three selected models, and I interpret more extensively the results in an aggregated manner based on the referred graphic representation.

The results of these models are important to draw the fundamental conclusions of this thesis. In particular, the three models converge for range of competition levels that includes the average number of bidders for the tenders in the dataset, which allows to obtain a robust average savings rate. Based on that average savings rate, in the final section of conclusions of this summary S.6, I analyze aspects of the efficiency of the tender procedure, and I elaborate suggestions to improve the design of this procedure.

• Flexible non-linear model.

$$\begin{aligned} indpago = {} & 1.151 - 0.154 DCATPRO1 - 0.132 BIDS_2 - 0.166 BIDS_3 - 0.192 BIDS_4 - \\ & - 0.277 BIDS_5 - 0.236 BIDS_6 - 0.242 BIDS_7 - 0.409 BIDS_8 - 0.209 BIDS_9 - 0.205 BIDS_{10} + \nu \end{aligned} \tag{S.4}$$

This flexible non-linear model points at a limit to the price competition effect as from eight bidders. This would be the typical bidding behavior in an auction environment satisfying the bidders' common value paradigm (CPV), where bidders try to avoid the winner's curse. This result is consistent with the discussions in previous works using a similar model, like (Brannman et al., 1987).

• Semi-elasticity model.

$$\log(indpago) = -0.172 DCATPRO1 - 0.027 bids + u \tag{S.5}$$

This model yields a semi-elasticity of -0.027 for all non-furniture goods. The same model applied exclusively to furniture goods yields a semi-elasticity of -0.098 for this category of products. The weighted average is -0.031. This result is comparable to that in (Onur and Özcam, 2012), who obtain an average semi-elasticity of -0.039 with a similar model for an unrestricted sample of all kind of procurement auctions in Turkey. The lower elasticity (in absolute value) in the empirical model of this research may correspond to a higher proportion of technological products in Europe Aid auction environment.

• Elasticity model (instrumented).

$$\log(indpago) = \text{-}0.179\text{DCATPRO1} \text{ -}0.076\log(bids) + \epsilon \tag{S.6}$$

The elasticity model is the best-fitting model according to criteria of statistic consistency. In this model, the competition effects would cease quickly with the entry of new bidders. The bidders' value would not be purely private. A certain level of affiliation would be expected. Once controlled for endogeneity, the model provides an elasticity of -0.08 for all non-furniture goods. The same model applied exclusively to furniture goods yields an elasticity of -0.28. The weighted average is close to -0.10. This result is comparable to (Iimi, 2006) who obtains an average elasticity of -0.2 in a model for an international sample of ODA auctions with high-value contracts over 7 EUR million, under simplifying IPVP assumptions. The lower elasticity in this research may correspond to a higher proportion of technological products and to the absence of potential high-value contracts sample selection bias.

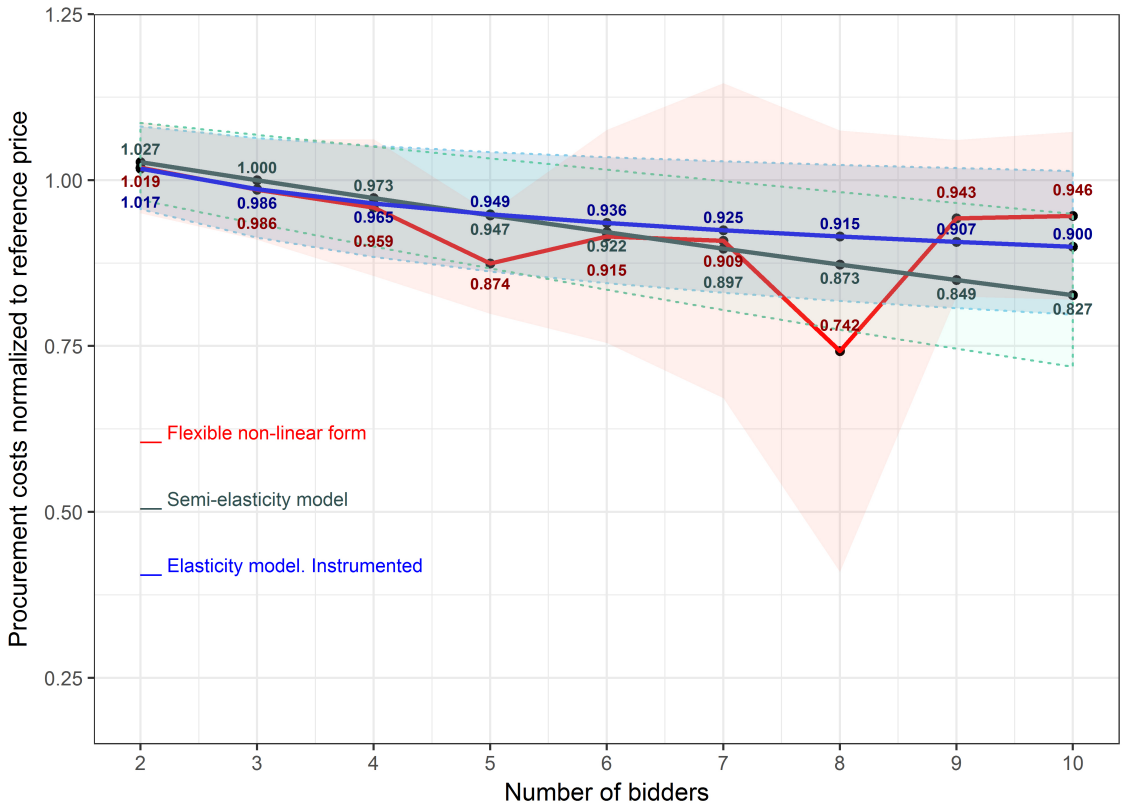


Figure S.5: Representation of best-fitting models to determine the influence of competition in procurement costs. The figure shows the predictors of the normalized procurement cost with confidence error bands for each number of bidders. It includes all kind of products, except for furniture goods, who have a different behavior.

The empirical results of the three selected models share the following relevant characteristics that are relevant for the conclusions of the research, and that can be directly interpreted from figure S.5, by noticing that the savings rate is simply the difference between unity and the represented curves, as expressed by equation (S.3):

1. The three models are statistically consistent. This means that their goodness of fit is adequate to make inference within the confidence margins commonly accepted.

2. As a consequence of the previous characteristic, there is a shared convergence range between the three models. In particular, for tenders with participation of between two and four bidders, the three models predict a similar savings rate. This behavior is logic as these are the categories of level of competition most frequently found in the dataset. With levels of competition of between five and eight bidders, the empirical predictions on the savings rate vary, although the increasing trend of this savings rate with higher levels of competition holds.

3. For levels of competition represented by nine or more bidders, the models diverge significantly, which does not only prevent to estimate the behavior of the savings rate, but also to interpret the underlying bidders' attributes in this tender environment. This is reasonable with regards to the comparative approach of the research, because the three models are consistent and, yet, each one responds to a solution of the equilibrium bid under different hypotheses on the bidders' attributes.

S.6 CONCLUSIONS

This research illustrates the positive effect of increased competition on procurement cost savings for Europe Aid supply tenders funded with the Pre-accession Assistance Instrument (IPA) and the European Neighbourhood Instrument (ENI).

In the research I identify three empirical models consistent with key features of procurement auction theory, like the fact that the relationship between the procurement cost and the number of bidders is non-linear. The empirical results are compatible with those obtained in other previous works in the Official Development Assistance (ODA) field.

The most innovative aspects of the research are: the creation and the treatment of the dataset; the estimation of a reference price homogeneously calculated for all the tendered goods requiring a participation tender guarantee, and the use of this reference price as an indicator of the buyer's unknown private reserve value of the lot; the definition of a savings rate referred to the estimated reference price of the lot, and the prediction of the evolution of the savings rate with increased levels of competition; and the multi-country, multi-product and comparative research approach based on the three identified empirical models.

The identified empirical models respond to a broad characterization of the bidders, whose attributes are unknown. The innovative aspects of the research focus on solving difficulties associated to absence of public data in the sector of ODA procurement auctions, and they contribute to the aim to analyze the efficiency of this market allocation mechanism. Consequently with it, the research results allow to suggest eventual improvements in the design of this mechanism for future implementation.

In this section I include a brief summary of the conclusions of the research structured in three subsections. Subsection S.6.1 focuses on describing the results related to the initial objective, namely the quantitative estimation of the effect on competition on the cost of the tendered goods. Subsection S.6.2 describes the measures suggested for a more efficient allocation, and higher savings on the acquisition costs. Finally, subsection S.6.3 indicates briefly which future research lines I consider more interesting as a complement and extension of the results of this research. All of them are conveniently developed and described in more detail in chapter 8 of this thesis.

S.6.1 *Level of competition and procurement costs*

The results of the prediction of the savings rate with the three selected empirical models converge up to the number of four bidders and diverge from eight bidders onwards. The average number of bidders in the tenders of the dataset is three, including also the void procedures. Because this average value is contained within the convergence range of the three models, the empirical results provide a robust value for the average savings rate.

The results of the research do not show differences between the effects of competition originated in tenders funded with IPA and ENI. However, the category of furniture goods exhibits a more competitive behavior than the rest of procured goods in the three selected models. This effect is reasonable in economic terms, because furniture goods would not require sophisticated production processes, and therefore they could be provided by different local suppliers at more reduced prices.

For the average number of bidders the three models predict a low savings rate below 1.5% regarding the reference price for all the geographic markets and for all products, with the exception of furniture goods.

The characterization of the bidders in the auction environment of the research can not be totally determined. In the first place, we do not count with relevant information on them, because this information does not appear in the public tender dossiers (data on the winner appear only). On the other hand, the fact that the three selected empirical models are all statistically consistent indicates implicitly that bidders can be characterized with different attributes compatible with the empirical results.

The model with the best goodness of fit to the dataset is the elasticity model, which yields an elasticity of -0.08 for all the products, except for the furniture goods. The estimation of this value requires endogeneity correction for the variable representing the number of bidders. The negative sign of the elasticity indicates that a higher level of competition stimulates savings on the procurement costs, which is in line with the theoretical predictions. The representation of an elasticity model depicts a procurement cost smoothing slope curve with the entry of new bidders, which would correspond to an auction environment with a certain level of bidders' affiliation.

Despite the fact that all selected models in the research are empirically consistent with the dataset, from an economic point of view, the elasticity model characterizes in a reasonable way the competitive auction environment. On one side, the endogeneity of the level of competition observed in this model could be induced by bidders' asymmetries. I have justified in section S.3.3 that these asymmetries would be usual in auction environments where bidders have different nationality, different size and are authorized to compete with joint bidding strategies, which are all situations found in the Europe Aid supply tenders of this research. On the other side, the iteration of these markets with regular tenders of similar products would justify a certain level of affiliation, that is, a certain common propensity to bid more or less aggressively for the same lot, in particular by incumbent bidders.

The reduced savings rate obtained for the average number of bidders in the tenders of the dataset, which is a robust value based on the convergence of the three selected models, indicates that measures promoting competition in Europe Aid supply tenders would contribute to achieve more significant savings and, hence, opening the door to political action in this field. I offer some suggestions of potential measures in next section.

S.6.2 *Improvement measures based on the design of the allocation mechanism*

Two kind of political actions have been proposed as improvement measures in the conclusions of this thesis. They are developed in section 8.1.2.1.

The actions of the first kind concern the tender rules. Based on the predictions of auction theory, and considering that the implications of the best-fitting empirical model regarding the underlying bidders' attributes: asymmetry (at least partially) and a certain level of affiliation, are also the most reasonable attributes also in economic terms, the first price English auction modality would provide a higher payoff to the buyer. In the English auction the bidders bid consecutively upgrading their previous bids, until a bidding round in which none of them can improve the final bid, which results the winning bid.

This action proposal involves introducing dynamic elements in the auction that reveal price signals on the bidders' valuation of the lot. In a practical context, such a modification of the tender rules may face significant challenges based on

the decentralized tender procedures to the beneficiary countries, and the complexity of the mechanisms to conduct the tender and to control the management of the funds. The feasibility of the implementation of this measure would be associated to the introduction of online bidding methods, which would simplify the procedure to conduct multiple bidding rounds. Significant savings in the procurement costs of the tendered lots induced by a higher competition would contribute to fund the investments in the technological system required for the implementation of this improvement measure.

The actions of the second kind concern favoring the participation of a higher number of potential bidders by reducing the requirements to access the tender procedure. In particular, the requirements of technical and financial capacity considered disproportionate in the current practice could be addressed. By limiting these requirements and by adapting the capacity criteria to the reality of local bidders and, in general, to bidders of lower size such as small enterprises, a higher participation in the tender procedure can be stimulated and, consequently, higher savings induced by the effect of raising the level of competition can be achieved.

The empirical results of the research would support this measure, because they detect how less sophisticated product categories, namely furniture goods, present a more competitive pattern and a highly significant number of local awarded enterprises.

Other measures promoting the participation of local bidders, or of small enterprises, would be alternative solutions to study under this kind of actions, like acting on the awarding rule with incentives to the local participation, for instance. Besides contributing to the positive externalities associated to the aims of ODA, like favoring internal markets in development countries, this measure would promote a higher competition in the tender procedures and would compensate reasonably the costs of the incentives.

s.6.3 *Future research lines*

The research can be extended in the future to other types of contracts funded by Europe Aid, like those related to works and services, which would result in a more complete characterization of the competitive behavior of this sector for the whole range of exchanged goods.

Another interesting field of research, and directly related to the field addressed in this thesis, is the analysis of similar data in the current EU budgetary period (2021-2027), which would allow drawing an impact estimation of the implementation of the new phase of the Pre-Accession Assistance Instrument (IPA III) and the European Neighbourhood programme withing the new Europe Global Instrument (NDICI) on the reduction of procurement costs for supply contracts. This temporal comparative approach would be innovative in the ODA sector, and it is a frequent approach in other related economic fields, like the economic convergence of these development countries with regards to the EU standards.

Endowing the research with a broader geographic context is another interesting future research line. For instance, to extend the geographic scope to more distant regions from Europe where official development aid is also provided, like Sub-Saharan African and Latin America. The major challenge to face in this case would be the potential lack of representativeness of the dataset, both owing to a lower number of tender procedures and its influence in the statistical treatment, and to a possible higher heterogeneity of the markets. This challenge of technical character would be compensated for the attainment of a more global view of the effectiveness and effectiveness of the allocation mechanism for these markets.

Finally, a relevant line of research corresponds to the characterization of the tender environment for this procurement auction environment focusing on the bidders' attributes. This is an ambitious objective that require the institutional implication and accessing to a richer dataset with bidder's relevant information. An immediate practical use of this research line would be the justification of the specific possible reforms of the auction rules governing the current tender procedure analyzed in this thesis.

Part II

COMPETITION EFFECTS IN EU EXTERNAL AID: A CASE STUDY FOR SUPPLY TENDERS

This second part of the thesis provides a detailed discussion of the research. The fundamental results regarding the quantification of the effect of competition on the costs of procurement auctions called by Europe Aid for supply contracts are included in the publication (García and Mochón, 2021).

My work in the referred publication included the dataset creation and the identification and estimation of the models used in the research. I counted with the inestimable support of Prof. Mochón Saéz in the revision of the theoretical concepts of procurement auction as well as in the discussion of the results and the elaboration of the conclusions of the paper.

Several sections of that publication are extended with more in-depth concepts and explanations. These include the dataset creation, the theoretical concepts, the characterization of the auction environment, the justification of the methodological approach for the identification of the empirical models. Other sections have been updated and complemented emphasizing the innovative contributions of the research. This concerns particularly the section related to the conclusions of the research and how policy measures in this tender environment could reduce procurement costs.

1

MOTIVATION, OBJECTIVES AND STRUCTURE OF THE THESIS

In this introductory chapter I present the motivation to conduct the research and the objectives of this thesis. The chapter is organized as follows:

In section 1.1 I motivate the choice of the Official Development Aid field as the subject of the research and I describe its economic relevance. I provide a brief insight to the history of this field and to the representative institutions. Then, I focus on the specific contribution of European institutions in subsection 1.1.1 and I describe the two financial instruments funding the acquisition of goods analyzed in this thesis in sections 1.1.2, instrument of Pre-Accession Assistance, and 1.1.3, European Neighbourhood instrument.

Subsequently, in section 1.2, I define the objectives of the research. They are oriented in the first place to estimate the performance of the allocation mechanism for the exchanged goods analyzed in the thesis, and based on the achievement of that initial objective I aim at proposing potential improvements in the mechanism design.

Finally, in section 1.3, I describe how I have structured the thesis in different chapters.

1.1 MOTIVATION

Foreign aid to development countries in modern era has followed an ever growing trend starting after World War II. United States launched the Marshall Plan for European recovery in 1948 shortly after the creation of the International Bank for Reconstruction and Development, the institution evolving to the current World Bank, one of the largest sources of funding for development countries.

Foreign aid involves the international transfer of capital, goods and services from a country or international organization to a beneficiary country for the benefit of its population. The aid can be of different nature, for instance economic aid, military aid, emergency aid and humanitarian aid, to mention a few purposes.

The most common type of foreign aid is official development assistance (ODA). Following the OECD Development Assistance Committee's definition, ODA is government aid that promotes and specifically targets the economic development and welfare of developing countries (OECD, 2021b).

United Nations established in 1970, under the resolution 2626, the ODA target of 0.7% of GDP at market prices from economically advanced countries to developing countries (UN, 1970). This is the best known international target in the official aid field, although few countries have achieved it yet.

ODA has two main features:

- It is provided by official governmental agencies.
- It is concessional. This means that the funding is organized typically as grants or soft loans to the beneficiary countries.

There are different institutions providing funding that fulfill the two distinctive features of ODA. Some of them are local, some of them are national, and some of them are supranational agencies, which manage the funds of donor countries. In addition, depending on the funding mechanism, we typically find financial institutions, like development and investment banks; and non-financial institutions, like external aid cooperation agencies.

The following non-exhaustive list identifies some of the more renowned ODA institutions according to their typology.

Financial institutions

- The World Bank (WB): It counts with 189 member countries. It consists of five institutions working for sustainable solutions that reduce poverty and build shared prosperity in developing countries. The WB finances development projects with traditional loans, interest-free credits, and grants.
- The European Bank for Reconstruction and Development (EBRD): The EBRD is owned by 71 countries, as well as the European Union and the European Investment Bank. The EBRD finances projects in the Southern and Eastern Mediterranean region, Central and Eastern Europe, and Central Asia. The EBRD promotes environmentally and socially sound and sustainable development as one of its values. The EBRD uses loans and equity investments as financial instruments.
- The Inter-American Development Bank (IADB): The IADB is one of the international development regional banks. It is owned by 48 member states, of which 26 are borrowing members in Latin America and the Caribbean. Each member country's voting power is based on its subscription to the institution's Ordinary Capital (OC) resources. IADB strategic priorities are: social inclusion and equality; productivity and innovation; and regional economic integration. IADB offers funding through loans, grants and guarantees to sovereign and private sector clients.
- Japan International Cooperation Agency (JICA): JICA is a national institution that works on human security and quality growth in accordance with the Development Cooperation Charter. It finances projects all around the world, with a primary focus on the Asian region. JICA finances the development actions with loans requiring repayment.

Non-financial institutions

- Europe Aid: This is the traditional name of the EU development agency, although there are different departments at the European Commission in

charge of development policies. EU development assistance policies operate via grants to beneficiary countries to fund development projects. Funds are organized through non-reimbursable budget support financial instruments and programmes covering different regions and specific sectors.

- US Aid: This is the United States of America International development agency. As part of its mission, US Aid leads the U.S. Government's international development and disaster assistance through partnerships and investments. Most of funded projects are financed with grants, although loans are part of the portfolio as well (USAid, 2019).

- United Nations Development Programme (UNDP): It operates as the United Nations development agency. UNDP assists countries to achieve the Sustainable Development Goals. It concentrates the current efforts on three areas: sustainable development; democratic governance and peace-building; and climate and disaster resilience. UNDP relies entirely on voluntary contributions from UN Member States, multilateral organizations, private sector and other sources to fund projects.

In addition to facilitate the classification of institutions providing ODA funds, the definition and the two main features of ODA funds are useful to account for the amount provided by governments to development assistance. The OECD Development Assistance Committee's mandate establishes as one of its specific objectives: "*to monitor, to assess, to report, and to promote the provision of resources that support sustainable development by collecting and analyzing data and information on ODA and other official and private flows, in a transparent way*" (OECD, 2017). Thus, the governments of OECD countries report their ODA expenditures to the DAC of the OECD and the DAC compiles and publishes ODA statistics.

The volume of ODA funds provided to developing countries by OECD members of the Development Assistance Committee exceeded USD 160 billion in 2020. In real terms, total ODA in 2020 rose by 3.5 % compared to 2019 and reached its highest level ever (OECD, 2021a).

Figure 1.1 shows the evolution of ODA funding in the last seven years, as recorded by the DAC of the OECD.

A major part of these funds comes from European Union countries, the EU being the largest development aid donor. The external action of the European Union manages a significant part of ODA funding from EU member states, and the EU institutions occupy the third place in the rank according to the standard for measuring ODA (OECD, 2021b).

The dominant mechanism used in the allocation of official development assistance is procurement auction. This is a widespread mechanism for the allocation of public markets, which responds to sound theoretical concepts to achieve best-value for money when properly implemented. Some of the assumed advantages are: suppliers are encouraged to compete for the award, negotiation costs are reduced and it is generally considered a fair mechanism. The most frequent challenge of the implementation of this mechanism is how to balance the quality assurance requirements with rules attracting a relevant number of participants.

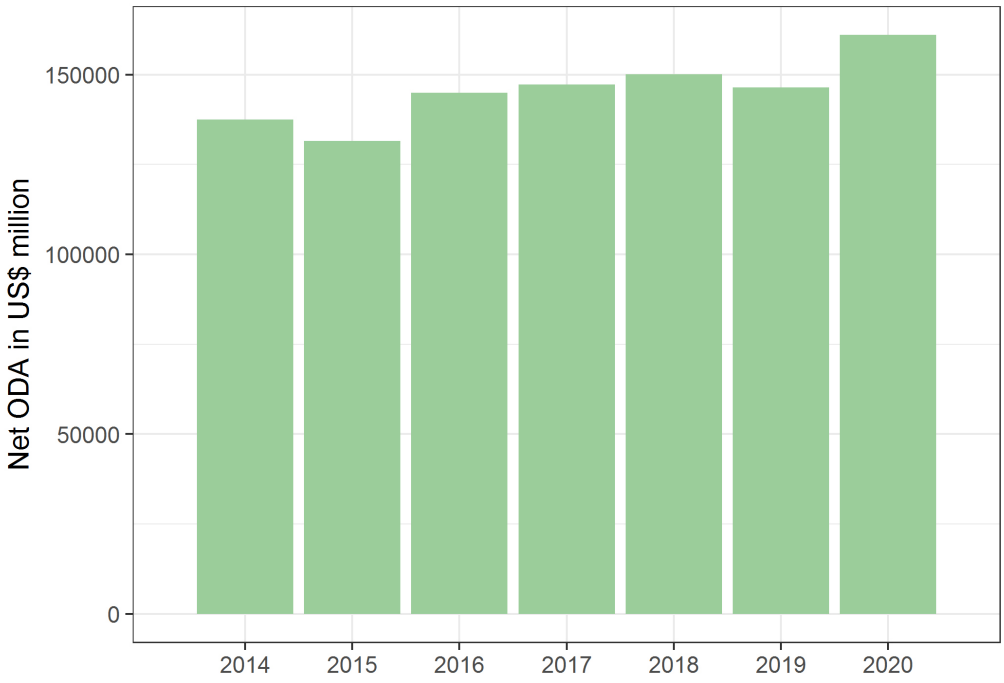


Figure 1.1: Net ODA funding in current USD million with preliminary figures from 2020. Source OECD

Despite the economic relevance for the international trade of goods and services that ODA generates, and the instrumental value of these funds for local business development and governance improvement, the number of empirical studies carried out to estimate the cost of the goods and services provided by ODA to the beneficiary countries is very limited. The most frequent argument in the literature is the lack of public data on bidding procedures in development countries. Other authors quote arguments that may be connected to the sensitive political aspects of ODA, (Iimi, 2006).

In the context of the EU, limited data and political implications of EU funding are considered as well in the methodological approach and the context of other empirical studies conducted in countries covered in this thesis, for instance (Tsanana and Katrakilidis, 2014) researching on income convergence with EU.

1.1.1 *ODA from Europe Aid*

The European Union has established in 2021 the legal basis for the new ODA financial instruments. These include: the third phase of the Instrument for Pre-accession Assistance (IPA) and the new Neighbourhood, Development and International Cooperation instrument - Global Europe (NDICI). IPA III has a financial envelope of more than EUR 14 billion (EC, 2021) and NDICI has a financial envelope of more than EUR 79 billion (Parliament and Council, 2021). Both instruments amount for most of the funding of EU External Action and, in conjunction with the Humanitarian Aid instrument and other specific instruments

with lower funding, make the whole allocation exceed EUR 100 billion for the period 2021-2027. This amount involves a significant increase with regards to the budget allocated in the period 2014-2020.

Some features of the implementation of EU ODA programmes in the period 2014-2020 quoted by peer-reviewers of OECD are: strengthened engagement with civil society and local authorities, committed support to effective multilateral co-operation and partnerships, and predictability towards partner countries through multi-annual funding instruments. In addition, the EU became the largest provider of ODA non-reimbursable budget support (OECD, 2018).

Two of the main ODA financial instruments of non-reimbursable budget support in force during the period 2014-2020 were the second phase of IPA and the ENI. Both instruments benefited countries that are geographically very close to EU borders or share EU borders and, thus, are strategically a priority for EU cooperation policies. Non-reimbursable budget support financial instruments for those countries have a long tradition in EU development assistance.

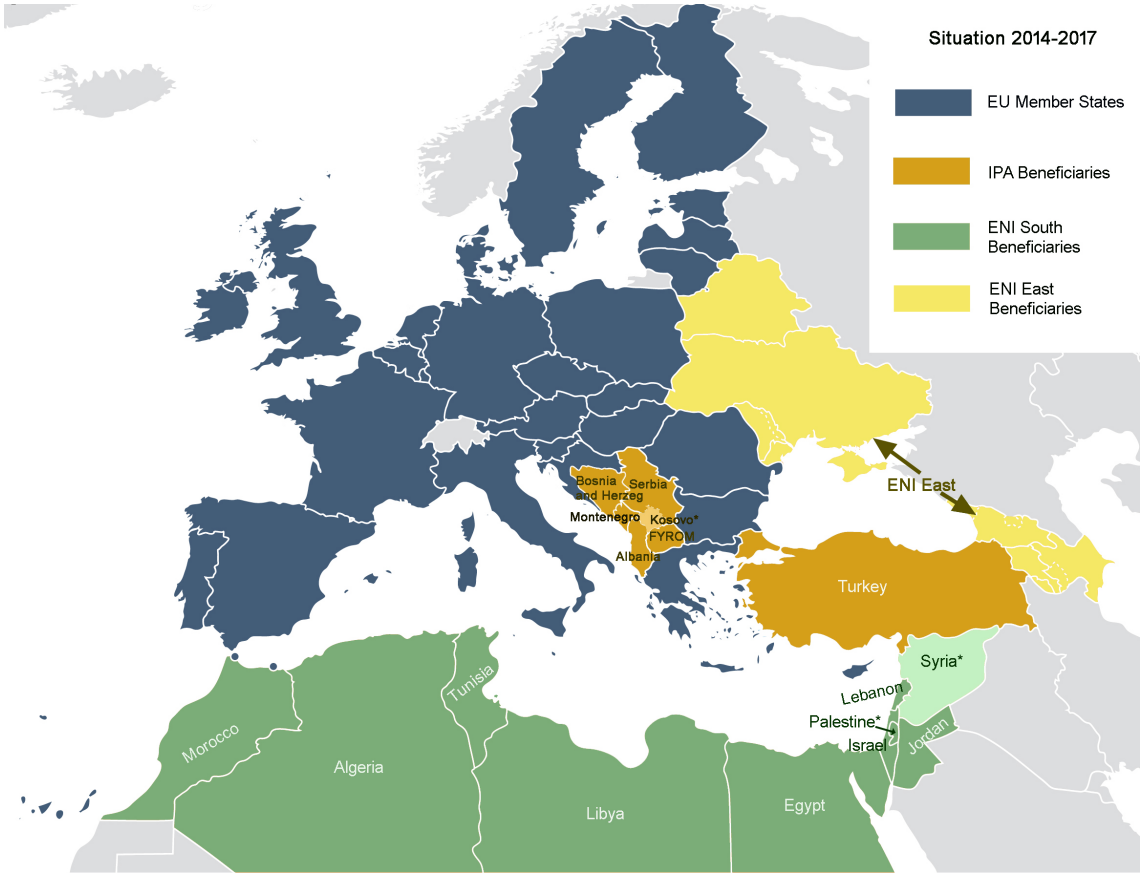


Figure 1.2: Geographic representation of EU ODA instruments in the Pre-accession and Neighbourhood regions. Situation 2014-2017

Figure 1.2 represents the geographic location and the beneficiary countries that are subject of the research in this thesis, in accordance with the situation in the period covered by the dataset.

1.1.2 *Instrument for Pre-accession to the European Union (IPA)*

This financial instrument started to be used at the beginning of the year 2007 in the first phase (IPA I) and it is still currently in force with the third phase (IPA III).

The legal framework for the IPA was established under the Council Regulation (EC) 1085/2006 and the implementation was regulated initially by the provisions in Commission Regulation (EC) 718/2007. Both documents have been amended subsequently. The legal framework for the IPA meant a significant policy change because this instrument replaced several funding programmes and financial instruments in force until that date.

The current beneficiaries of the IPA are: Albania, Bosnia and Herzegovina, Kosovo, Montenegro, North Macedonia, Serbia, Turkey.

1.1.2.1 *IPA I. Period 2007-2013*

The allocated budget of the first phase of the IPA instrument was EUR 11.5 billion.

The instrument was structured in five funding components:

- Transition Assistance and Institution Building.
- Cross-Border Co-operation with EU Member states and other countries that were classified as eligible for the IPA instrument.
- Regional Development, with specific priorities of providing support to transport and environment infrastructure, of enhancing competitiveness and of reducing regional disparities.
- Human Resources Development with the aim of strengthening human capital and combating exclusion.
- Rural Development.

1.1.2.2 *IPA II. Period 2014-2020*

The allocated budget of the second phase of the IPA instrument was EUR 12.8 billion.

A main novelty of IPA II was strategic planning with individual focus on each beneficiary country. This was implemented through the documents called *Indicative Strategy Papers*, which were drafted for each beneficiary country and for the 7-year period. They served as the basis for financing programming. These documents intended the integration of beneficiary countries' own reforms and development agendas.

In addition, to this individualized approach, a Multi-Country Strategy Paper addressed priorities for regional cooperation and territorial cooperation.

The five components of IPA I remained in force.

1.1.2.3 *IPA III. Period 2021-2027*

The allocated budget of the current phase of the IPA instrument is EUR 14.162 billion, as it is established in its legal framework, the Regulation (EU) 2021/1529 of the European Parliament and of the Council.

The IPA III Programming Framework is the overarching strategic document for the programming of IPA III funds. It is developed in accordance with the policy framework and general principles set out in article 6 of the IPA regulation, and it takes the relevant national strategies and sector policies into due account. The Programming Framework replaces the indicative country and multi-country strategy papers that served as the basis for the programming of EU financial assistance under IPA II.

The new programming framework 2021-2027 focuses on the priorities of the enlargement process according to five thematic windows, which are strictly connected with the revised enlargement methodology. These windows are:

- Window 1: Rule of law, fundamental rights and democracy.
- Window 2: Good governance, EU acquis alignment, good neighbourly relations and strategic communication.
- Window 3: Green agenda and sustainable connectivity.
- Window 4: Competitiveness and inclusive growth.
- Window 5: Territorial and cross border cooperation.

The programming framework established as well IPA III indicative allocations per window and per year in the period 2021-2027. Window 3 is expected to receive the major proportion of the funds, amounting to more than 40% of the total envelope.

1.1.3 *European Neighbourhood Instrument (ENI)*

This financial instrument has been in force between 2014 and 2020. ENI built on a previous financial instrument, the European Neighbourhood and Partnership Instrument (ENPI), which was in force between 2007 and 2013. ENI continued supporting the European Neighbourhood Policy (ENP) of the European Union launched in 2004. A review of this policy took place in 2015.

Regulation (EU) No 232/2014 of the European Parliament and the Council provided the legal framework for the ENI. This regulation establishes the objectives of the instrument; the indicative programming and the allocation of funds; and the Cross-Border Cooperation with neighbour countries, which was further developed with Commission Implementing Regulation (EU) No 897/2014.

The objectives of the ENI are structured in six main specific cooperation targets in Title I of the Regulation:

- Promoting human rights and fundamental freedoms, the rule of law, principles of equality and the fight against discrimination in all its forms.
- Achieving progressive integration into the Union internal market and enhanced sectoral and cross-sectoral cooperation.
- Creating conditions for the better organization of legal migration and the fostering of well-managed mobility of people.
- Supporting smart, sustainable and inclusive development in all aspects.
- Promoting confidence-building, good neighbourly relations and other measures contributing to security in all its forms.
- Enhancing sub-regional, regional and European Neighbourhood-wide collaboration as well as cross-border cooperation.

The programming of ENI establishes three types of programmes in Title II of the Regulation: bilateral, multi-country and cross-border cooperation programmes. The majority of the tender dossiers included in the research belong to bilateral programmes, because the financial allocation for this type of programmes reaches the 80% of ENI financial envelope.

The beneficiaries of ENI were distributed in two areas, east and south.

- ENI South, including the following countries: Algeria, Egypt, Israel, Jordan, Lebanon, Libya, Morocco, Palestine[1], Syria[2], Tunisia
- ENI East, including the following countries: Armenia, Azerbaijan, Belarus, Georgia, Moldova, Ukraine.

The research conducted in the thesis focuses on the ENI South area.

The financial envelope set in the ENI regulation was EUR 15.4 billion, increasing with regards to the ENPI financial envelope, which was of EUR 11.2 billion.

In the current EU budget period (2021-2027) ENI has been integrated in the new EU financial instrument Neighbourhood, Development and International Cooperation Instrument - Global Europe (NDICI), established by the Regulation (EU) 2021/947 of the European Parliament and of the Council, as a part of the geographic programmes. These programmes are structured in three areas, besides EU Neighborhood: Sub-Saharan Africa; Asia and the Pacific; and Americas and the Caribbean.

The budget allocated for the geographic programmes is established in Article 6 of the NDICI regulation. The budget for the Neighbourhood area is set with at least EUR 19.3 billion of the total of EUR 60.4 billion for the geographic programmes.

1 The designation of Palestine is not construed as recognition of a State of Palestine and is without prejudice to the individual positions of the Member States on this issue.

2 EU Cooperation with Syria was suspended due to the political situation.

1.2 AIMS AND OBJECTIVES

The initial objective of this thesis is to measure the effect of competition on procurement costs in a multilateral market of different ODA goods. These goods are supplied to different beneficiary countries with the funding from the Europe Aid Pre-accession Assistance and Neighbourhood instruments. Building on the achievement of this objective, the aim of the thesis is to determine to what extent the allocation mechanism results in an appropriate acquisition price for the public contracting authorities acquiring the goods, and what measures would be required to obtain a more efficient allocation and higher savings on the public funds financing the acquisitions.

The goods are provided to the beneficiary countries by using the mechanism of procurement auction. In the auction environment of the research this mechanism takes the form of an open tendering procedure. The goods that are most frequently procured are technological equipment and machinery for different industries. Three other general categories of goods complete the market: vehicles, medical and laboratory equipment and furniture.

The aim of this thesis envisages to contribute to an optimized deployment of the beneficiary countries' resources and to a more cost-efficient use of the funds granted by European donors, through the implementation of the recommended measures.

To fulfill the aim of the thesis, I needed to complete four subsequent milestones related to the main challenges of the research:

1. To create the dataset and to define based on the data the relevant variables for the research.

2. To specify the empirical models of the research by using well-established concepts of auction theory applied to the International tender procedure.

3. To estimate the specified empirical models consistently with regards to the features of the dataset, by using adequate econometric methods.

4. To identify potential improvements in Europe Aid allocation mechanism, by using the predictions of auction theory applied to the empirical results of the research.

Completing each of these milestones requires achieving specific objectives, some of them of technical nature. They are addressed in the different chapters of this thesis following a structured methodological approach in subsequent related steps.

1.3 STRUCTURE OF THE THESIS

To finalize this introductory chapter, I describe in this section the structure of the rest of the chapters in the thesis.

Chapter 2 provides an overview of the state of the art in procurement auction, with a particular emphasis on the auction environment of Europe Aid supply tenders. It establishes as well the main theoretical concepts needed for the specification of the empirical models.

Chapter 3 describes the research methodology, which is structured in several steps. This chapter also introduces the Europe Aid supplies tendering procedure and provides the basis to model it as a sealed-bid first-price reverse auction.

Chapter 4 defines the dataset design based on Europe Aid public documents and the methodology to create this dataset. Finally, it determines the main variables used in the research, which are built from the information in the dataset.

Chapter 5 uses the discussion of the theoretical concepts for the specification of the empirical models of the research, provides the characterization of the significant variables in these models, including auxiliary variables, and describes the three specified models studied in the research.

Chapter 6 provides the empirical estimation of the models specified in the research. It justifies the estimation methods required based on the features of the relevant variables in the models.

Chapter 7 presents the results of the research. The empirical results are graphically illustrated showing a comparative analysis of the three selected models and their correspondence to other related works.

Chapter 8 summarizes the main conclusions of the empirical results, introduces suggestions for the improvement of the tender procedure based on those results, presents the innovative contributions of the research, and indicates future research lines in this field.

2

STATE OF THE ART IN PROCUREMENT AUCTION

In this chapter I analyze the state of the art in procurement auction, because Europe Aid tenders can be treated as one of the practical applications of this allocation mechanism.

For the purpose of the research, Europe Aid supply tenders are modeled as a type of reverse auctions. The contracting authority (the buyer) demands openly a product. A set of bidders (the sellers) send their bids privately (*sealed-bid* auction) according to their bidding strategies. The bidder with the lowest bid become the winner and sells the product at that price (*first-price* auction) to the buyer.

Hence, I focus particularly on specific concepts of auction theory applied to reverse first-price sealed-bid auctions. Three of these theoretical concepts are essential for the identification of the models that relate procurement costs to the level of competition in the auction environment of the research. The identification of these models, their estimation and the selection of those ones with the best goodness of fit are necessary steps to obtain the empirical results. Furthermore, understanding the theoretical concepts is also relevant to interpret the results, because there are several consistent empirical models selected in the research.

The chapter is organized as follows, in the initial section 2.1 I provide an overview of the topic of procurement auction. Then, in section 2.2, I describe the three referred concepts relevant for the identification of the models used in the research. Subsection 2.2.1 discusses the influence of the bidders' cost paradigm in the pattern of the relationship between procurement cost and level of competition, and the difficulties to determine such paradigm in our auction environment; subsection 2.2.2 analyzes the influence of the revealed information on this relationship between procurement cost and level of competition, and specifies which information is revealed in our auction environment and how can it be used for the purpose of the research; finally, subsection 2.2.3 describes how the bidder's asymmetries may affect both the determination of a uniform bidders' cost paradigm across tenders and the existence of a specific closed functional relationship between procurement cost and level of competition.

2.1 OVERVIEW ON THE TOPIC OF PROCUREMENT AUCTION

Procurement auction is a market allocation mechanism that attracts the attention of different research fields. It is rooted in auction theory and, therefore, the first relevant reference is the seminal paper introducing the analysis of auctions (Vickrey, 1961). Other relevant introductory works to auction theory are: (Klemperer, 1999), which is a comprehensive survey introducing and describing some of the essential papers on the subject; and (Milgrom, 2004), a book describing insights about auction design.

The literature includes many papers related to bidding behavior in auctions. Bidding behavior is approached under different research perspectives like general game theory, industrial organization for particular sectors, or more technical econometric methods to address conditions of the bidding environment in the estimation models. Particularly important for the purpose of this thesis are those papers that take into consideration the paradigms under which bidders build the value of the procured goods. Section 2.2.1 presents relevant references on this topic.

A second set of papers focuses on the importance played by information. Procurement auction is characterized as a game with incomplete information. Both the contracting authority and the bidders have private information related to the estimation of the value of the tendered good. The effect of disclosing, of partially disclosing or of not disclosing this information is critical to conduct the research and to propose eventual improvements to the auction mechanism. Some relevant references are presented in section 2.2.2.

Strictly connected with the handling of information in the auction procedure is the symmetry or asymmetry of the bidders entering to participate in the procedure. Many papers follow the assumption of symmetric bidders entering competition to establish simplified structural models for the equilibrium solution of the analyzed market. However, assuming symmetry in our auction environment does not seem *a priory* a realistic hypothesis. Section 2.2.3 refers to different papers approaching this phenomenon.

Finally, as we have seen in the introductory chapter 1, there are few works devoted to auction procurement in the ODA field owing to the absence of public data and the sensitive political implications of ODA, among other reasons. The most relevant papers in the literature focusing specifically on ODA and related research purposes with the purposes of this thesis are the following ones:

(Iimi, 2006) uses data on procurement auctions for Japanese official development assistance projects and estimates the equilibrium bid function under restrictive assumptions of pure private values and symmetric bidders. He finds an average competition price elasticity of -0.2 in large funded projects by the Japan Bank for International Cooperation.

(Onur and Özcam, 2012) investigate the effect of the competitive environment (number of participants) on the cost of procurement for all of the government procurement auctions called between the years 2004 and 2006 with data from the Public Procurement Authority of Turkey. With the estimation of a predefined empirical model they find an average competition price semi-elasticity of -0.039.

2.2 THEORETICAL CONCEPTS

Under the modeled auction environment for the supply tenders of this research, I consider that the bidders are non-cooperative. This means that I rule out any collusive behavior. In addition, I consider that the market of Europe Aid supply tenders is in equilibrium, and the bidders behave with a benefit optimizing strategy. This implies the assumption of rational bidders neutral to risk.

With the hypotheses described in the previous paragraph, the research uses three well-established concepts of procurement auction theory that influence the competition effects on the price of the procured goods introduced in section 2.1. These concepts are required to specify the models following a theoretical structural approach. They include:

1. Influence of the bidders' cost paradigm.
2. Influence of the revealed information in the procurement procedure.
3. Influence of bidders' asymmetries.

2.2.1 *Influence of bidder's cost paradigm*

According to auction theory, competition effects on the price of procured goods are directly related to the bidders' estimation of the value of the cost of the goods. (Milgrom and Weber, 1982a) provide a comprehensive introduction to the different value paradigms.

When the estimated cost has the same value for all the bidders (Common Value Paradigm, CVP), there is a limit to the competition effect on the price, even when this common value may be generally unknown. Thus, after the entry of a certain number of bidders into the tender procedure, the entry of new bidders does not modify the expected acquisition price significantly. This aversion to bid lower than a certain price, in situations of incomplete information, is known as the attempt to avoid the *winner's curse*.

When the estimated cost is private for each of the bidders (Independent Private Value Paradigm, IPVP), the effect of competition on the price of the procured good increases with each new bidder. This means that the price of acquisition gets continuously reduced.

(Paarsch, 1992) constructs two theoretical models of rational bidding for sealed-bid auctions leading to an empirical specification. Then he applies them comparatively to auctions for tree planting to decide between the two competing paradigms in that auction environment.

(Li, 2005) shows how the presence of entry decisions and binding reservation prices complicates the structural analysis. When using the observed bids and the number of actual bidders, they propose an MSM estimator to estimate the parameters in the distribution of private values assuming a private value paradigm.

(Silva et al., 2009) show in a theoretical model that regardless of whether the procurement is characterized by private or by common values an increase in the potential number of bidders may lead to higher procurement costs under certain circumstances, thus putting a limit to the positive effect of competition for the buyer.

(Hill and Shneyerov, 2013) develop a consistent non-parametric test of common values in first-price auctions and apply it to British Columbia Timber Sales data, by using the bid distribution.

More general approaches consider that the estimation of the cost derives from a broader value paradigm (Affiliated Value Paradigm, AVP) where the effect of competition on the price of the good ranges from the two extreme cases CVP and IPVP. This means that we may expect an intermediate effect between the other two special cases, which has a more complex interpretation.

(Pinkse and Tan, 2005) study the monotonicity of the equilibrium bid with respect to the number of bidders, n, in affiliated private-value models of first-price sealed-bid auctions and prove the existence of a large class of such models in which the equilibrium bid function is not increasing in n.

(Hubbard et al., 2012) develop a tractable empirical model of equilibrium behavior at first-price, sealed-bid auctions, within the affiliated private-values paradigm. The model is non-parametrically identified, and it is used to rejecting the hypothesis of bidding independence in a practical example, finding significant (and high) affiliation in cost signals.

Both references support the idea that the AVP is, in general, a more realistic value paradigm in the context of the auction environment of the research and that the empirical behavior may not respond clearly to a specific value paradigm. Different bidders' value paradigms can produce similar empirical behaviors under certain circumstances, in particular those behaviors where the positive effect of competition for the buyer restricts to a certain range of bidders.

2.2.2 *Influence of revealed information*

Under general considerations, when the buyer reveals information on the reference price of the goods for the kind of procurement auction used in this research, participation increases and, therefore, so does competition (Milgrom and Weber, 1982b). Hence, provided that the underlying cost paradigm is not a pure CVP for all bidders, the theory predicts that the effect of revealing information on the expected price of the procured goods will contribute to reduce the acquisition price based on the increased level of competition.

(Dufwenberg and Gneezy, 2002) report experimental results on the importance of information disclosure policy in first-price sealed-bid auctions. They find that when bidders are informed about the losing bids in previous periods, prices are higher than the theoretical prediction. However, when this information is not revealed the bidding becomes more competitive, and the bids come close to the theoretical prediction. They conclude that price signaling may be important for explaining these results.

(Silva et al., 2008) use a natural experiment and field auction data to test the phenomenon of auction theory according to which the release of information regarding the seller's valuation of an item can cause bidders to bid more aggressively and that this effect can be more pronounced in auctions with larger common cost uncertainty. All their empirical results are in accordance with the theory.

(Rosar, 2014) offers a theoretical explanation for the use of secret reserve prices in auctions considering first-price auctions with and without secret reserve price

in an independent private values environment with risk-neutral buyers and a seller who cares at least minimally about risk. He finds that fixing the rules early and keeping the right to set a secret reserve price can be strictly optimal.

(Matoso and Rezende, 2014) analyze bidding behavior in oil and gas tract auctions in Brazil. They test predictions from the theory of common-value, first-price, sealed-bid auctions with asymmetric information. The tests indicate that the winner was better informed about tract values than other bidders and bid higher than her competitors for more profitable tracts in accordance with the theory.

In the tenders studied in the research, the buyer reveals indirectly part of the information on the expected price of the good through the participation guarantee to enter the procurement procedure, which is required in most of the tender procedures. The use of this price signal in the empirical models to define a consistent savings rate across tenders is one of the innovative aspects of the research. In addition, and in line with the predictions, tenders with this price signal are more competitive than tenders without the price signal. The later exhibit a significant higher rate of void procedures than the former.

2.2.3 *Influence of bidders' asymmetry*

The bidders' typology influences the competition effect when there are significant differences between those types. The strategies to estimate the cost of the procured goods generally differ between bidders owing, among other potential reasons, to the asymmetry of the information they have and the asymmetry in their cost function. In the auction environment of Europe Aid supply tenders, the openness to the international origin of the bidders, the different size of the bidding companies and the possibility to participate as a part of a bigger consortium are reasons to create these asymmetries. Under these conditions, the solution to market equilibrium does not have a closed form (Campo et al., 2003).

(Li and Phillips, 2012) find empirical evidence to support the hypothesis of asymmetric auction theory that predicts that weak bidders will bid more aggressively when facing strong bidders, while strong bidders will bid less aggressively when facing weak bidders, regarding the behavior of weak bidders in a study with construction auctions.

(Chernomaz, 2012) explores the effect of a subset of symmetric bidders joining to bid together in an experiment. Contrary to the theory, joint bidding in this experiment increases efficiency and the seller's revenue decreases by less than expected.

(Hubbard et al., 2013) simulate auctions and calculate numerically approximated solutions fulfilling properties that bid functions concerning asymmetric auctions must satisfy under certain conditions in models of first-price auctions. They assume that bidders are *ex ante* heterogeneous, and that deriving explicit equilibrium bid functions is typically impossible according to the theory. They find that, for the examples considered, low-degree polynomial approximations

perform poorly and can lead to incorrect policy recommendations concerning auction design.

(Mares and Swinkels, 2014) provide new tools for studying asymmetric first price auctions, connecting their equilibria to the rho-concavity of the assumed underlying type distributions, and show how one can use surplus expressions for symmetric auctions to bound equilibrium behavior in asymmetric auctions.

Asymmetries in procurement auction procedures for different sectors and their causes are often found in the literature. For example, (Bajari, 2001) for highway construction and (Flambard and Perrigne, 2006) for snow removal auctions analyze asymmetries based on bidders' geographic locations. (Hendricks and Porter, 1992) discuss asymmetries associated to joint bidding for oil lease auctions. (Armantier and Sbaï, 2006) find asymmetries based on bidders' capacity to obtain quality information and on risk aversion for French Treasury auctions.

The consequence of the referred literature for the research is that there might not be *a priori* a closed-form equation satisfying the structural bid equilibrium. In addition, the public data do not allow to identify the bidders and their bids, they only provide information about the winner and the winning bid. Therefore, I cannot make any reasonable assumption on the bidders' typologies in this auction environment. This justifies the approach I have taken in the research to compare the empirical results of models satisfying different assumptions about the bidders' characterization and, then, focus on the similarities and differences of the results to draw the conclusions.

3

METHODOLOGY

The methodological steps described in this chapter indicate how the different milestones of the research were approached.

Figure 3.1 synthesizes the methodological process.

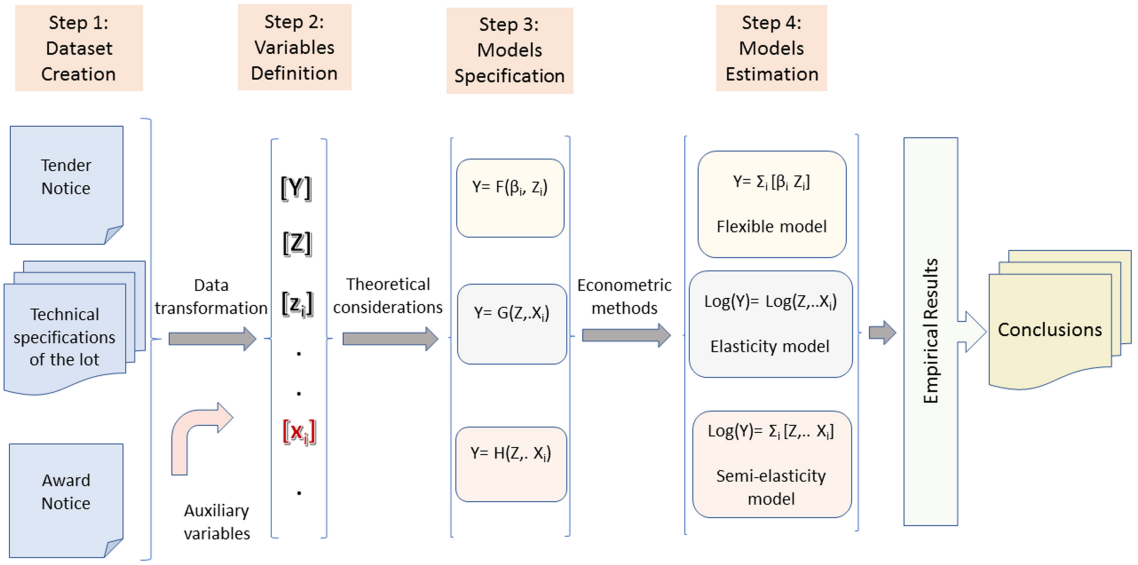


Figure 3.1: Graphic representation of the methodological process of the research.

The chapter is organized as follows.

Section 3.1 provides an overview of the the procurement auction procedure applied to ODA tenders. Section 3.2 focuses particularly on the procedure of Europe Aid supply tenders and model them as reverse auctions. Section 3.3 introduces the dataset creation process. Section 3.4 lists the main variables of the procedure. Section 3.5 characterizes the specification of the empirical models based on theoretical considerations and, finally, section 3.6 address the estimation methods used to select the empirical models of the research. The empirical results and the conclusions are specifically addressed in chapters 7 and 8 of this thesis.

3.1 OVERVIEW OF PROCUREMENT AUCTION PROCEDURE IN ODA TENDERS

Official development assistance tenders are an instantiation of procurement auction. These tenders may be classified depending on the number of bidders that are admitted to participate in the tender procedure called by the contracting authority. A basic and comprehensive typology is the following:

Open procedure: Any bidder may submit a bid.

The bidder must provide evidences of technical and economic capacity.

Restricted procedure: Only a maximum number of n bidders may submit their bids. The contracting authority selects the qualified bidders after conducting a prequalification procedure with criteria of capacity.

Negotiated procedure: Only a reduced number of n' bidders may submit their bids. They are invited at discretionary criteria by the contracting authority. For instance, after successful implementation of a previous contract.

In addition, based on the goods that are being tendered, tenders are usually classified in three broad categories: works, supplies and services.

Generally, Europe Aid tenders for works and supplies use open procedures, while tenders for services use restricted procedures[1].

Europe Aid uses negotiated procedures in limited cases. They usually apply to small-amount contracts or under exceptional situations like crises. They also apply when a previous procedure (open or restricted) has been unsuccessful, but the detected faults may be amended. In this last case, the contracting authority must motivate the decision based on technical and efficiency criteria against the alternative of relaunching the tender procedure.

Besides the descriptive purpose, this basic classification is relevant for the choice of the sample to fulfill the objectives of the research. The principle of identically distributed observations characterizing a random sample, which is used in the estimation of the empirical models may not be reasonably met for a sample that mixes procurement procedures with different restrictions on the number of admitted bidders, especially when the number of incumbent bidders is high[2]. Hence, in the research, I designed the dataset creation based on supply tenders only. This avoids risks of sample selection bias in the estimators of the magnitudes that are relevant for the research (Copas and Li, 1997).

Based on this dataset design, for every supply tender procedure used in the research n bidders bid openly in a procurement auction, n being unknown before the resolution of the auction. Tenders are open to international competition and

1 Tenders for services, apart from the bid, include an additional technical component influencing the score of the resolution. This means that the quality of the technical component is assessed in conjunction with the bid. Tender assessment costs to be incurred by the contracting authority influence the maximum number of admitted bids.

2 Restrictions in the number of bidders may condition bidders' strategies with regard to open procedures. For instance, bidders may decide to bid jointly with other bidders to be pre-selected in the previous qualification procedure.

bidders must respect the general rules of participation established by Europe Aid[3].

3.2 MODELING EUROPE AID SUPPLY TENDERS AS REVERSE AUTIONS

We have seen in previous chapters that in the thesis I model supply tenders as reverse first-price sealed-bid auctions. In this section I explain the modeling process.

Bidders form their bidding strategies based on the costs of production and delivery they can obtain for the tendered lot, provided that they respect the lot technical specifications.

To be eligible for each specific tender, bidders must provide several documents proving their technical and financial capacity[4]. In addition, the buyer usually requires the bidders to provide a tender guarantee to participate in the auction with the purpose to deter them from leaving the procedure.

The bidders cannot modify their bids during the auction. Once the bidding period finishes, the buyer opens and compares the bids, and the bidder with the lowest bid becomes the winner. The winner may be required to provide new documentation to confirm her capacity before signing the contract at that bidding price. The contract signed by the contracting authority and the winner terminates the auction procedure and the awarded price is officially published in a public notice.

The typical variables of interest for a reverse auction with the features of the tenders analyzed in the research are described by equations (3.1), (3.2), (3.3) and (3.4). They are: the winning bid, the awarded price, the winner's payoff (or winner's benefit) and the buyer's payoff (or buyer's benefit).

1.- The winning bid:

$$B^* = \min \{B_j\} \qquad j = 1...n \tag{3.1}$$

Where B_j is the bid of the j bidder in the group of n competing bidders.

2.- The awarded price:

$$p_w = P^* = B^* \tag{3.2}$$

Where P^* is the awarded price and w the winner.

I identify the awarded price of the auction with the procurement cost, for the purpose of the research[5].

3 Bidders' nationality, origin of the goods and not falling within any legal and administrative exclusion criteria. Nationality and origin rules include, in general, EU and European Economic Area member states, and Europe Aid beneficiary countries.

4 Usually, these are evidences of successful sales of similar goods and the description (or confirmation) of the features of the offered product.

5 We may think of other costs associated to the tender procedure, but the homogeneity of the procedure in the selected sample makes reasonable assuming that these other costs are similar in all cases, and therefore the relevant cost is the price of the acquired lot.

3.- The winner's payoff:

$$\pi_w^* = P^* - c_w \tag{3.3}$$

Where π_w^* is the winner's payoff and c_w is the cost for the delivery of the product estimated by the winner, which I assume is the bidder w.

4.- The buyer's payoff:

$$\pi_b^* = P_R - P^* = P_R - B^* \tag{3.4}$$

Where π_b^* is the buyer's payoff and P_R is her private reserve price. The reserve price is the maximum amount the buyer can pay for the lot. The buyer's payoff can be interpreted as savings with regards to her reserve price.

The buyer will buy the product and obtain the benefit π_b^*, provided that the winning bid is lower than the buyer's reserve price. Otherwise, the auction is declared void.

Figure 3.2 illustrates graphically the tender procedure. It also provides an overview of the data source for the creation of the dataset introduced in section 3.3, and shows the main variables associated to the corresponding auction defined in this section and complementary variables introduced in section 3.4.

3.3 DATASET CREATION

The dataset was created from the official publications issued by Europe Aid.The curation process extended over several months and required to examine 220 tender dossiers for supplies of different goods called for between 2014 and 2017, and then to look up the relevant information for the purpose of the research.

The tender dossiers are typically characterized by two relevant public documents published at the beginning and at the end of the tender procedure: the *supply contract notice* and and the *supplies contract award notice*. In addition, there is a *document of technical specifications* of the tendered lot, which generally can be accessible upon request to the contracting authority only. The technical specifications characterize the features and functions that the supplied product must fulfill.

The supply tenders analyzed in this research were funded with the financial instruments of: European Neighbourhood (ENI) and EU Pre-accession Assistance (IPA).

The sample consists of 587 observations. The procured goods concern equipment and machinery for different industries, hardware and software, vehicles, medical and chemical materials, and furniture.

A full description of the dataset is provided in chapter 4.

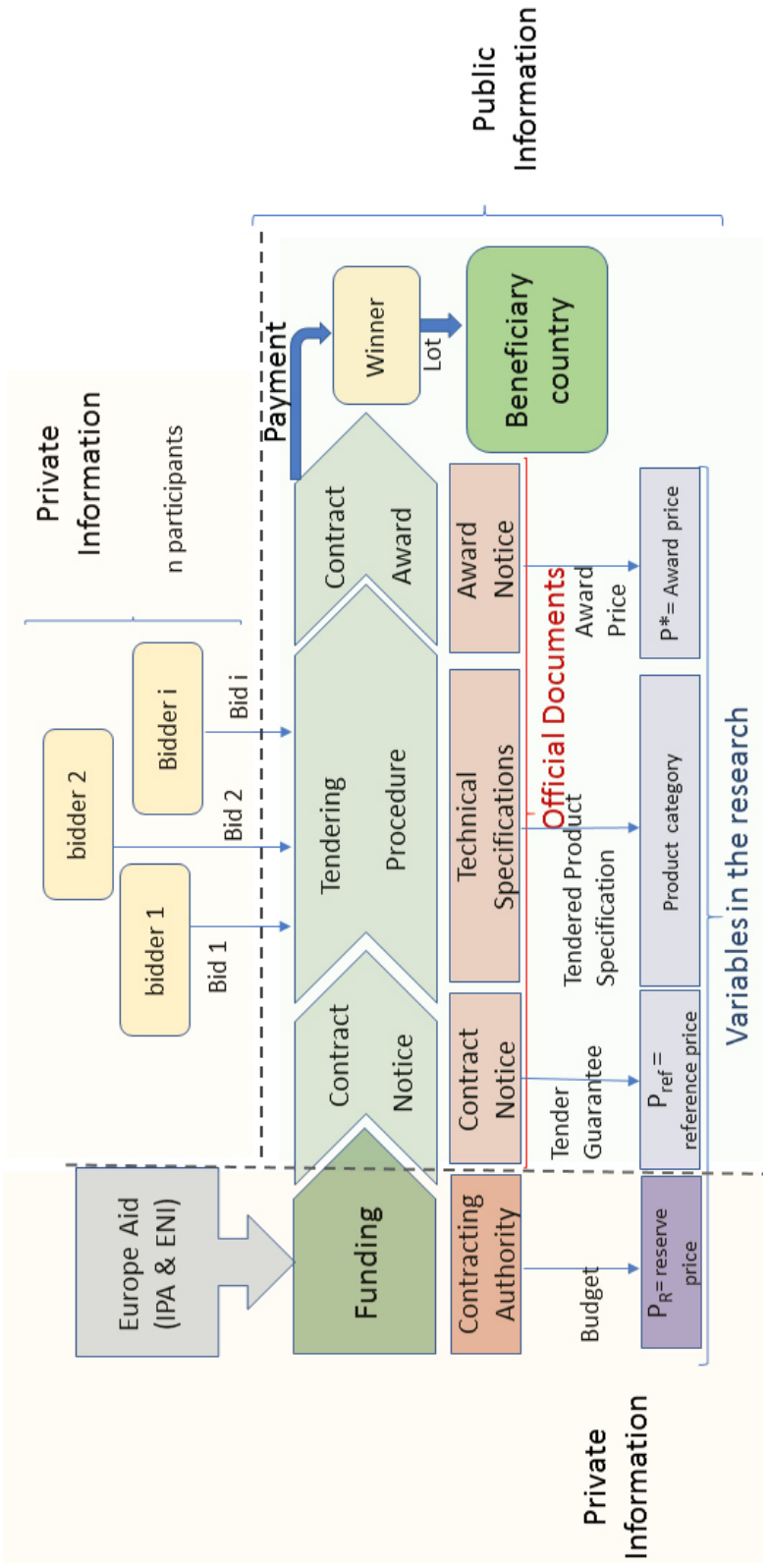


Figure 3.2: Representation of the supply tender procedure as a reverse auction.

3.4 DEFINITION OF THE MAIN VARIABLES

Based on the approach to the tender procedure described in section 3.2, the main variables of the research are those variables characterizing the type of reverse auction that represents Europe Aid supply tenders.

These variables must by directly looked up from the documents of the tender dossier or transformed from the data in those documents. There are two main data essential for the purpose of the research, the awarded price of the lot and the number of bidders entering the tender procedure. The awarded price provides information on the procurement cost and the number of bidders indicates the level of competition.

The awarded price appears in the left side of the specified models. It is used as a component of the dependent variable, which appears normalized to a reference price. Depending on each specific model, it appears in different functional forms.

The number of bidders appears in the right side of the specified models as the main explanatory variable. Depending on the specified model, it is treated as a continuous or as a discrete variable. It also appears in different functional forms depending on each specific model.

Besides these main variables, there are other variables defined from the data in the tender dossiers. They include the mentioned reference price, which is a transformed variable, different binary variables characterizing categories of market places and products, and other binary variables characterizing the tender procedure that are not statistically significant.

Finally, the specification and the estimation of some of the models require additional auxiliary variables that do not originate in the tender dossiers. This concerns particularly to instrumental variables to treat the potential endogeneity of the variable representing the number of bidders in the models.

Chapter 4 provides some relevant information of the main variables. The detailed definition of all the variables entering the specific empirical models is included in chapter 5.

3.5 EMPIRICAL MODELS SPECIFICATION

I study three statistically consistent empirical models used dominantly in public procurement auction literature. In the studied models, a random number of n bidders enters each tendering procedure. The tenders include different products and different countries. Hence, I control for this heterogeneity with the regressors characterizing the categories of products and the market places.

Each bidder estimates a cost for the tendered lot and defines her bidding strategy based on the estimated cost of the lot.

In the research, other than the assumptions that bidders are non-cooperative and that they use a benefit optimizing strategy yielding to a market equilibrium, I do not assume *a priori* any privileged bidders' cost distribution paradigm or any other specific simplifying assumption to define a privileged model with

closed form solution. The theoretical reasons to follow this approach were fully discussed in chapter 2.

The initial model I specify in the research has a non-closed relationship between the procurement cost and the number of bidders in the equilibrium solution. As the tenders involve a restricted number of bidders, an empirical discrete model can treat flexibly this situation.

In addition to a discrete model with non-closed form, I specify other two additional models regressing the procurement cost on the number of bidders treated as a continuous variable with closed non-linear functional forms, and controlling for heterogeneity market factors, as approximated models.

The thesis dedicates chapter 5 to explain thoroughly the process to specify the empirical models.

3.6 EMPIRICAL MODELS ESTIMATION

For the empirical estimation of the discrete model, I try regressing different functional forms of the dependent variable representing the normalized procurement cost on dummies representing each value of number of bidders, and on other regressors representing the tender environment (basically the features of the market place and the tendered products). The selected model after completing this purely empirical procedure is the best-fitting one according to econometric criteria. I call this model the *flexible model*.

Similarly, for the estimation of the models in which the number of bidders is represented by a continuous variable, I try regressing consecutively different functional forms of the dependent variable representing the normalized procurement cost on different functional forms of the regressor representing the number of bidders as a continuous variable. I also include other regressors representing the tender environment, as I do for the specification of the flexible model. Based on the functional forms that provide the best goodness of fit in the estimation process, I call one of the models the *elasticity model* because the estimated coefficient represents an elasticity, and I call the other model the *semi-elasticity model* because the estimated coefficient represents a semi-elasticity.

The three resulting estimated models are statically consistent for the data in the dataset, at least in a broad range of values of the variable representing the number of bidders. I use a comparative approach to elaborate the empirical results of the research and draw conclusions. This comparative approach is an innovative aspect of this research, since previous works in the literature impose restrictive assumptions to identify a privileged functional form for the selected model used in their research.

I provide in chapter 6 all the relevant details and considerations to estimate consistently the three selected models identified in the research.

4

CREATION OF THE DATASET AND DEFINITION OF THE MAIN VARIABLES

In this chapter, I describe the the dataset creation process, the sources of data and the definition of the main variables, which contribute to the two initial steps of the methodological process conducted in the research.

Figure 4.1 represents the scope of this chapter.

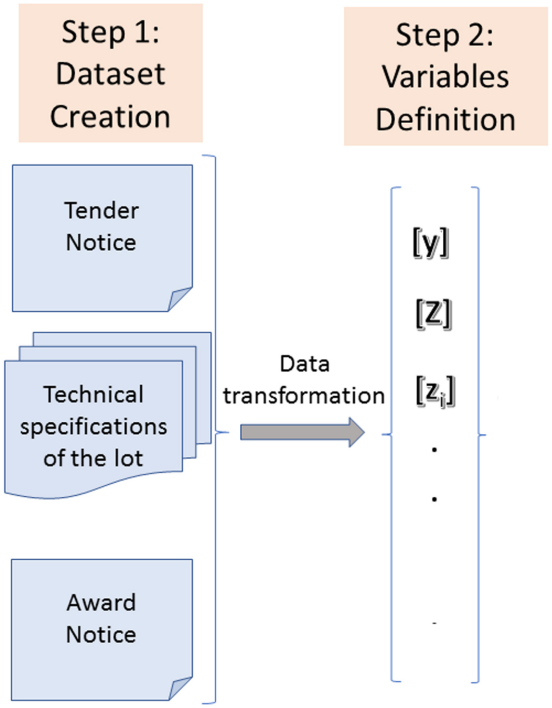


Figure 4.1: Dataset creation and definition of main variables.

This chapter is organized as follows:

Section 4.1 addresses the creation of the dataset based on the documents of Europe Aid tender dossiers. It also explains these documents and the data extraction rules to create the dataset.

Section 4.2 defines the main variables that are used to specify the empirical models, which are based on the extraction and transformation of the data in the dataset. This section also provides a numeric overview of these variables.

4.1 CREATION OF THE DATASET

The dataset was created from the publications issued by Europe Aid[1], which is the source of the data for the research. It is intended to be transformed into a data article[2]. These official publications are gathered according to individualized publicly accessible dossiers for each tender procedure.

For the purpose of the research, the tender dossiers are typically characterized by two relevant documents: the *supply contract notice*, whose official template is presented in section A.1 of the Appendix and the *supplies contract award notice*, whose official templates are presented in sections A.2 and A.3 of the Appendix.

In addition, in each tender dossier there is a *document of technical specifications* of the tendered lot, which provides a thorough description of the products that shall be supplied, their functionality, the terms of use, and related services that must be provided for those products. The document of technical specifications does not correspond to a pre-defined template. Frequently, it is not directly accessible from Europe Aid openly published documents either[3].

Finally, there are other documents that correct, clarify, cancel or replace the contract notice or the technical specifications of the tendered lot. These include: the *cancellation notice of a supply tender procedure*, the *corrigendum to the tender procedure*, the *clarifications to the tender dossier* and the *relaunch of a contract notice*[4].

4.1.1 *Data from the supply contract notice*

The supply contract notice includes among other general details: the title of the contract funded by Europe Aid, the region and the country (or countries) where the contract will be implemented, a six-digit unique reference code for the contract, the budget line of the instrument or the programme funding the contract, and the name of the contracting authority.

Subsequently, the supply contract notice includes the summary of the contract specifications, in particular: the description of the object of the contract (that is, the goods to be acquired), and the number and title of each of the tendered lots. The tender dossiers in the research comprise one or several lots. Generally, the lots are awarded simultaneously. Each tendered lot produces and independent observation in the dataset, because it corresponds to a specific and indivisible good acquired at an independent price from the price of the rest of the lots.

Afterwards, the supply contract notice specifies the terms of participation, that comprise among other: the eligibility rules and the rules of origin for the bidders and the goods, the grounds for exclusion, the amount of the participation tender guarantee (if required), the amount of the performance guarantee (if required), the tender validity, and the contract implementation period.

1 The publications were accessed through this website: https://ec.europa.eu/europeaid/home_en
2 The comprehensive dataset can be accessed through Mendeley repository: data.mendeley.com, under a Creative Commons license.
3 Normally, the document is public but must be requested directly to the contracting authority.
4 The *relaunch of a supply contract notice* uses exactly the same template that the *supply contract notice*.

The next section in the contract notice includes the selection criteria and the award criteria. Selection criteria are based on: economic and financial capacity of the bidder; professional capacity of the bidder; and technical capacity of the bidder. The award criterion for the tender dossiers in the research is the best price.

Finally, the supply contract notice establishes the tender instructions, in particular: how to obtain the tender dossier, the deadline to submit tenders, the place and date of the tender opening session, the language of the tender procedure and the legal basis.

4.1.2 *Data from the contract award notice*

The contract award notice includes details that are common to the contract notice such as: the title of the contract, the region and the country or countries where the contract will be implemented, the reference code, the contracting authority and the legal basis. In addition, it includes the specific information on the awarded contract, which comprises: the type of procedure; the number and title of the awarded lot; the number and the value of the contract; the award date; the number of received tenders; the name, the address and the nationality of the winner; the duration of the contract; and the Development Assistance Code (DAC) of the awarded lot (when applicable).

4.1.3 *Data extraction rules*

The curation process involved looking up and classifying all the relevant information from 220 tender dossiers for supplies of different goods called for between 2014 and 2017. The list with all the tender dossiers is provided in annex B of the Appendix.

The sample consists of 587 observations. Some of the lots are awarded after several months from the initial call for tender, and the publication of the official resolution takes some time as well. Hence, the research uses the date of 31/05/2018 as the deadline to collect data from Europe Aid published dossiers[5].

The majority of the procured goods are equipment and machinery for different industries (around 35% of the total). Hardware and Software is also a dominant category of goods in the sample (around 29% of the total). The rest of the goods are different kind of vehicles, medical and chemical materials, and furniture. To retrieve this information, I used the summary of the contract specification in the contract notice and the DAC codes in the award notice (when available).

Based on the information of the country of implementation contained in the contract notice, I extracted for the purpose of the research supply all the tenders funded with the financial instruments of: Neighbourhood Southern Area (ENI South) and EU Pre-accession (IPA).

5 This deadline has been taken considering the average period of 7-8 months for the entire procedure estimated in Europe Aid regulations and the date of the last tendered lot in 2017.

Figure 4.2 displays graphically the countries with tender procedures funded with ENI South: Morocco, Egypt, Tunisia, Jordan, Lebanon and Algeria.

Figure 4.2: Beneficiary countries of supplies funded with the ENI instrument included in the dataset used in the research

Figure 4.3 displays graphically those countries with tender procedures funded with IPA: Albania, Bosnia, FYROM (Former Yugoslav Republic of Macedonia, currently North Macedonia[6]), Serbia, Montenegro and Turkey. In addition, I included procedures in Kosovo, under the status of the resolution of the United Nations Security Council 1244[7] as a singular geographic market, owing to the fact that Kosovo benefited both from IPA funds and funds from the instrument EULEX.

Figure 4.3: Beneficiary countries of supplies funded with the IPA instrument included in the dataset used in the research. Kosovo is cited under the status of UN Security Council resolution 1244. FYROM, currently North Macedonia, is the official country name corresponding to the data collection period

6 FYROM is referred to be consistent with the denomination existing in the data collection period.
7 In the thesis, any mention to Kosovo must be understood in connection with the referred United Nations status.

The dataset includes 457 lots in which the buyer required a tender guarantee specified in the contract notice to enter the procurement auction and 130 lots in which such a guarantee was not required.

In the dataset there are 479 awarded lots with a specific price that is public through the award notice and 108 unsuccessful procedures. The unsuccessful procedures yielded void lots and they resulted in one of the following situations: relaunching of a new tender procedure or cancellation of the tendered lot.

Among the awarded lots, 29 correspond to negotiated procedures. All the negotiated procedures arise from an unsuccessful previous open procedure[8]. Thus, the negotiated awarded price behaves in a similar way than the price awarded in open procedures because it must fulfill the same restrictions.

Several unsuccessful tendered lots have originated relaunched procedures within the period covered by our sample. In these cases, the dataset includes two different records: the first one includes the unsuccessful initial lot (a record with no bids). The second record includes the data of the awarded relaunched lot[9]. When the procedure is unsuccessful and the lot is canceled the sample includes only one record with no bids.

The buyer generally breaks down the number of received bids per lot in the resolution of every tender. There is a reduced number of 25 tenders in which the number of bidders included in the resolution is the global number of bidders for all the tendered lots. For the estimation of the empirical models I discarded those records where we cannot ascertain the real number of bidders competing for the single lots.

The buyer decides to take a joint resolution for several lots very seldom. In these cases, she issues a single contract to the winner for the total awarded price of the several lots involved and creates a composite lot *ad hoc*. In these cases, there is only one observation recorded in our dataset. The record registers the awarded price for the composite lot and the sum of the amounts of the tender guarantees required initially to bid for the original lots.

4.2 DEFINITION OF THE MAIN VARIABLES

Once I have identified the variables of interest for the generic reverse first-price sealed-bid auction that is used as the model of our tender environment in section 3.2, and based on the dataset created with the relevant information of the supply tender dossiers, as defined in section 4.1, the next step of the research methodology is to build the main variables.

8 In the initial open procedure all prices may have exceeded the contracting authority's reserve price, although some could be close to it and the related bidders may be invited to reconsider them with a new bid. Or the contracting authority may consider that some faulty technical aspects can be amended upon her request, while holding the received bids.

9 The lot that is tendered in the relaunched procedure may change its specifications. For instance, the quantities of the goods, their features or the amount for required tender guarantee may vary. Therefore, I consider that it is reasonable to keep two separated records in the sample because they are strictly different procurement auctions.

4.2.1 *The winning bid*

The winning bid is determined directly from the *supply award notice* of the tender dossier. As we have seen in section 4.1.3 there are 479 awarded lots with a specific price. These awarded prices correspond to the winning bids in the context of the procurement auction model of the research. For the 108 unsuccessful procedures, the lots are not awarded and, therefore, there are no winning bids.

4.2.2 *The number of bidders*

The number of bidders is also determined directly from the *supply award notice* of the tender dossier. Only in those few cases where the tender includes different lots and the number of bidders does not appear broken down for each of the lots in the award notice, the number of bidders of the individual procurement auctions cannot be ascertained. In the cases where there is no winning bid the number of bidders is zero[10].

4.2.3 *The winner's payoff*

To calculate the winner's payoff or winner's expected benefit we must know the cost she incurs to supply the awarded lot, according to equation (3.3). The information about the winner's cost of the lot cannot be determined with the data available in our data source, because this cost is not publicly revealed[11].

4.2.4 *The buyer's payoff*

The buyer's payoff or buyer's benefit depends as well on a variable that is not public in the documents of the tender dossier, the reserve price P_R. The information about the buyer's reserve price is private. The bidders do not know the exact amount over which the buyer will not acquire the lot. Inferring a reference price of this reserve price consistently enables achieving the initial goal of the research presented in this thesis.

4.2.5 *Inference of a reference price for the buyer's reserve price*

We have seen in section 4.1.3 that the dataset includes 457 lots in which the buyer required a tender guarantee to enter the procurement auction. The rules of the tender procedure (DEVCO, 2018) establish that the contracting authority is entitled not to require the participation tender guarantee to the bidders for proportionality reasons. This happens when the reserve price is below a certain threshold, although many contracting authorities prefer to require the participation tender guarantee also in those cases.

10 Either there was no participation at all, or none of the received bids were valid in accordance with the selection procedure.

11 It cannot be even estimated, because the auction design does not require any related information.

The *supply contract notice* indicates the amount of the tender guarantee to enter the procurement auction, when this guarantee is required. These data are included in the dataset used for the research.

The rules of the tendering procedure establish as well that the tender guarantee must fall between 1% and 2% of the engineered (or reference) value of the contract. Therefore, we can infer a reference price for the lot, P_{ref}, from the price signal of the tender guarantee. All bidders can estimate their own reference price and this price may be interpreted as an indicator of the common value for the lot, if this exists. I have calculated the reference price with equation (4.1).

$$P_{ref} = A/0.015 \tag{4.1}$$

Where A is the amount of the tender guarantee.

I use the middle point of the interval bounded by the thresholds of the tender guarantee amount to calculate the reference price of the lot for symmetry reasons[12]. This variable is well-defined in economic terms and it allows a robust and conservative estimation of the procurement cost savings.

Considering that the preliminary buyer's market study for the tendered lot provides always a precise and accurate value and that the buyer is risk neutral[13], the highest threshold signaled by the tender guarantee provides a bound to the buyer's reserve price. This bound is calculated with the equation (4.2).

$$P_{RH} = A/0.010 \tag{4.2}$$

Where A is the amount of the tender guarantee.

This bound is useful to estimate the maximum savings that may be achieved with the auction mechanism. However, the maximum savings may involve estimation bias, if the restrictive assumptions about the buyer's behavior are not satisfied. In other words, if the engineered price is imprecise, or if the buyer does not want to clearly reveal her reserve price to promote more aggressive competition, we would expect that her reserve price lies in the region between the maximum bound of equation (4.2) and the estimated reference price of equation (4.1).

Comparing the awarded price to the unknown buyer's reserve price of the lot yields higher estimated savings because, under the assumption that the buyer cares at least minimally about acquiring the lot, the following inequality holds in all cases: $P_R > P_{ref}$.

Figure 4.4 represents graphically the concepts of the buyer's private reserve price, the price signals of the bank guarantee and the estimated reference price used for the purpose of the research.

12 The choice of this reference price does not imply any interpretative restriction for the results, because the quantitative estimation of costs savings must be related to a reference price. The choice of any other reference price based on the tender guarantee involves an algebraically transformation of the coefficients of the models only.

13 The buyer's strategy is to give a true signal of the lot value with the tender guarantee amount, instead of a signal prioritizing its purchase even if this is produced at a higher cost.

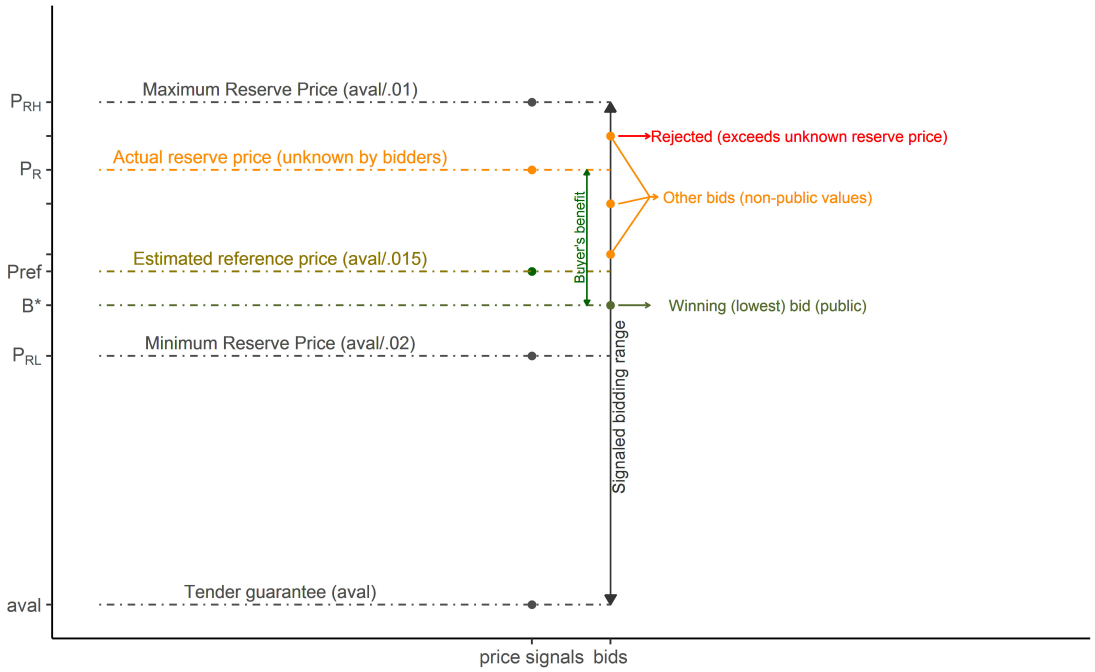


Figure 4.4: Representation of the estimated reference price in the context of the information of the tender procedure and the signal of the tender guarantee

Arguably, the buyer's reserve price could be placed between the estimated reference price and the low bound showed in figure 4.4, which is calculated with equation (4.3). However, this increases the risk of a void tender, because bidders may misinterpret the price signal hoping for a higher reserve price and, consequently, place bids exceeding the reserve price and being rejected.

$$P_{RL} = A/0.020 \tag{4.3}$$

Where A is the amount of the tender guarantee.

4.2.6 *Numeric overview of the main variables*

Table 4.1 presents a summary of the values of the relevant numeric variables explained in this section for all the awarded tendered lots. The table includes values of the winning bid that we identified with the procurement cost P^*, as defined in equation (3.2); the tender guarantee amount, which is named *aval*; and, finally, the reference price, P_{ref}, as it has been defined in equation (4.1).

Table 4.1 shows that I build a reference price for all the tenders with the requirement of a tender guarantee. The number of observations with a defined awarded price P^* includes tenders both with and without a participation tender guarantee. The empirical work of the research uses only those observations for which a reference price exists based on the tender guarantee price signal.

Table 4.1: Features of the main numeric variables for all the awarded lots (in EUR)

Variable	N	Mean	St. Dev.	Min	%ile(25)	Median	%ile(75)	Max
aval	457	9,597	37,679	100	1,500	3,050	7,000	600,000
Pref	457	639,789	2,511,948	6,667	100,000	203,333	466,667	40,000,000
P*	479	539,160	2,135,949	580	53,480	169,770	391,375	29,676,883

I finish this section with Figure 4.5. This figure presents the distribution of the number of bids per lot, when this number is stated in the official resolution of the award notice. It includes the tenders where the requirement of a participation tender guarantee has been established only. The right-skewed shape is similar to the one found in previous studies on this topic. In lighter color I show the unsuccessful tendered lots (void lots with zero bids) and in darker color than the rest I show the tendered lots that received 10 bids or more[14]. I also depict the mean of the distribution.

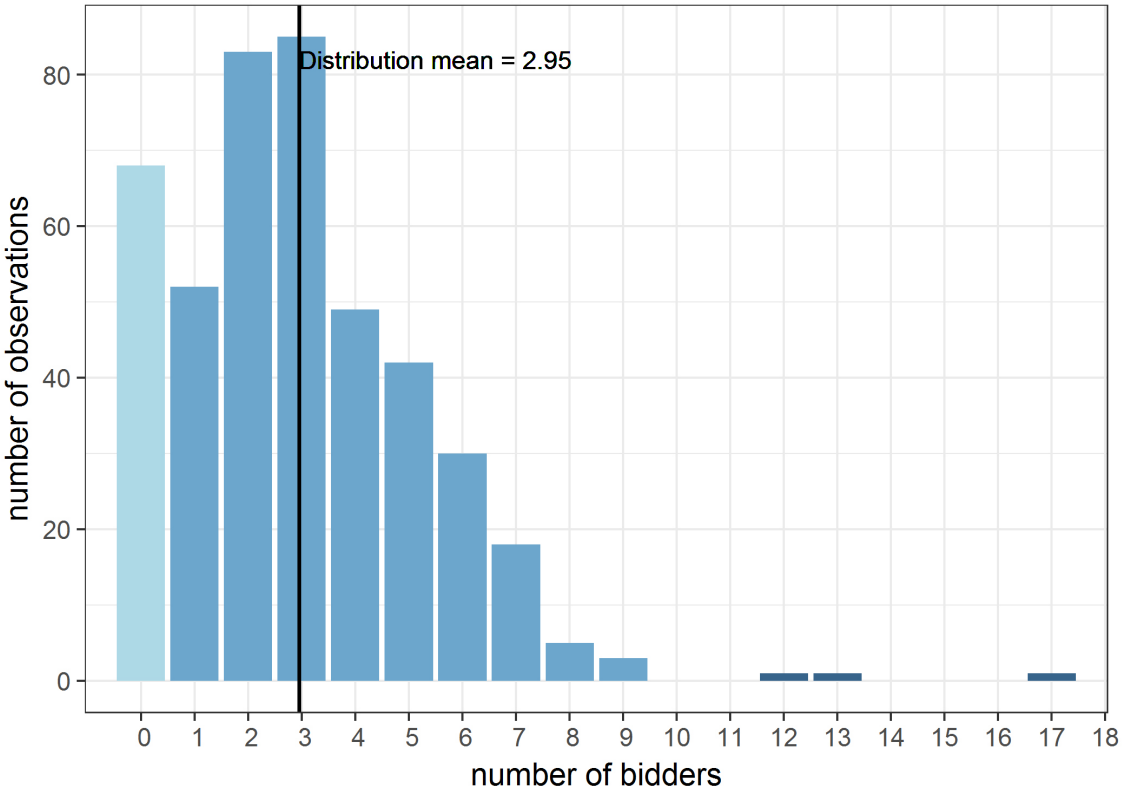


Figure 4.5: Distribution of number of bidders for tenders with requirement of a participation tender guarantee

14 The tenders with 10 bids or more have been grouped in a single category in some of our empirical models to achieve statistical representativeness.

It is important to notice that a significant percentage of more than 15% of the resolutions are void. There are multiple reasons for such unsuccessful tenders, ranging from the early cancellation by the contracting authority to the absence of valid bids.

(Milgrom and Weber, 1982b) study the effects of revealed information in a sealed-bid auction. They conclude that this strategy raises competition when the revealed information contains part of the better-informed bidders' information. I find evidences of this effect when comparing void tenders in procedures with and without participation guarantee requirement. In this last case the ratio of void tenders raises to more than 35%.

Unsuccessful auction procedures entail additional procurement costs, whether they involve relaunching or cancellation of the tendered lots. These costs are not accounted for in the research because they cannot be estimated. However, the incorporation of these unsuccessful cases to calculate the mean of the bids in the sample allows to estimate more accurately the expected additional savings with increased competition.

5

SPECIFICATION OF THE EMPRIRICAL MODELS

In this chapter I describe the rationale to identify the models that I have used in the empirical research. I specify them with the help of auxiliary variables.

Figure 5.1 represents the scope of this chapter.

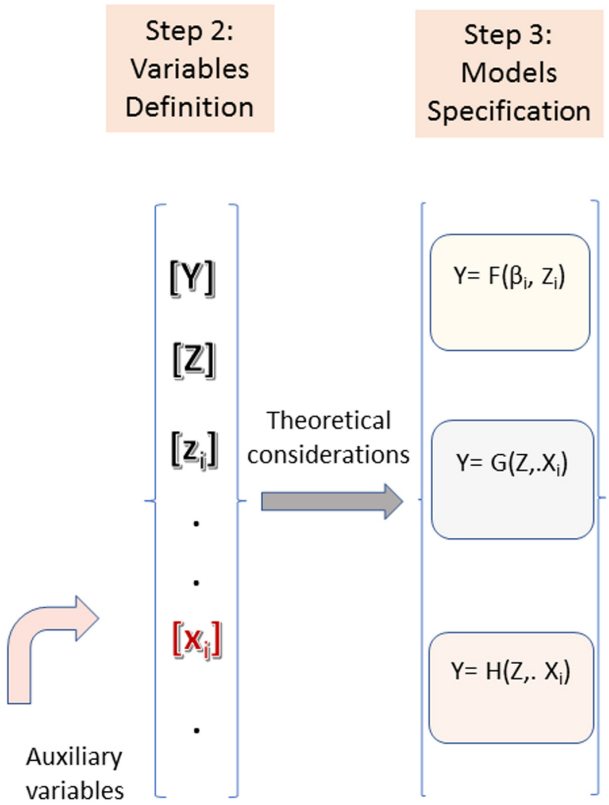


Figure 5.1: Definition of auxiliary variables and specification of the empirical models

I start the chapter with some theoretical foundations in section 5.1 that justify the hypotheses used to specify the models. Subsequently, in section 5.2, I extend the main variables described in chapter 4 with auxiliary variables. In particular, I create a composite dependent variable to normalize procurement costs, I define additional categorical variables to characterize the markets and I introduce instrumental variables. Finally, I follow different complementary approaches to specify the models based on considerations about the variable representing the number of bidders. The first approach introduced in section 5.3 treats this variable as discrete. The second approach followed in section 5.4 treats this variable as continuous.

5.1 THEORETICAL FOUNDATIONS

In the specification of the models, I consider a random number of n bidders entering each tendering procedure. The tenders include different products and different countries. I control for this heterogeneity with the variables described in section 5.2.

Each bidder estimates a cost for the tendered lot and defines her bidding strategy based on this cost. As we have seen in chapter 2, the estimation of this cost may come from a value of the cost that is the same for all bidders (Common Value Paradigm, CVP); from a value of the cost that is private for each bidder (Independent Private Value Paradigm, IPVP); or from a value of the cost derived from a broader paradigm (Affiliated Value Paradigm, AVP), where the CPV and the IPVP are the extreme special cases. I do not assume *a priori* any privileged cost distribution paradigm to specify the models.

I assume that bidders are non-cooperative and they use a benefit optimizing strategy. I also assume market equilibrium, in line with the principles to build structural models.

The auctions in the research are likely affected by asymmetries caused by the international origin of the bidders, their different size and the possibility of joint bidding, among other circumstances. A few empirical studies characterizing bidders' asymmetries exist in the literature as I have presented in section 2.2.3. (Bajari, 2001) and (Flambard and Perrigne, 2006) analyze asymmetries based on bidders' geographic locations. (Hendricks and Porter, 1992) discuss asymmetries associated to joint bidding. (Armantier and Sbaï, 2006) find asymmetries based on bidders' capacity to obtain quality information for procured goods.

Therefore, I do not assume *a priori* bidder's symmetry in the auction environment of the research.

In general, asymmetric auctions result in non-closed form solutions to the equations characterizing the bidding equilibrium strategies (Campo et al., 2003).

Taking into consideration the assumptions that in the auction environment of the research there is no privileged cost paradigm and that bidders are most likely asymmetric, I consider initially a non-closed relationship between procurement costs and number of bidders. As the tenders involve a restricted number of bidders, I can apply an empirical discrete model to treat flexibly this situation.

Furthermore, if we assume that the real features of the auction environment approximate to a certain extent to conditions for a closed form, we would expect it to be typically non-linear. This would happen if the level of affiliation among bidders is close to the CVP or IPVP extreme cases, and if the level of bidders' asymmetries do not cause significant changes in the bidding strategies.

Hence, the empirical approach I have followed in the research is to test several discrete models and closed non-linear functional forms regressing the procurement cost on the number of bidders, controlling for heterogeneity market factors. Afterwards, I have selected those that are statically consistent and compared them to discuss the implications of their specification for the conclusions of the research.

With this approach, the results of the research are valid in an unchanged empirical framework in which the specified models are consistent (Rezende, 2008). The stable framework of Europe Aid financial instruments along the years and the similar operation of other ODA funding institutions make reasonable the comparison of the conclusions or this research with results in broader similar auction environments.

5.2 DEFINING THE FULL SET OF VARIABLES IN THE EMPIRICAL MODELS

5.2.1 *Dependent variable*

The dependent variable of the models used in the research is a composite variable, which is strictly associated to the awarded lots. I define it as follows:

• *Normalized procurement cost*. This variable is named *indpago* in the models and it represents the ratio between the awarded price of the lot, or procurement cost P^* as defined in (3.2), and the reference price, *Pref*, as defined in (4.1).

$$indpago_k = P_k^*/Pref_k \qquad k = 1, 2, ..., K \tag{5.1}$$

where *k* represents each of the *K* awarded lots included in the sample that required the provision of a tender guarantee to participate in the tender.

This choice of the dependent variable is useful to interpret directly the marginal effects of competition on the procurement cost, controlling for other specific auction attributes that are statistically significant. The lacking information on the bidders' characteristics in the dataset is partially captured by the market study yielding the reference price. A consequence of this lacking information is the potential endogeneity of the number of bidders in the empirical models.

There is a strong correlation between the procurement cost and the reference price[1] of the lots. Referring procurement cost to this engineered price, which is calculated homogeneously across tenders, allows us to isolate the effect of competition based on the accessible data of the winning bid only. It also limits prices intertemporal effects. The few studies on this topic counting with a reference price for the tendered lots make the same treatment for this variable. See for instance, (Onur and Özcam, 2012).

Finally, the normalized approach allows to calculate immediately the savings rate, SR, which is the main objective of the research.

$$SR_k = \frac{Pref_k - P_k^*}{Pref_k} = 1 - indpago_k \qquad k = 1, 2, ..., K \tag{5.2}$$

where k and K have the same interpretation than in equation (5.1).

1 The coefficient of determination of the linear regression between both variables is greater than 0.90.

5.2.2 *Regressors*

The regressors to specify the best-fitting empirical models include in the first place the variable of interest, the number of bidders, which indicates the level of competition as introduced in section 4.2. They include as well the categories of products and geographic markets that characterize the tender environment. Finally, they include other potential sources of heterogeneity in the dataset that may be induced by the tender procedure itself.

I present in this section a brief description of the relevant regressors in the specified models.

• *Number of bidders*. This is the main regressor, because it indicates the level of competition in the procedure. I represent it either as a set of categorical discrete variables or as an approximation to a continuous variable.

When I represent it as a set of discrete variables, these variables define individual categories that I indicate with subscripts. For instance, BIDS_3 is a dummy variable taking the value 1 when the number of bidders participating in the tender is 3, and the value 0 otherwise.

When I represent the *number of bidders* as a continuous variable, I call it *bids* in the models. The variable takes the null value when the procurement auction is unsuccessful and, otherwise, it takes the value of the number of valid bids received by the contracting authority.

The empirical methodology I have followed in the research considers all the characteristics that the variable representing the number of bidders in the auction may exhibit, taking into consideration:

- its modeling as a categorical variable (individual non-linear effects) or as a continuous variable in an approximated closed functional form.
- its endogenous or exogenous behavior in the models where it appears as a continuous variable.

This methodology is consistent with the unrestricted approach to the auction environment of the research, as I explained in section 5.1.

When I use the number of bidders as a categorical variable (which is essentially its nature as the number of bidders is a whole number), the empirical models allow the estimation of different effects with every new bidder entering competition. When I use the continuous variable approximation, I obtain a smoother shape for the curve representing new bidders' entry effect.

In the models where the number of bidders is endogenous, the direct estimation of the effect of competition on procurement costs with the OLS method is biased. Hence, besides controlling for the heterogeneity of the market, the estimation for inference purposes requires to correct the bias with instrumental estimation methods as I describe in chapter 6.

I consider the following regressors to control for the heterogeneity of the market:

• *Market place*. Data on the market place have been modeled with a set of categories. These categories have been created taking into consideration as differentiating factors the Europe Aid financial instrument funding the tender and the geographic position of the countries. I represent the categories in the models used in the research with the following dummies:

a) *DCATMAR1*. This dummy takes the value 1 for tenders in Turkey, which is the country with the highest number of supply tenders called for.

b) *DCATMAR2*. This dummy takes the value 1 for tenders in those countries benefiting from the IPA instrument, excluding Turkey and Kosovo, which benefit from IPA as well.

c) *DCATMAR3*. This dummy takes the value 1 for tenders in Kosovo, which benefits both from EULEX and IPA instruments.

d) The beneficiary countries from ENI, the Neighbourhood instrument, is the base group in the models.

Figure 5.2 represents the proportion of lots tendered in the different geographic market places in the dataset.

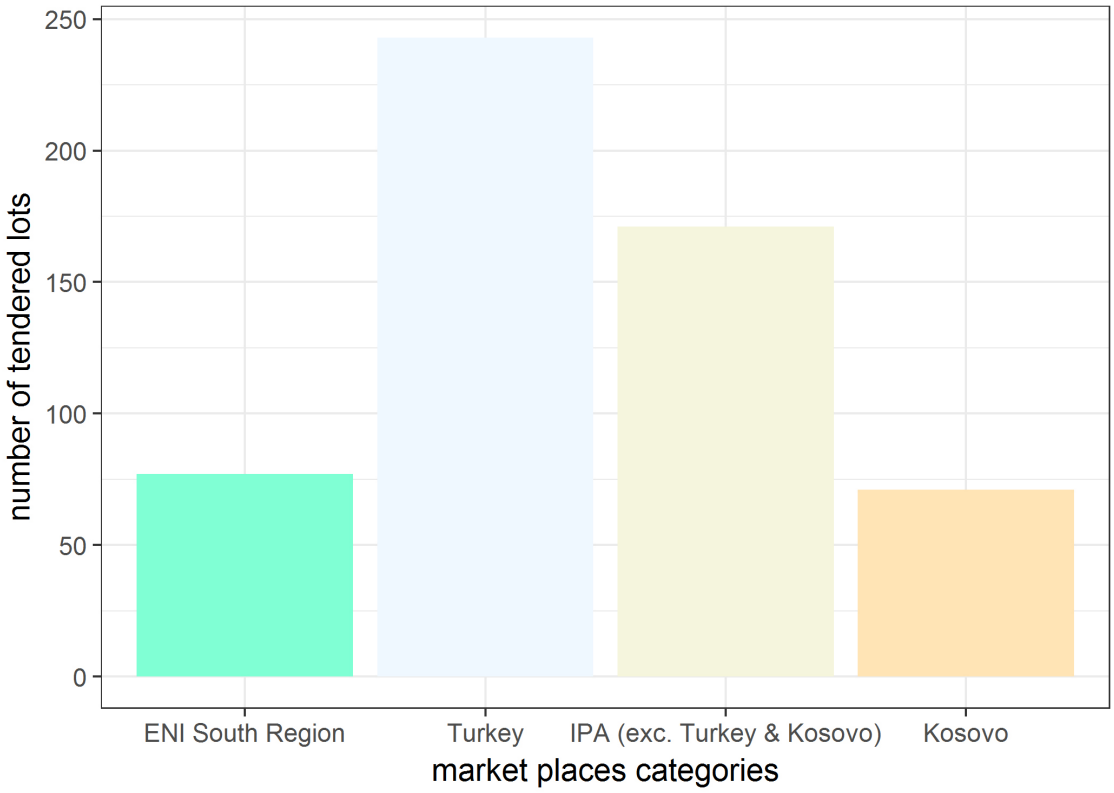


Figure 5.2: Distribution of number of lots per market place for all lots with specified number of bidders

• *Product*. The tendered products in the dataset are heterogeneous. I have classified the data in general categories traditionally well recognized by the bidders competing for Europe Aid supply contracts[2]. I represent the categories in the models or the research with the following dummies:

a) *DCATPRO1*. This dummy takes the value 1 for lots in the general category of *furniture*. This category includes dominantly pieces of furniture to equip offices and premises of different organizations.

b) *DCATPRO2*. This dummy takes the value 1 for lots in the general category of *hardware and software*. This category includes computers, peripherals and software applications for different purposes.

c) *DCATPRO3*. This dummy takes the value 1 for lots in the general category of *mechanical and industrial equipment and machinery*. This category is broad because it encompasses equipment for different industries.

d) *DCATPRO4*. This dummy takes the value 1 for lots in the general category of *vehicles*. The dominant products in this category are road vehicles like cars, vans and buses. In some cases the contract relates to spare parts.

e) *Medical, forensic and laboratory equipment*. This category includes medicines, vaccines, laboratory instruments and materials of chemical nature. This category is the base group for products in the models.

Figure 5.3 represents the proportion of lots tendered for each product category in the dataset.

Other data extracted from the tender dossiers have been transformed in dummies. These dummies characterize some aspects of the tender environment. They have been tested in the models without resulting statistically significant. This means that the aspects controlled with these dummies do not contribute to the heterogeneity of the tender environment.

These complementary variables include: a dummy indicating whether the award relates to a negotiated procedure following an unsuccessful open call; a dummy indicating whether the scope of the tender is local[3]; and another dummy indicating whether the tendered look originated in a the tender with a single lot or with several lots.

2 The tender dossiers used as data source include generally several classification codes of the goods for each lot. These codes follow the CPV (Common Procurement Vocabulary) standard. I use in the research a classification in general categories according to these codes and to the description of the goods in the tender dossiers. I select the dominant nature of the lot when goods with several CPV codes are listed in it.

3 Local tenders are open to international bidders, but they may establish specific rules hampering broader competition like local publicity only, local administrative procedures, quotations and payments in local currency and other restrictions influencing bidders' decision to enter the tender. A tender with local scope involves always a contract value below a certain threshold. In the period covered by the research this threshold is 300.000.- EUR

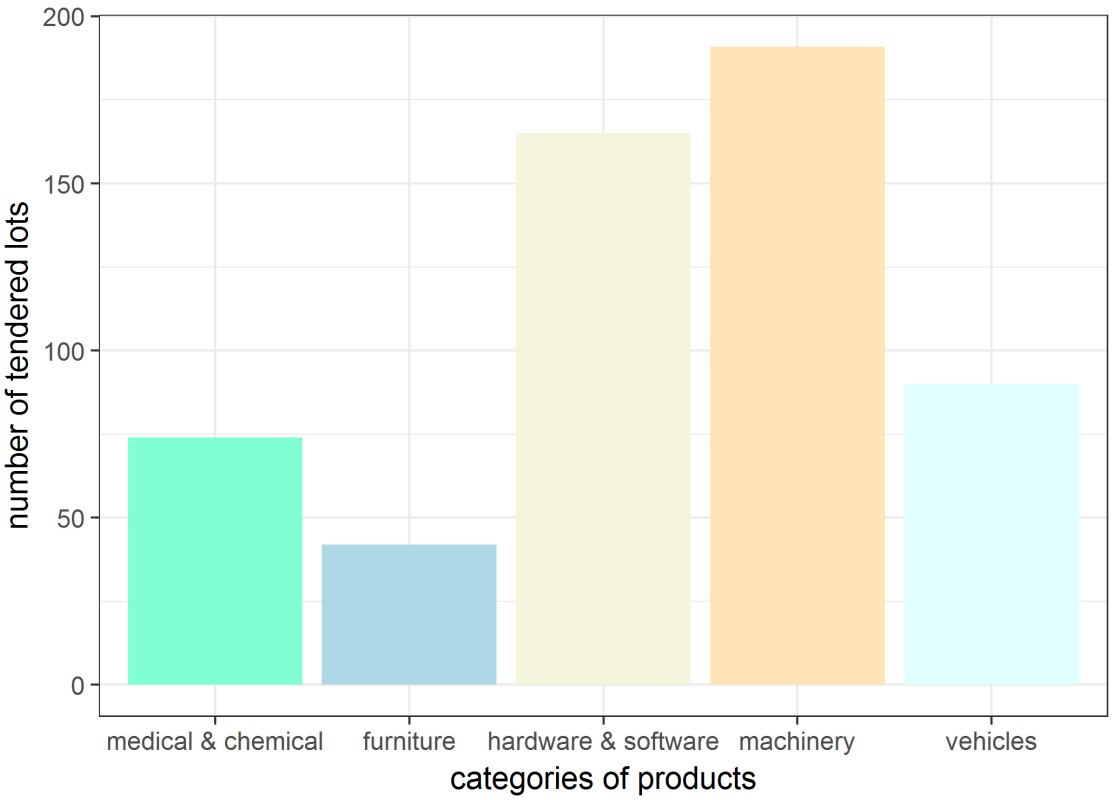


Figure 5.3: Distribution of number of lots per product category for all lots with specified number of bidders

5.2.3 *Instrumental Variables*

Finally, to test the endogeneity of the variable `bids` I use instrumental variables. Instruments in the auction environment of the research are difficult to find for three reasons:

- They can be endogenous to the auction procedure as well.
- They may not have enough instrumental value.
- A trustable source of data for the instrumental variable in all the different countries included in the sample of the research may not exist.

I select the following instruments that fulfill the necessary instrumental criteria:

• *Gross domestic product lagged a year (GDP_1)*. GDP characterizes the development of each beneficiary country. Hence, it may reasonably have an influence on the bidders' decision to tender. Countries with higher GDP may trigger a higher interest in the tender procedure from domestic and foreign bidders. I take the annual GDP in year 2000 constant USD billion.

• *DTF lagged one year (DTF_1)*. The index DTF (*Distance to Frontier*) captures the gap between the country performance and a measure of the best practice performance across a sample of 41 indicators related to the regulatory economic

environment. It does not have necessarily the same behavior than GDP[4]. The economic argument to choose this instrument is similar to the argument for GDP regarding the potential interest of foreign bidders. A better performance in this macroeconomic index may stimulate the participation of foreign bidders.

• *Exports to the European Union lagged one year (EXPORTS_1)*. Exporting figures are an indicator of foreign trade activity of the beneficiary countries and they may have an influence on the number of incumbent bidders for the procured goods in the sample. I consider exports to EU countries to account for the fact that Europe Aid tenders involve mostly[5] direct trade between EU countries and beneficiary countries.

I build this variable from the data of the Direction of Trade Statistics of the International Monetary Fund[6]. This source presents FOB Exports in current USD million. In order to make the figures retrieved from this source consistent with the previous instruments I convert them to constant USD million[7].

GDP, DTF and EXPORTS are lagged one year in the models because this is the information accessible to the bidders at the time of tendering.

5.3 MODELS ASSUMING DISCRETE AND EXOGENOUS NUMBER OF BIDDERS

Under this non-linear approach of the dependence between procurement cost and number of bidders, I estimate models in which the dependent variable *indpago* is expressed either in levels or in logarithms.

$$indpago = \beta_0 + \sum_{i=2}^{10} \beta_i BIDS_i + \lambda x + u \tag{5.3}$$

$$\log(indpago) = \beta_0' + \sum_{i=2}^{10} \beta_i' BIDS_i + \lambda' x' + u' \tag{5.4}$$

x and x' represent the different statistically significant variables characterizing the market place, the product and any other relevant variable related to the tender procedure.

This flexible non-linear functional form for the number of bidders is the one suggested when the bidders' cost distribution is unknown and the purpose of the study relies on a simplified structural model. (Rezende, 2008) proposes it under the assumption of bidders' independent private values. This functional form is also used in the broader context of CVP and AVP. (Brannman et al., 1987) use it to analyze the price-effect of competition for bonds, oil and timber auctions.

4 The source of macroeconomic data for GDP_{-1} y DTF_{-1} is the webpage http://www.doingbusiness.org/en/methodology of the World Bank, which provides detailed information on the methodology for the elaboration of the mentioned variables.

5 This is due to the rules of nationality and origin.

6 At the webpage data.imf.org

7 To accomplish that I deflate the exports values by using the Consumer Price Index indicator of the World Bank data.worldbank.org. This indicator uses 2010 as the reference year for the index.

The estimation of models (5.3) and (5.4) by OLS does not present difficulties and the interpretation is immediate: each coefficient β_i and β'_i provides information of the entry effects of each new bidder on the procurement costs expressed in levels and as a semi-elasticity, respectively. This price effect of competition is conditioned to the specific market place and product represented by the value taken by the rest of the variables with statistically significant coefficients (λ and λ'). The main difficulty for the use of these models is to ensure the statistical representativeness of the different categories of the number of bidders, in particular those which are less frequent[8]. I use heteroskedastic consistent estimators to correct for the higher variance associated to those categories.

5.4 MODELS ASSUMING NUMBER OF BIDDERS AS POTENTIALLY ENDOGENOUS AND TREATING IT AS A CONTINUOUS VARIABLE

The models described in this section include the number of bidders, the variable *bids*, as an approximation to a continuous explanatory variable for all the range of positive values. For the purpose of identifying the best-fitting models, I tried *bids* entering the general model in three different functional forms: quadratic, linear and logarithmic. The dependent variable in all the models is the logarithm of the variable *indpago*. These variations of the general model are the ones included in (Iimi, 2006). The three variations provide consistent results with different levels of goodness of fit. Other purely empirical studies relax even more the potential non-linearity of *bids* considering a flexible parametric approach to identify the most accurate functional form of *bids* to be included in the model, for instance (Chapela et al., 2019).

The approximation of *bids* to a continuous variable is useful to overcome the difficulties associated to the reduced representativeness of the higher categories of the number of bidders in the models of section 5.3. In addition, this approximation enables the use of correcting treatments to its potential endogeneity in the estimated models.

I use instrumental variable methods to correct for potential endogeneity. I build a structural equation regressing *log(indpago)* on a function of *bids* and other exogenous variables, and a reduced form that estimates *bids* with a second regression. Equations (5.5) and (5.6) summarize the general form of the instrumental model.

$$\log(\mathrm{indpago}) = G(\mathrm{bids}, x_M, x_P) + e \tag{5.5}$$

$$\mathrm{bids} = F(z_M, z_P, z_L) + \epsilon \tag{5.6}$$

If the variable bids does not exhibit endogeneity, structural equation (5.5) holds alone as the most efficiently estimated model. If it does, then equation (5.6) enables the endogeneity correction.

8 The empirical application of models (5.3) and (5.4) in the research uses a single category for those auction procedures with 10 or more bidders. The information on the base group of procedures with only one bidder is included in the intercept to avoid perfect multicollinearity.

The generic variables x_M and x_P represent respectively the market place and product variables defined in section 5.2.2. z_M is the set of instrumental variables related with the market places, which must satisfy $x_M \subseteq z_M$, and in addition they must be valid instruments. In a similar way, z_P, satisfying $x_P \subseteq z_P$, is the set of valid instrumental variables related to the products. Finally, z_L groups any other exogenous factors to the bidding procedure that satisfy the conditions of valid and relevant instruments.

I use the three instruments described in section 5.2.3 and two different instrumental variable (IV) estimation methods: 2SLS and GMM, with linear approximation, to estimate the different variants of the generic model defined in this section. The estimation of the models is presented in next chapter.

6

ESTIMATION OF THE SPECIFIED MODELS

In this chapter I estimate the models specified in chapter 5. The estimation of the models is the fourth step of the methodological process and it produces the empirical results of the research.

Figure 6.1 represents the scope of this chapter.

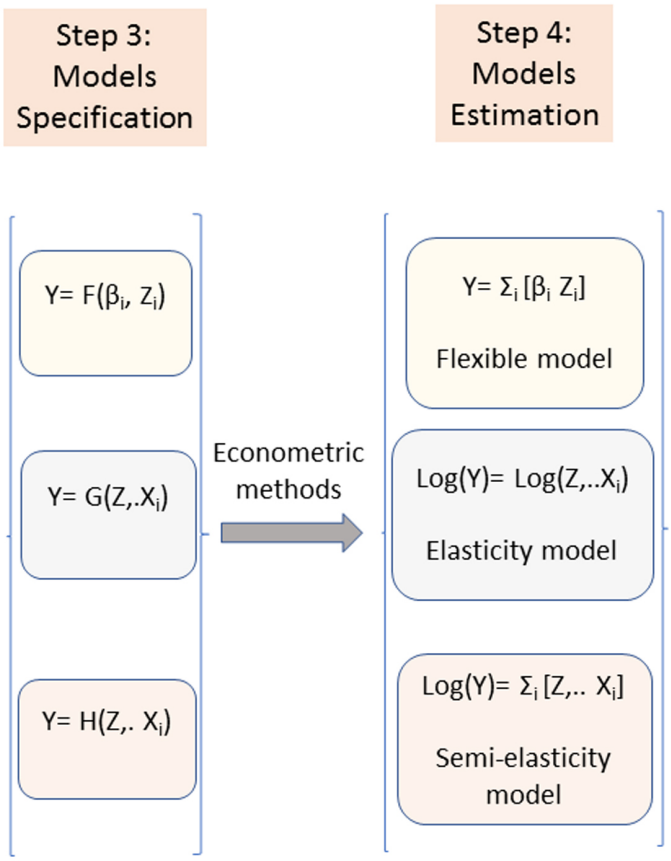


Figure 6.1: Estimation of the empirical models and determination of the results

This chapter is organized as follows:

In section 6.1 I estimate the flexible model considering the number of bidders as a discrete variable. I compare the two models with the best goodness of fit and select the most consistent one.

In section 6.2 I estimate the models in which the number of bidders is approximated as a continuous variable, potentially endogenous. I find two consistent models: an elasticity model and a semi-elasticity model, controlling for the endogeneity of the number of bidders.

6.1 MODELS ASSUMING NUMBER OF BIDDERS AS A DISCRETE VARIABLE

In this section I estimate the models based on the generic specification in equations (5.3) and (5.4). Table 6.1 presents the estimation of the two best-fitting models.

Table 6.1: Best-fitting estimated models assuming number of bidders as an exogenous and discrete variable

	Dependent variable:	
	indpago	log(indpago)
	(RM 1)	(RM 2)
constant	1.1512***	0.1071***
	(0.0415)	(0.0395)
DCATPRO1	−0.1535*	−0.2002*
	(0.0880)	(0.1041)
$BIDS_2$	−0.1321**	−0.1339**
	(0.0542)	(0.0521)
$BIDS_3$	−0.1655***	−0.1993***
	(0.0565)	(0.0633)
$BIDS_4$	−0.1924***	−0.2353***
	(0.0668)	(0.0746)
$BIDS_5$	−0.2767***	−0.2829***
	(0.0567)	(0.0602)
$BIDS_6$	−0.2359**	−0.3045***
	(0.0912)	(0.0932)
$BIDS_7$	−0.2424*	−0.2985***
	(0.1276)	(0.1006)
$BIDS_8$	−0.4089**	−0.5271**
	(0.1741)	(0.2198)
$BIDS_9$	−0.2087***	−0.1722**
	(0.0730)	(0.0733)
$BIDS_{10+}$	−0.2049***	−0.1693**
	(0.0765)	(0.0787)
Observations	370	370
R^2	0.061	0.073
Adjusted R^2	0.034	0.047
AIC	286.59	358.39
F statistic (df = 10; 359)	3.188***	3.732***

Note: Robust estimations HC0 *p<0.1; **p<0.05; ***p<0.01

Both models include all the categories representing the number of bidders as statistically significant variables at the usual confidence level of 95%. They both also include the variable, *DCATPRO1*, which represents the category of furniture goods.

All the coefficients associated to the categories representing the number of bidders include a negative sign. This indicates that competition reduces procurement costs regarding those tenders of the base group. The base group represents procurement auctions with only one bidder for non-furniture goods. The effect of competition is continuously growing up to 6 to 8 bidders. From 9 bidders onwards, the effect of competition becomes stable.

Tenders for furniture goods are more competitive than the rest (savings are higher), based on the negative coefficient of the variable DCATPRO1.

I use Ramsey's RESET test[1] to detect functional misspecification of any of the models. I obtained a negative result of the tests. Consequently, I cannot reject the null hypothesis that both models are correctly specified at the usual 95% confidence level.

Because the dependent variable is different in the models, I make additional calculations to determine which functional form is preferred. The method can be found in (Wooldridge, 2012). I select functional form (5.3) expressing the normalized procurement cost in levels as the best-fitting one to the empirical data.

Finally, I conduct an outlier test based on the concepts of leverage and influence used in (Davidson and MacKinnon, 2003). I detect two potential outliers in the observations of the sample. Both relate to auctions with a significantly high number of bidders and an unusual procurement cost. I have kept both observations in the estimation of the models because I did not find evidence of their influence in the regression beyond the limits usually established. None of the cases shows any remarkable inconsistency in the auction procedure based on the public information found in the tender dossier.

The details of the mentioned tests are included in section D.1 in the Appendix.

6.2 MODELS ASSUMING NUMBER OF BIDDERS AS A POTENTIAL ENDOGENOUS VARIABLE AND TREATING IT AS CONTINUOUS.

As a preliminary step, I estimate the structural equation of the general model represented by equation (5.5). I consider all the regressors associated to the tendering procedure. I fit the subsequent nested models until reaching the best-fitting one according to the highest adjusted R^2 and lowest AIC criteria.

In these models, I use *bids* in the three functional forms indicated in section 5.4: quadratic, linear and logarithmic.

Table 6.2 presents the estimation of these models with heteroskedastic consistent standard errors.

1 I take the usual variant of including the squared and cubed terms of the independent variable fitted values in the expanded regression.

Table 6.2: Best-fitting models assuming number of bidders as an exogenous and continuous variable in different functional forms

	Dependent Variable:		
	log(indpago)		
	(RM3v1)	(RM3v2)	(RM3v3)
DCATPRO1	−0.1595	−0.1721*	−0.1635
	(0.1050)	(0.1046)	(0.1038)
bids	−0.0370***	−0.0271***	
	(0.0095)	(0.0052)	
$bids^2$	0.0016		
	(0.0011)		
log(bids)			−0.0950***
			(0.0171)
Observations	370	370	370
R^2	0.094	0.091	0.100
Adjusted R^2	0.086	0.086	0.096
AIC	353.27	352.44	348.46
F statistic	11.51***(3;367)	16.08***(2;368)	18.16***(2;368)

Note: Robust estimations HC0 *p<0.1; **p<0.05; ***p<0.01

The regressions of the three variants of the structural equation (5.5) produce estimations that are consistent with the results of the models estimated in section 6.1.

Their coefficients indicate a reduction of the procurement cost as the number of bidders increases. Only the product category related to furniture goods exhibits a behavior different from the rest. Even when the coefficient is not significant at the usual level of 95% confidence, its inclusion improves the fitting of the three models and it affects the value of the coefficients related with the variable *bids*.

According to the adjusted R^2 and AIC criteria, the third functional form with the variable *bids* in logarithmic form is the empirically best-fitting model.

The model including the quadratic form of *bids* does not improve the model in which *bids* appears in linear form only. Its adjusted R^2 is similar, its AIC statistic is higher and the Ramsey's RESET test gives a p-value just above the threshold of adequate functional specification at the 95% of confidence. In addition, the coefficient of the quadratic form is not statistically significant. Hence, I consider the models with *bids* in logarithmic and linear form as the ones to compare with each other only.

The reduced form (5.6) of the IV model enables testing for potential endogeneity of the variable *bids*.

Endogeneity tests are found in the few works following a similar approach to the one in this research, for instance (Onur and Özcam, 2012). In economic terms, sources of endogeneity may be associated to features of the auction environment not captured in the proposed models. They affect procurement costs and, in addition, amplify or reduce the effect attributed to the number of bidders. Categories of products and market places are already included in the models, but there might be other missing specificities related to them. Furthermore, bidders' characteristics in each tender are absent from the available public data and, hence, excluded. Finally, there are different contracting authorities involved. Even when the general procedure is the same for all of them, there may be distinguishing management patterns in the individual beneficiary countries not captured in the models.

A first indication of the potential endogeneity of the variable *bids* in the structural equation can be obtained from the correlation between this variable (in the functional form entering the model) and the residuals of the corresponding estimated model in Table 6.2.

For the model with *bids* in linear form, this correlation yields the following value: $corr = -0.0543$, with $p - value = 0.2975$. Therefore, I cannot reject the hypothesis that the correlation is not significantly different from 0 at the usual 95% of confidence and, thus, there is no clear evidence of endogeneity of *bids* in this model.

However, for the model with *bids* in logarithmic form, this indicator points at certain level of endogeneity. The correlation value is: $corr = -0.0925$, with $p - value = 0.0755$. Therefore, correlation would be reduced, but significant at the 92.45% level of confidence.

Economic reasons and this first indicator of endogeneity justify that I test for potential endogeneity of the functional form of bids in the estimated models.

6.2.1 *Estimation of the structural model with IV methods.*

Both *GDP_1* and *EXPORTS_1* fulfill the initial conditions of adequate instruments for the variable *bids*, because at the usual level of confidence they have a significant correlation with this variable (relevance condition) and an insignificant correlation with the residuals (exogeneity condition) of the models estimated according to the structural equation (5.5). *DTF_1* presents a reduced correlation with the variable *bids*, and no correlation with the residuals of the concerned models. Therefore, I can use it in conjunction with *GDP_1* and *EXPORTS_1* if it proves to increase the joint instrumental power.

Exports are a component of GDP through the balance of trade and they may be correlated. Hence, it is advisable not to include both instruments in the same model. However, replacing one instrument with the other in the proposed models provides a test of robustness for the coefficient of the instrumented variable.

I estimate again models RM3v2 y RM3v3 in table 6.2 controlling for endogeneity. First, I use the instruments GDP_{-1} and DTF_{-1}, expressing them in the functional forms with the highest instrumental power.

The best-fitting estimated models are represented by equations (6.1) and (6.2).

$$\text{RM4}: \begin{cases} log(indpago) = \gamma_1\ DCATPRO1 + \gamma_2\ bids + u \\ bids = \lambda_1\ DCATPRO1 + \lambda_2\ GDP_{-1} + \lambda_3(GDP_{-1}) * (DTF_{-1}) + v \end{cases} \tag{6.1}$$

$$\text{RM5}: \begin{cases} log(indpago) = \gamma_1'\ DCATPRO1 + \gamma_2'\ log(bids) + u' \\ log(bids) = \lambda_1'\ DCATPRO1 + \lambda_2'\ log(GDP_{-1}) + \lambda_3' log(DTF_{-1}) + v' \end{cases} \tag{6.2}$$

Both estimation methods, 2SLS and GMM, provide the same coefficients, which is consistent with the linear form of the models. The instrumented coefficients for *bids* in model RM4 and $log(bids)$ in model RM5 are negative as it was the case with the estimation of the models without instrumentation. Yet, the values are higher (less negative). In the model with *bids* in linear form, the variation with regards to model RM3v2 in table 6.2 is of about 5%, but in the model with *bids* in log form, the change is close to 20% indicating that there is indeed endogeneity of this variable in the model.

I conduct specific tests for the diagnosis of the instrumental models.

The first-stage F-statistic test provides evidence against the null hypothesis that the instruments both for model RM4 and RM5 are weak and, hence, I conclude that they are valid.

An overidentification robust score test indicates that adding DTF_{-1} as a second instrument (in the adequate functional form) provides additional instrumental value in both models.

Finally, Hausman's endogeneity test does not allow rejecting the null hypothesis that using OLS to estimate the model RM3v2 yields consistent results. Thus, there is no significant evidence against considering *bids* exogenous in this model and, hence, RM3v2 provides a more efficient estimation than the instrumented model RM4. Reversely, Hausman's test applied to model RM5 shows evidence against the null hypothesis that *log(bids)* is exogenous in model RM3v3 with a 99% of confidence. I must therefore use the instrumented coefficient of this variable estimated in model RM5 for inference purposes.

As a final test, I replace GDP_{-1} by $EXPORTS_{-1}$ in the instrumental models to verify the robustness of the instrumented values.

$$\text{RM4v2}: \begin{cases} log(indpago) = \gamma_1\ DCATPRO1 + \gamma_2\ bids + u \\ bids = \beta_1\ DCATPRO1 + \beta_2\ EXPORTS_{-1} + \beta_3(EXPORTS_{-1}) * (DTF_{-1}) + w \end{cases} \tag{6.3}$$

$$\text{RM5v2}: \begin{cases} log(indpago) = \gamma_1' \; DCATPRO1 + \gamma_2' \; log(bids) + u' \\ log(bids) = \beta_1' \; DCATPRO1 + \beta_2' \; \log(\text{EXPORTS}_{-1}) + \beta_3' \log(\text{DTF}_{-1}) + w' \end{cases} \tag{6.4}$$

The estimation of RM4v2 confirms that the variable *bids* in model RM3v2 does not show substantial endogeneity.

The estimation of RM5v2 yields coefficients that take basically the same values obtained in the estimation of RM5. They are displayed in table 6.3. This confirms the endogeneity of *bids* in model RM3v3 and the robustness of the instrumental estimation.

Table 6.3: Endogeneity correcting models for variable log(bids) in RM3v3. Linear approximation 2SLS and GMM estimation methods

	Dependent Variable: log(indpago)		*Dependent Variable: log(indpago)*	
	Instruments: $\log(\text{GDP}_{-1})$, $\log(\text{DTF}_{-1})$		Instruments: $\log(\text{EXPORTS}_{-1})$, $\log(\text{DTF}_{-1})$	
	RM5(2SLS)	RM5(GMM)	RM5v2(2SLS)	RM5v2(GMM)
DCATPRO1	−0.1787*	−0.1787**	−0.1789*	−0.1789**
	(0.1045)	(0.0896)	(0.1045)	(0.0896)
log(bids)	−0.0763***	−0.0763***	−0.0761***	−0.0761***
	(0.0186)	(0.0187)	(0.0186)	(0.0187)
Observations	370	370	370	370
R^2	0.097		0.097	
Adjusted R^2	0.092		0.092	
F statistic (df = 2; 368)	11.20***		11.10***	

*p<0.1;**p<0.05;***p<0.01 2SLS with robust estimations HC0; GMM in two steps with quadratic spectral kernel for HAC

The full discussion of the estimation of the models in this section and the referred tests can be found in annex D in the Appendix.

7

RESEARCH RESULTS

In this chapter I present the results of the research based on the estimated models I have selected in chapter 6.

Figure 7.1 represents the scope of this chapter in line with the methodological approach I have followed in the research.

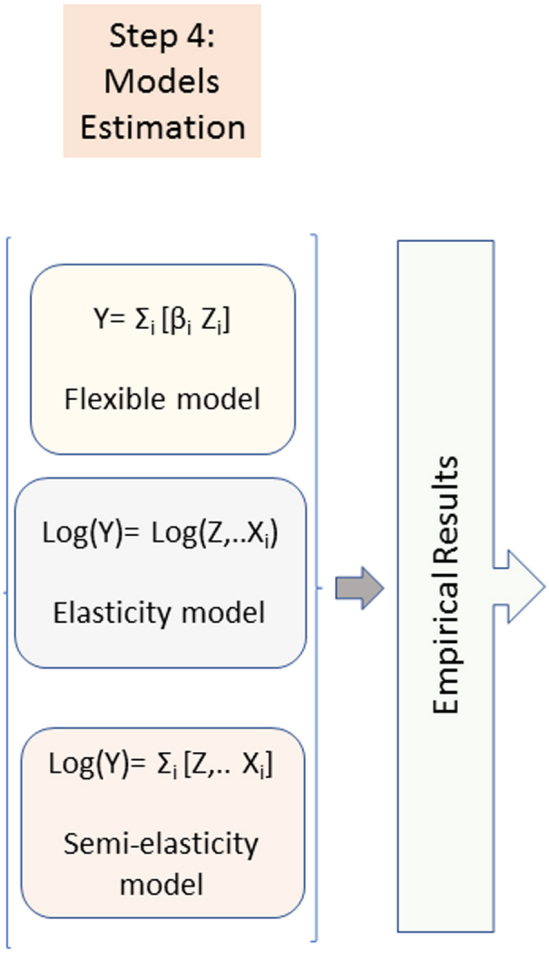


Figure 7.1: Estimation of the empirical models and determination of the results

This chapter is organized as follows:

In section 7.1 I discuss the empirical results of the research focusing on the three estimated models and comparing them.

In section 7.2 I represent the three estimated models graphically to better illustrate their properties.

Finally, in section 7.3, I interpret the results, summarizing the observed effects of competition on procurement costs.

7.1 DISCUSSION OF SELECTED EMPIRICAL MODELS.

I discuss in this section the estimation of the three selected empirical models and their main features:

• Flexible non-linear model.

$$\begin{aligned} indpago = {} & 1.151 - 0.154DCATPRO1 - 0.132BIDS_2 - 0.166BIDS_3 - 0.192BIDS_4 - \\ & - 0.277BIDS_5 - 0.236BIDS_6 - 0.242BIDS_7 - 0.409BIDS_8 - 0.209BIDS_9 - 0.205BIDS_{10} + \nu \end{aligned} \tag{7.1}$$

This flexible non-linear model points at a limit to the price competition effect as from eight bidders, as the coefficient associated to the variable representing this number of bidders is the most negative one, and the last two coefficients are very similar and they break the decreasing trend. This would be the typical bidding behavior of an auction environment satisfying the bidders' common value paradigm, where bidders try to avoid the winner's curse.

This model relaxes all the restrictive assumptions on the bidders' value paradigm and it has been used in previous works in the literature. For instance, (Brannman et al., 1987) uses it in four different first-price sealed-bid auction environments to discuss the most likely underlying value paradigm with the help of the full set of bids.

• Semi-elasticity model.

$$log(indpago) = -0.172DCATPRO1 - 0.027bids + u \tag{7.2}$$

This semi-elasticity model provides a semi-elasticity of -0.027 for non-furniture goods. The same model applied exclusively to furniture goods yields a semi-elasticity of -0.098 for this category of products. The weighted average is -0.031. This result is comparable to that in (Onur and Özcam, 2012), who obtain an average semi-elasticity of -0.039 with a similar model for an unrestricted sample of all kind of procurement auctions in Turkey. The lower semi-elasticity in absolute value in this research may correspond to a higher proportion of technological products in Europe Aid auction environment.

• Elasticity model (instrumented).

$$log(indpago) = -0.179DCATPRO1 - 0.076log(bids) + \epsilon \tag{7.3}$$

The elasticity model is the best-fitting model according to criteria of statistic consistency. In this model, the competition effects would cease quickly with the entry of new bidders. The bidders' value would not be purely private. A certain level of affiliation would be expected. Once controlled for endogeneity, the model provides an elasticity of -0.08 for non-furniture goods. The same model applied exclusively to furniture goods yields an elasticity of -0.28. The weighted average is close to -0.10. This result is comparable to (Iimi, 2006) who obtains an average elasticity of -0.2 in a model for an international sample of ODA auctions with high-value contracts over 7 EUR million, under simplifying IPVP assumptions. The lower elasticity in absolute value in this research may correspond to a higher proportion of technological products and to the absence of potential high-value contract sample selection bias, because I do not restrict the lots by contract value.

The empirical results of the three selected models are important to draw fundamental conclusions of the research. It is particularly important to outline the following characteristics applying to all of them.

1. The three models are statistically consistent, that is their goodness of fit is appropriate to conduct inference within the levels of confidence usually applied.

2. As a consequence of the previous feature, there exist a broad range of values for the number of bidders for which the three models converge. In particular, for tenders with a level of competition of between two and four bidders, the three models predict similar savings rates. This is a reasonable finding because these are the most representative categories in the dataset. With levels of competition of between five and eight bidders, the empirical predictions on the savings rate vary, although the increasing trend of the savings rate with the level of competition holds.

3. For higher levels of competition from nine bidders onwards, the models diverge significantly, which not only prevents from estimating the savings rate, but also from interpreting the underlying attributes of the bidders in this auction environment from an empirical perspective. This result is also reasonable taking into account the comparative approach followed in the research, because the three models are consistent, but each of them corresponds to different assumptions to find the structural solution to the equilibrium bid.

7.2 GRAPHICAL REPRESENTATION OF THE EMPIRICAL MODELS

The estimated models presented as empirical results of the research involve different functional forms relating procurement cost to the level of competition represented by the number of bidders.

In order to provide an easier interpretation of the three models we can transform the equations specifying them in such a way that procurement cost normalized to reference price appears in levels in the left side of the equations.

Figure 7.2 represents graphically the three determinant models in the research after conducting the necessary transformations of the equations specifying them. The depicted values are the predictions conditioned to the whole values of the number of bidders between 2 and 10 and to the value 0 of the variable *DCATPRO1* representing furniture goods. This means that the figure predicts the normalized procurement cost for each level of competition and for all the tendered products, with the exception of furniture goods.

For models (7.2) and (7.3) I use the unbiased predictor of the level form for the dependent variable *indpago*. I calculate the exponential transformation from its logarithmic form as described in (Wooldridge, 2012). I also show the 95% confidence bands calculated with heteroskedasticity-robust standard errors.

Model 7.1 does not need to be transformed as it includes the normalized procurement cost in level form as the dependent variable. I also show in this case the 95% confidence bands calculated with heteroskedasticity-robust standard errors.

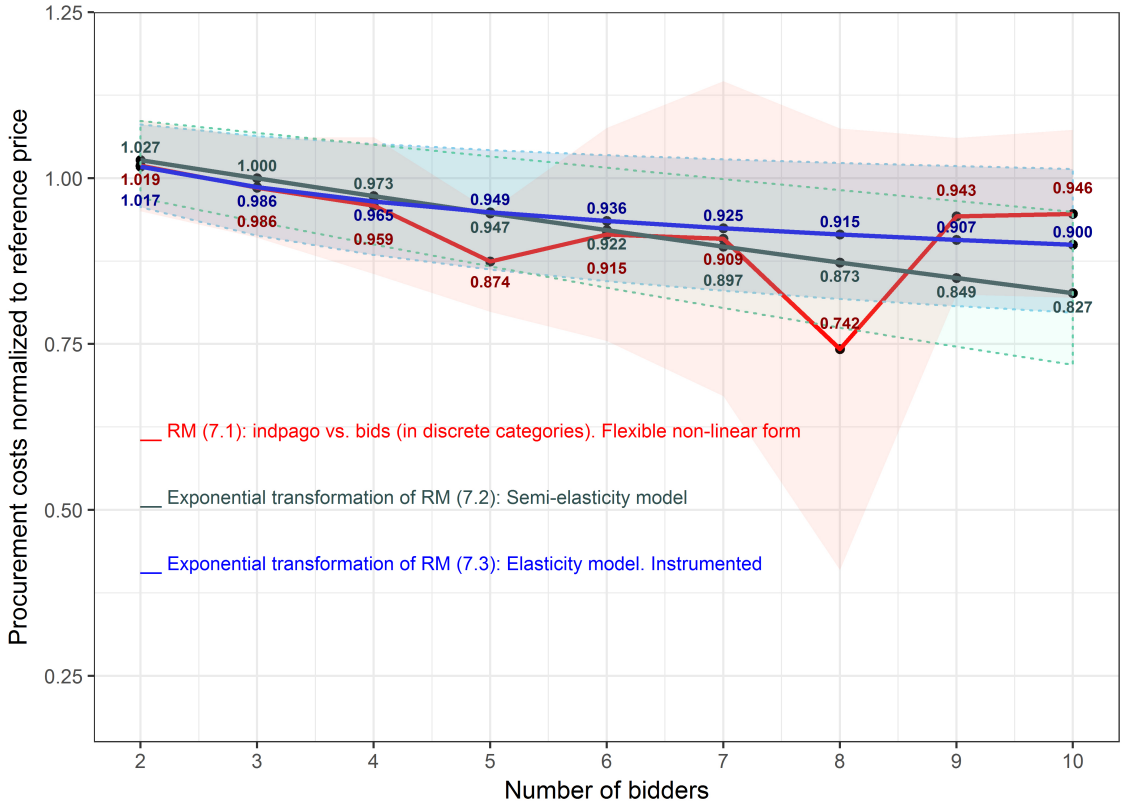


Figure 7.2: Representation of the best-fitting models to determine the influence of competition on procurement cost. The figure shows normalized procurement costs predictors with their confidence bands for each number of bidders, excluding tenders for furniture goods.

The main empirical results of the research concerning the savings rate achieved with the procurement auction mechanism can be directly interpreted from figure 7.2 by noticing that the savings rate is simply the difference between unity and the represented curves, as expressed by the equation (5.2).

7.3 HIGHER LEVEL OF COMPETITION REDUCES PROCUREMENT COSTS

The results of the research show empirical evidence of the positive effect of increased competition on procurement cost savings for Europe Aid supply tenders funded with the Pre-accession Assistance (IPA) and European Neighbourhood (ENI) instruments. This empirical evidence is in line with the theoretical predictions.

The three selected models discussed in section 7.1 imply a non-linear relationship between the procurement cost and the number of bidders. This empirical result confirms the theoretical predictions as well.

The estimated reference price is a key feature of the three models. The estimation of the reference price is based on a price signal that the contracting authority issues in the majority of the tender procedures. The signal relates to the amount of a bank guarantee required to participate in the tender procedure. The procurement cost normalized to the estimated reference price is consistently calculated across tenders using the price signal indicated by the bank guarantee. This variable is directly connected with the savings rate.

Estimating this reference price for each tendered lot enables determining the approximate savings obtained with the auction mechanism. The difference between the estimated reference price and the award price indicates the savings achieved with the auction mechanism. The initial objective of the research focuses on predicting the evolution of a relative magnitude, the savings rate, with the level of competition. This prediction can be directly interpreted from figure 7.2. Hence, the approach followed in the research overcomes the difficulties associated to the absence of the contracting authority's reserve price in the public data and facilitates the achievement of this first objective of the thesis.

The results of the three selected empirical models converge up to four bidders and diverge as from eight. In the range from two to eight bidders, each new bidder entering the tendering procedure involves a reduction in the estimated procurement cost in the three models. This implies that for the type of auction in this research, and regardless of the the features of the auction environment, the positive effect of competition is present in most of Europe Aid supply tenders. More precisely, over 70% of the procedures fall within this fully competitive range as it is shown in Figure 7.3.

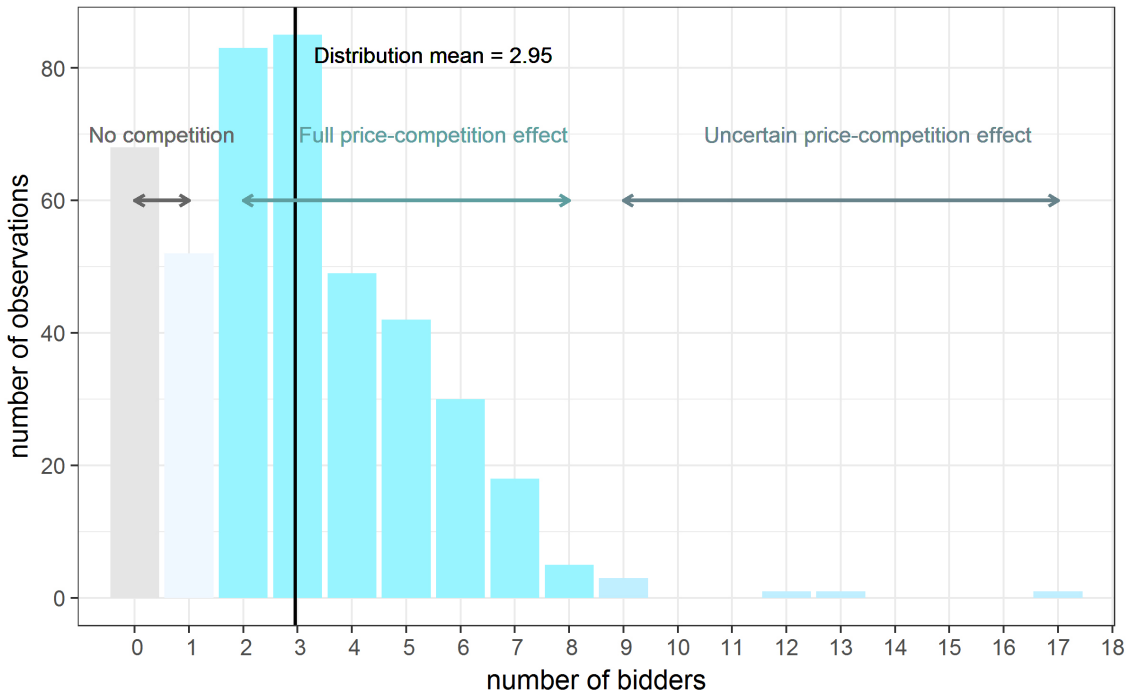


Figure 7.3: Ranges of price effects of competition according to the number of bidders

The best-fitting model provides an elasticity close to -0.08 for all categories of non-furniture goods, once corrected from endogeneity. Considering furniture goods, the average elasticity is close to -0.1. A quick interpretation of this measure is that increasing the number of bidders in 10% yields an approximate average reduction of 1% in the procurement cost normalized to the estimated reference price. If the tendered good does not belong to the category of furniture, the approximate reduction of the procurement cost for a 10% of increase in the number of bidders is 0.8% only.

This empirical result is compatible with those from previous studies in similar public procurement environments.

The average number of bidders in the dataset used in the research is three, including also the unsuccessful procedures. This figure is significantly below the critical value of eight bidders, wherefrom the three models diverge. The savings rate for three bidders, regardless of the model we consider, is lower than 1.5% for all categories of products, excluding furniture goods.

This savings rate for the average number of bidders indicates that measures promoting competition in Europe Aid supply tenders would achieve more significant savings. For instance, doubling the average number of bidders to six would enable the buyer to achieve a savings rate in the range of 6.5% to 8.5%, regardless of the model we use.

Referring savings to the unknown reserve price of the contracting authority would yield a higher absolute value because, by construction, the estimated reference price used in the research is strictly lower than the maximum reserve price in an approximate factor of 1.5. The estimated average savings rate referred to this extreme bound yields an approximate value of 35%. However, it is reasonable to think that the contracting authority does not use the extreme bound in the tender guarantee signal when building her reserve price, to avoid disclosing it.

Based on these quantitative results of the research, the effective promotion of competition in the tendering procedures would achieve higher procurement cost savings. I draw specific conclusions on this fact and I elaborate some recommendations in chapter 8.

Finally, each of the estimated models presented as results of the research corresponds to a structural solution to the equilibrium bid based on implicit assumptions on one or several aspects characterizing the auction environment. The three empirical models are statistically consistent and, thus, we cannot determine with certitude through them all the features of the auction environment, and particularly those related with the bidders' attributes. I discuss in chapter 8 some conclusions that can be drawn based on economic arguments to complement this undetermined empirical result.

8

CONCLUSIONS, INNOVATIVE CONTRIBUTIONS, AND FUTURE RESEARCH LINES

In this chapter I present the main conclusions of the research results, the innovative contributions of this thesis and related future fields of research. This is the final phase of the methodological process.

Figure 8.1 represents the scope of this chapter.

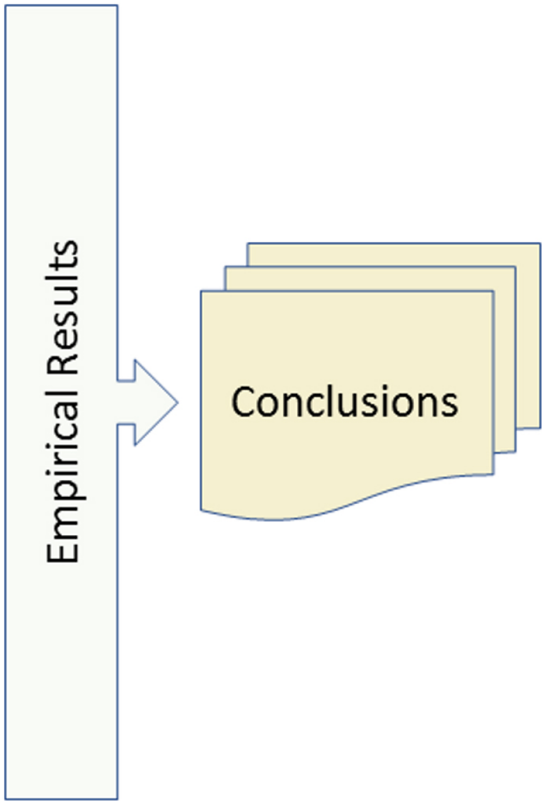


Figure 8.1: Conclusions of the research based on the results

Section 8.1 summarizes the conclusions of the research. In particular, it focuses on the quantitative effects of competition on procurement costs estimated with the empirical results and on the characterization of different factors of the auction environment of Europe Aid tenders. The section finishes with suggestions to improve this auction mechanism based on the empirical results of the research.

Section 8.2 outlines the innovative contributions of this thesis regarding previous research works in this field.

Finally, section 8.3 indicates different research lines that would be complementary to the research conducted in this thesis, and other lines of related research.

8.1 CONCLUSIONS

In this section I gather the main conclusions related the aim of this thesis. I have structured them according to the main outcomes of the research.

It is a well established prediction of auction theory that the increase in the number of bidders competing in the auction is correlated positively with the benefit of the auctioneer. In direct auctions, the auctioneer is the seller, and the theory predicts that an increase in the number of bidders results in an increase of the sale price. In reverse auctions, the auctioneer is the buyer, and auction theory predicts that the increase in the number of bidders results in the reduction of the acquisition price.

The pattern of the dependence between the two magnitudes includes as determining conditions: the auction environment and the rules of the auction. Within the auction environment, the typical factors with influence are: the type of good being auctioned, the bidders' attributes and the industry features.

I analyze in section 8.1.1 the evidence of the empirical results of the research regarding the reduction of procurement costs with increased levels of competition, in accordance with the theoretical predictions.

Subsequently, I characterize the auction environment analyzing the different factors and their implications for the conclusions of the research.

Subsection 8.1.1.1 focuses on the bidder's attributes, on the importance of the assumptions made on those attributes, and on how to interpret their influence in the empirical results of the research.

Subsection 8.1.1.2 focuses on the different categories of goods, and on the different competitive results obtained based on their technological level.

Subsection 8.1.1.3 focuses on the market places, which are classified by combining the financial instrument funding the supply contracts with the geographic location of the countries where they take place. This classification enables to define four specific country categories. The homogeneous competitive pattern of the empirical results concerning this factor is a relevant conclusion of the research.

Section 8.1.2 summarizes the relevant features of Europe Aid supply tenders according to which I have modeled them as reverse auctions. I present a brief comparative analysis of the different typologies of auctions and I focus on the auction environments where each typology presents benefits for the auctioneer.

Based on the conclusions of previous works and the empirical results of the research, I finish this section with some suggestions of policy measures that would improve the benefit for the auctioneer (the contracting authorities acquiring the supplies in the context of this research) by modifying the rules of the auction. The challenges to be faced with these modifications are outlined as well.

8.1.1 *Conclusions on the price effect of competition*

The first relevant conclusion of the research presented in the thesis, in line with the theoretical predictions, is the empirical evidence of the positive effect of increased competition on procurement cost savings for Europe Aid supply tenders funded with the Pre-accession Assistance (IPA) and Neighbourhood (ENI) instruments.

To draw this conclusion I have modeled Europe Aid supply tenders as a specific type of first-price sealed-bid reverse auctions. Based on an unrestricted approach to the characteristics of the auction environment, I have specified three general models satisfying structural conditions for the solution to the equilibrium bid, covering a broad range of required assumptions. The three specified models generate statistically consistent estimations with a non-linear relationship between the procurement cost and the number of bidders, controlling for different potential sources of heterogeneity of the market.

Procurement cost appears in the three models normalized to a reference price that is consistently calculated across tenders using a price signal issued by the contracting authority. This normalized magnitude is directly connected with the estimated savings rate.

The results of the three empirical models show the evolution of the savings rate with increased levels of competition. These results converge up to four bidders and diverge as from eight. In the range from two to eight bidders, each new bidder entering the tendering procedure involves a reduction in the estimated procurement cost in the three models determined in the research. Hence, the savings rate follows a continuous increasing pattern until the critical value of eight bidders, even when the three models predict different values of the savings rate for each particular level of competition.

The best-fitting model provides an elasticity close to -0.08 for all categories of non-furniture goods, once corrected from the endogeneity of the variable representing the number of bidders. Considering furniture goods, the average elasticity is close to -0.1. A quick approximate interpretation of this measure is that increasing the number of bidders in 10% yields an approximate average reduction of 1% in the procurement cost of the tendered lot normalized to the estimated reference price.

This result quantifies precisely the effect of the level of competition in the procurement cost, at least in the region of convergence shared by the three models, and it characterizes the first conclusion of this thesis.

A second immediate conclusion is related to the application of this result to the average number of bidders in the tenders of the dataset used in the research, which is three including also the unsuccessful procedures. Because this average level of competition is significantly below the critical value of eight bidders, the procurement auction mechanism in this auction environment does not produce optimal results. Therefore, measures promoting competition in Europe Aid supply tenders would achieve more significant savings, opening room for political action in this field.

For instance, with measures achieving doubling the average number of bidders from three to six, the contracting authority would obtain a savings rate in the range of 6.5% to 8.5%, regardless of the model we use, instead of a savings rate lower than 1.5% predicted by the three models for the average number of bidders.

8.1.1.1 *Conclusions related to the bidders' attributes*

The first model found in the research is estimated relaxing most of the restrictive assumptions about the bidders' attributes. This model assumes only that the bidders behave rationally to maximize their benefits. There are no assumptions on their costs distribution or on whether they are symmetric or not to the purpose of establishing their bidding strategy.

In this model, the effect of each new bidder entering competition can differ freely from the effect of the rest when the number of bidders increases, because each level of competition is treated with a discrete variable. Figure 8.2 shows the graphic representation of this model.

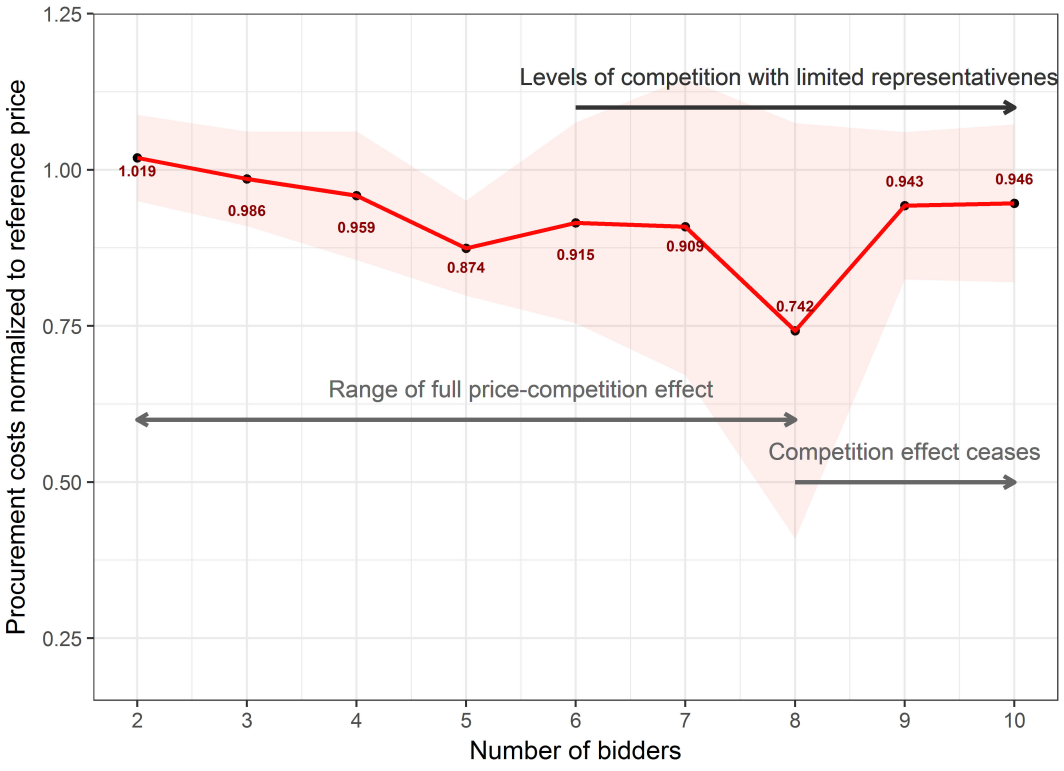


Figure 8.2: Ranges of price effects of competition for the flexible non-linear model

Relaxing assumptions about bidders' costs structures and bidding strategies is realistic in our auction environment. In the first place, this is due to the fact that the access to tender data is limited. We just know publicly who has won the tender and the winning bid. We do not have any information about the competitors in the tender procedure. Secondly, the rules of the auctions incorporate sources of asymmetries. I present in section 2.2.3 detailed explanations of the effects of asymmetries based on the current state of the art.

This first model is adequately adapted to this unrestricted approach, because it does not respond to an equilibrium solution in closed form, which is one of the theoretical predictions in the general context of bidders' asymmetries. In fact, the behavior of the shape of the curve for this model is irregular. Until five bidders, there is a steady reduction of procurement costs with the entry of each new bidder, but between five and eight bidders the cost reduction is no longer steady. It shows a short ceasing effect with six and seven bidders, and a new drastic reduction with eight bidders.

The main drawback of this model is the different degree of representativeness of the level of competition indicated by the number of bidders. The categories of tenders according to the number of bidders competing in them loose their representativeness progressively as the number of bidders increases. In other words, there are few observations in those categories and the statistical inference includes a significant error dispersion for the estimators representing those categories. The error confidence bands in figure 8.2 show this phenomenon. Hence, the irregular behavior of the curve as from five bidders may be explained partially for the mentioned reason.

The shape of the curve would indicate that competition effects cease as from eight bidders. Yet, as from six bidders, the error confidence bands are so broad for this model, that the interpretation of this conclusion must be taken with caution.

To find a limit to the competition effects is compatible with previous results in the field. The easier way to justify the ceasing of competition effects is an auction environment with prevalence of bidders' cost distribution according to the CVP paradigm. However, I have referred other auction environments in section 2.2.1, under the more realistic AVP paradigm, where the ceasing of the competition effect is also possible.

The second and third empirical models provide a semi-elasticity and an elasticity as the underlying patterns between the dependence of procurement costs and the level of competition.

The first relevant feature of both models is that they represent a closed-form for the solution to the equilibrium bid. This feature implies that our underlying assumptions are more restrictive on the bidders' attributes than the assumptions for the first flexible model. Implicitly, we are assuming with these new models that the bidders' asymmetries do not have a severe influence on the bidders' strategies to formulate their bids, regardless of how they build their strategies based on the valuation of the tendered good.

Another important feature of these models is that the level of competition represented by the number of bidders may be an endogenous variable. We cannot detect and treat easily the effect on endogeneity in the number of bidders in the flexible non-closed model because each category of number of bidders would need its own correction. However, the test and correction for endogeneity in the elasticity and semi-elasticity models is possible with the use of instrumental variable methods.

In chapter 6 I have explained the correction for endogeneity of the number of bidders in the estimation of the elasticity model with instrumental variables for inference purposes. Tests for endogeneity of the variable representing the number of bidders in the semi-elasticity model indicated that corrections are not needed because they would not be significant.

For models in closed-form, the bidders' cost distribution paradigm defining their bidding strategies determines the functional dependence between procurement cost and level of competition. Once the models are corrected for endogeneity, the steadier is the slope of the curve defining the functional dependence, the more approximate the cost distribution paradigm will be, in general, to a pure IPVP.

Figure 8.3 represents the semi-elasticity model. We can see from this figure that visually the curve has an almost constant slope. The slope actually decreases with the entry of new bidders, but the rate of decrease is very small as it can be calculated with the values of the predictions depicted in the figure.

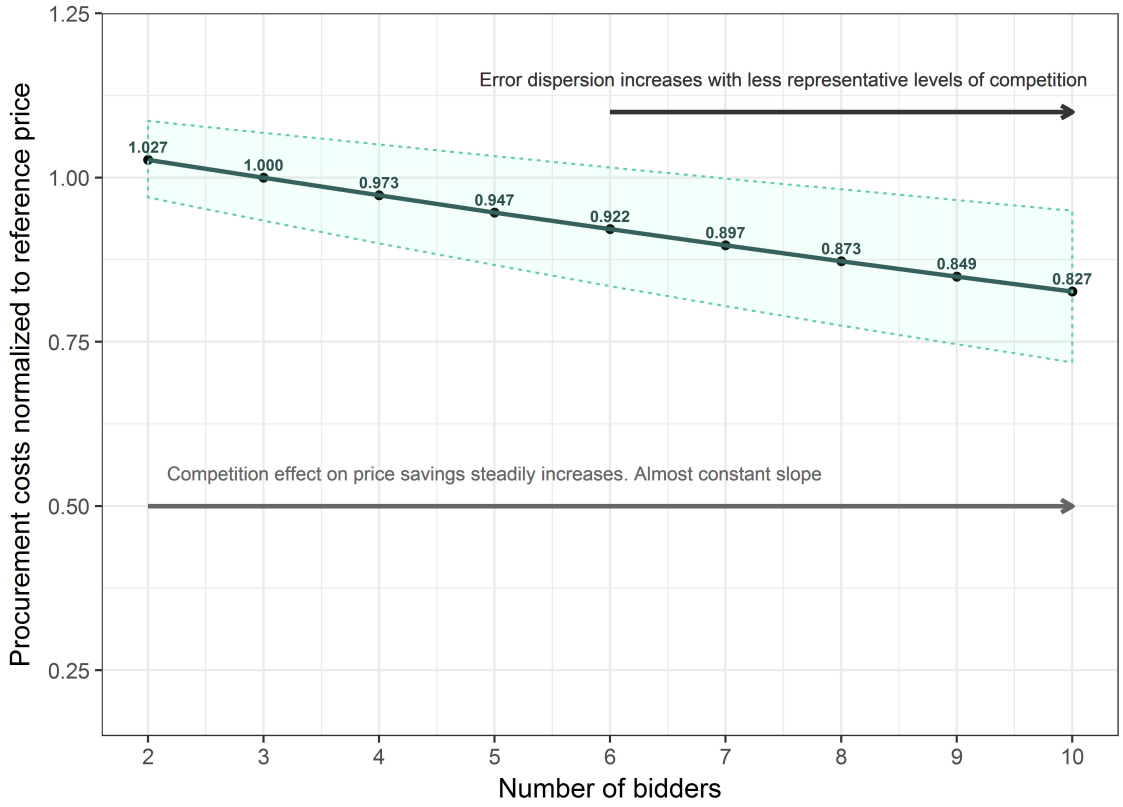


Figure 8.3: Steady price effects of competition in the semi-elasticity model. Semi-elasticity = -0.027 for non-furniture goods.

This behavior of the dependence between the procurement cost normalized to the estimated reference price and the level of competition representing the number of bidders competing for the tendered lot would indicate an almost pure IPVP paradigm in the bidders' cost estimation.

The elasticity model represented in figure 8.4 exhibits a similar pattern, but in this case the slope does not approximate to a constant. As the level of competition increases the slope of the curve decreases significantly. This indicates that a certain level of affiliation among the bidders may be present, which is the more realistic situation in our auction environment.

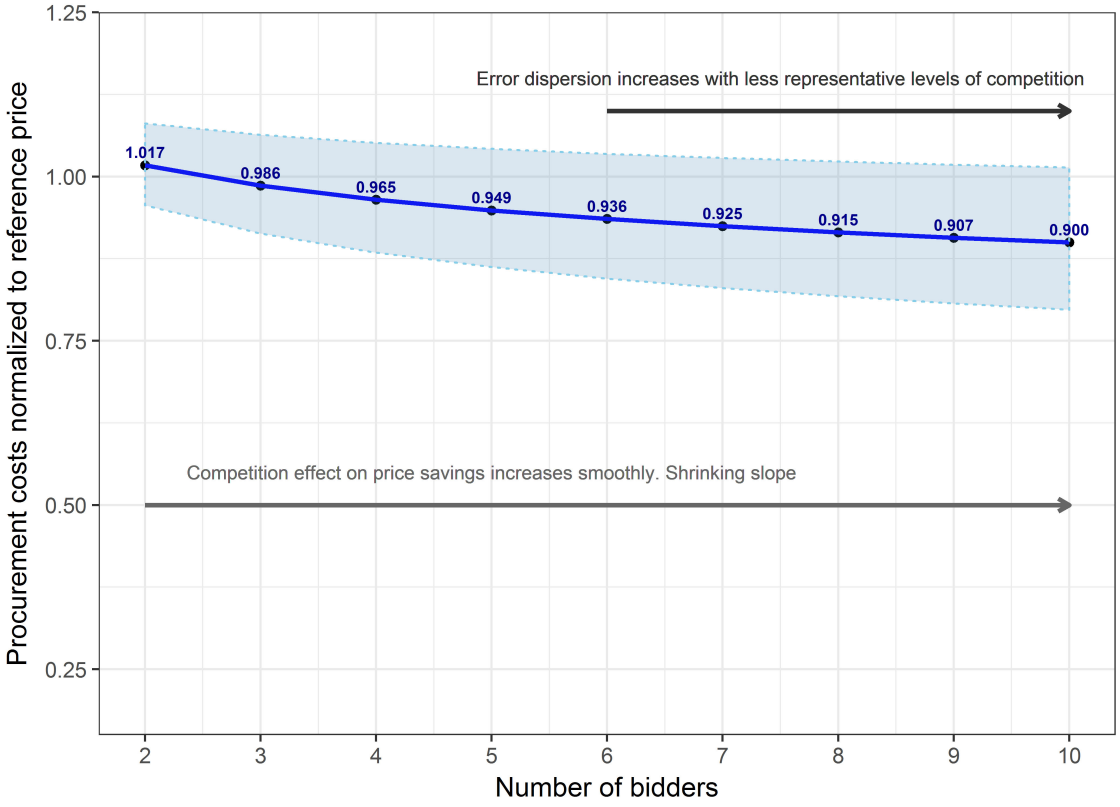


Figure 8.4: Smooth price effects of competition in the elasticity model. Elasticity = -0.08 for non-furniture goods, corrected from endogeneity

Because both the elasticity and semi-elasticity models are statistically consistent, we cannot categorically conclude on any underlying cost distribution paradigm. Moreover, we have seen that the less restrictive flexible non-closed form model is also consistent and theoretically well adapted to the auction environment. Hence, even when the elasticity model is the best-fitting model to the dataset once corrected for endogeneity, from a pure empirical point of view we can only conclude that the three models can be considered just adequate approximations and their predictions are robust in the shared region of convergence. We need other theoretical arguments to decide on the most likely bidders' attributes.

Previous papers in the literature of procurement auction impose the restriction of assuming an exogenous number of bidders. Exogeneity means that the number of incumbent bidders is predetermined in the analyzed market. Under this assumption, the only reason for the existence of different numbers of bidders in each tender relates to the bidders' cost valuation for supplying the tendered good with reference to the buyer's reserve price that they estimate. It is a competitive reason.

The exogeneity restriction can be reasonable by the construction of the dataset. For example, by using contracts over a certain value in a particular industry, only accessible to a limited number of companies with enough technical and financial capacity. In more general auction environments like the one in this research, endogeneity in the number of bidders would be a more realistic phenomenon.

Endogeneity means that the individual tender procedure determines the number of incumbent bidders. In other words, the actual number of bidders for each tendered lot may be determined not only based on the cost valuation of the lot by a previously determined group of incumbent bidders, but also based on the features of the auction environment itself. These features concern the industrial sector, the geographic location of the market, the price of the good, and also the bidder's attributes for each of these specific markets.

We discussed in 2.2.3 several reasons that would justify bidders' asymmetries in the auction environment of the research. These asymmetries would justify in turn, aside from potential features of the products or of the market places that may not be captured with the categories created in the dataset, the appearance of endogeneity affecting the number of bidders in the identified models, which we have seen is the case for the elasticity model.

Hence, the best goodness of fit to the dataset, the adequacy of the pattern of the savings rate to the realistic AVP paradigm, and the existence of endogeneity in the level of competition that could be associated to bidders' asymmetries would point at the elasticity model as the better adapted to explain the auction environment, and in particular the factor of the bidders' attributes.

Figure 8.5 depicts the main conclusions of this section graphically.

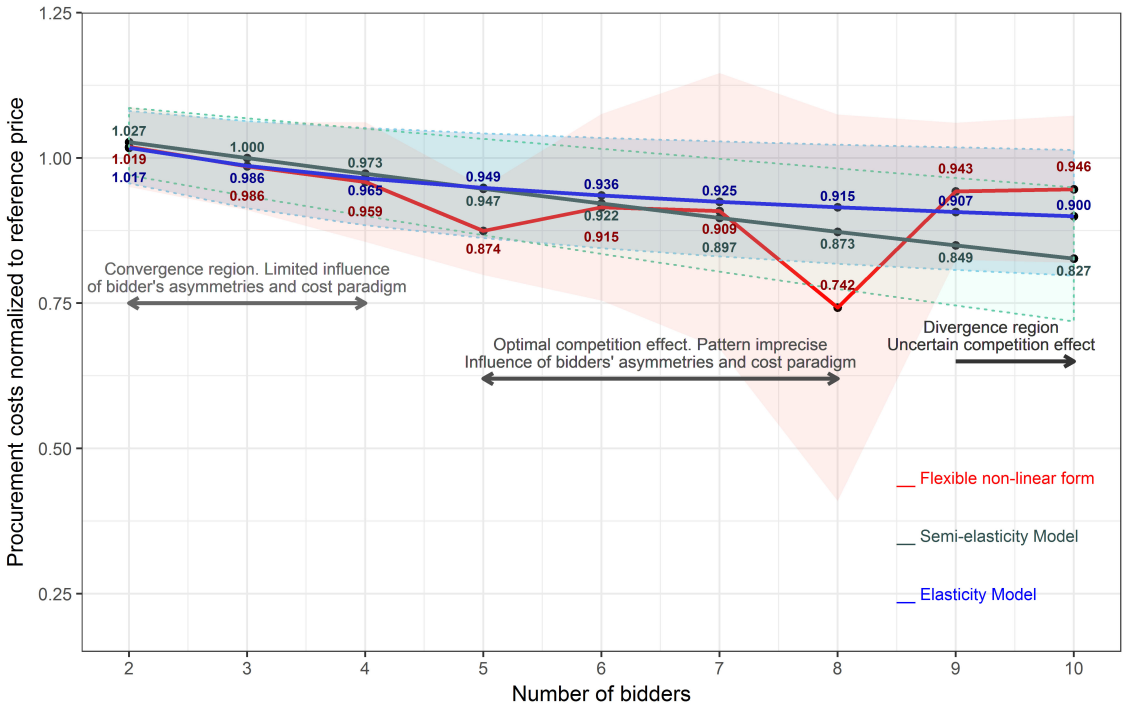


Figure 8.5: Competition effects based on bidders attributes

Based on the arguments exposed and with the support of figure 8.5, I summarize the conclusions of this section.

- The bidders' attributes in our auction environment cannot be fully determined. The first reason is that we lack relevant information on them because it is not present in the public data of the tender dossiers (we only access to public data from the winner). The second reason is that the three empirical models identified in the research are all of them statistically consistent, and each of them implicitly represents different bidders' attributes.

- The heterogeneity of the analyzed market and the tender rules (for instance, the possibility of joint bidding) would induce *a priori* bidders' asymmetries and, hence, we would expect bidders from one or several typologies forming their bidding strategies differently from bidders of other typology. According to auction theory, this implies that, in general, there is no closed-form solution to the equilibrium bid.

  Notwithstanding bidders' potential asymmetries in the auction environment, the data allow estimating empirical consistent closed-form models as valid approximations. Thus, asymmetries would not be completely determinant in the full range of competition levels. In fact, up to four bidders, a flexible model for treating bidders' asymmetries and approximated models disregarding these asymmetries conclude with similar results.

  In addition, we observe endogeneity in the number of bids for the elasticity model, but not for the semi-elasticity model. This phenomenon would support the same argument: bidders' asymmetries would induce the endogeneity, but endogeneity must be relevant only for a limited range of values, likely those levels of competition with higher number of bidders, where the differences between the models are evident and the representativeness of the categories reduced.

- The best-fitting model to the dataset is an elasticity model, which requires correction for endogeneity of the variable representing the number of bidders. This model would characterize reasonably well the bidders' attributes in economic terms.

  In the first place, endogeneity would be expected in an auction environment of different products in different market places and with a broad range of prices, where joint bidding is also possible. Endogeneity would be induced by bidders' asymmetries. Asymmetries would not be fully determinant in the whole auction environment because the closed-form solution of this model is statistically consistent and, thus, a sufficiently valid approximation. In economic terms, we would expect that in an iterative market with regular tenders along time incumbent bidders for each category of products and each country know each other. Only those lots attracting more competitors would involve significant asymmetric bidding behaviors.

Secondly, the underlying bidder's cost distribution for this best-fitting model would not adapt well to a pure IPVP, because the slope of the curve for the dependence between procurement cost and level of competition is not very steep, and appreciably flatter than the semi-elasticity model. This would respond to a level of affiliation between bidders, indicating that there is a higher propensity to bid more or less aggressively when other bidders do the same. The iterative market of Europe Aid supply tenders would be also a valid economic reason for this phenomenon because incumbent bidders compete with each other regularly. If an incumbent bidder finds an aggressive bidding strategy reasonable on account of the tender guarantee price signal, it is likely that other incumbent bidders find that strategy reasonable as well.

8.1.1.2 *Conclusions on the influence of the tendered goods*

The approach followed in the research to classify the great variety of tendered goods is to establish five broad categories of products attending to the descriptions appearing in the tender dossiers, namely: equipment and machinery for different industries, hardware and software, vehicles, medical and chemical materials, and furniture. A graphic illustration showing the proportion of each of these categories in our dataset was presented in figure 5.3 to illustrate the market of this tender environment.

These five categories of products control the heterogeneity of the tendered goods in the specified models of the research. In section 7.1, when discussing the research results, I have mentioned that each of these models yields different values for the key estimators: elasticity, semi-elasticity and individual discrete effects, for the category of furniture goods with regard to the rest of product categories. In particular, tenders for furniture goods show a more competitive bidding pattern than the rest. This behavior is found in the three selected models that I present as results of the research because the coefficient related to the category of furniture goods is negative and statistically significant with a high level of confidence[1].

The existence of several local suppliers is the more reasonable economic argument for the different individual effects, elasticity and semi-elasticity obtained for furniture goods in the empirical models. The lower technological level of this category of products with regards to the rest of the tendered lots would support this argument. The empirical results point at local suppliers for furniture goods winning the 90% of the tenders for this category of products. A relevant question for future research would be whether making an easier access to local suppliers in the auction rules would make the auction procedure more competitive. I offer a brief discussion on this topic in section 8.1.2.

1 The level of confidence is around 90%. Being high, it is below the usual 95% for inference purposes. One of the reasons is that the category of furniture goods is the less representative of all categories of goods, thus involving a higher error dispersion.

8.1.1.3 *Conclusions on the influence of the geographic markets*

The geographic market is another of the factors of the auction environment. The approach followed in the research is similar than the approach followed for the tendered goods. Market places were modeled in four categories. I presented in figure 5.2 the proportion of lots tendered in each of these market places.

These four categories of market places are used to control the heterogeneity of the beneficiary countries in the empirical models. Opposite to the behavior observed for the categories of products, market places do not present in the estimated models statistically significant coefficients indicating different bidders' behavior in them. We can interpret from this empirical result that market places in our dataset do not appear to cause relevant asymmetries in the tenders. Even when the tender procedures are called in different countries and are funded with different financial instruments, Europe Aid rules are the same and this fact seems to involve similar ways to proceed by the different contracting authorities and bidders concerned.

Finding similar bidding patterns in the different geographic markets is a useful result to characterize the auction environment of the dataset in the research and to compare it with other environments. On one side, extending the research to other kind of contracts for services and works would allow either to confirm this pattern for all kind of Europe Aid ODA tenders, or to restrict the result to supply contracts only. On the other side, extending the research to other geographic markets and funding instruments would allow to confirm if this homogeneous pattern across the market places analyzed in this thesis is general, or it should be considered as restricted to the market places of this research only. Both comparisons look as interesting fields of research.

8.1.2 *Conclusions related to the auction rules. Modifiable aspects*

The last factor characterizing the auction environment is the auction rules. Auction rules for the Europe Aid supply tenders studied in this thesis have been described in section 3.2. Basically, the tenders have been modeled as first-price sealed-bid reverse auctions, with price signal issued by the buyer. The rules are therefore fully determined and they are homogeneous for all the tenders in the dataset.

In this section, I present conclusions related to the influence of the auction rules on the price effects of competition, based on the empirical results of the research.

As we have seen, the effect of the auction mechanism applied to the tenders in the dataset does not look optimal for the revenue obtained by the buyer. The average number of bidders in the tenders is approximately three, which is significantly lower than the level of competition of eight bidders producing the highest savings, considering the results of the three estimated models simultaneously. The savings for the contracting authority (and for the tax payers of the donor countries) could be improved by modifying aspects of the auction rules to stimulate further competition.

Section 8.1.2.1 addresses actions on the design of the auction rule that could be implemented to increase the level of competition, and hence, to increase savings. I also discuss the challenges these actions would involve.

8.1.2.1 *Improval options based on auction typology*

Sealed-bid auction is the typical case for a static auction. Bidders issue their bids privately only once and the bids cannot be modified. At a certain date in the tendering procedure the bids are opened and compared to identify the winning bid (the one with the lowest price, in the case of reverse auctions like the one in our auction environment). The lot is then awarded to the winner in a single step at the price determined by the price rules (generally first price or second price. In our case at the price of the winning bid).

Dynamic auctions, reversely, incorporate several bidding rounds, in which bidders disclose information about their valuations of the lot. The typical cases considering direct auctions are the English (or ascending auction) and the Dutch (or descending auction). In reverse English auctions, the buyer indicates her reference price and bidders reduce their bids in each round until there is a final bidder offering the lowest price. In reverse Dutch auctions, auction starts from a reduced price of the lot, which is regularly increased until one of the bidders accepts it, or until the buyer's reserve price is reached without a winner.

According to auction theory (Vickrey, 1961), first-price and Dutch auctions are strategically equivalent. Each bidder calculates an optimal bid based on her individual valuation and on the number of bidders. This theoretical result is based on the assumption that the distribution of valuations among all bidders is common knowledge.

For English auctions, instead, bidders' dominant strategy is to bid up to their individual valuation. This strategy is also dominant in second-price auctions, in which the winner's award price is the immediately highest bid to the winner's bid for a reverse auction.

Vickrey proved a theorem for auctioneer's revenue equivalence (RET) considering the four mentioned auction formats, provided that certain restrictive assumptions hold. In more general auction environments, knowing the factors with influence on the auction environment analyzed above in this chapter: the type of good being auctioned, the industry features and specially the bidders' attributes, is essential to propose the specific auction format and bidding rules to maximize the auctioneer's revenue when some of the assumptions of the RET do not hold.

In addition, to propose specific bidding rules, it is also essential to determine beforehand performance criteria. Throughout this thesis I have focused on the buyer's revenue, but ODA includes often broader objectives that may enter in conflict with each other, as I discuss later in this section.

In section 2.2.3 we have seen how the auction environment characterizing the tenders in the dataset of the research incorporates reasonably bidders' asymmetries. Furthermore, when discussing the conclusions on the bidders' attributes

in section 8.1.1.1 I have explained that bidders' asymmetries would explain the different behavior of the three identified empirical models in the research, at least for the tenders attracting higher competition.

First-price and Dutch auctions yield higher auctioneer's revenues when there are specific asymmetries in bidders' valuations. The bigger these asymmetries, the more important this effect (Maskin and Riley, 2000). Hence, even when the asymmetries in our auction environment do not seem to be severe and extended to all the procedures, which would be supported by the consistency of the empirical elasticity and semi-elasticity models, the first-price rule would be justified attending to the performance criterion of the buyer's revenue only.

In the same section 8.1.1.1, I discuss that another likely characteristic of the auction environment of the research based on the empirical results is the affiliation of the bidders' valuation, and that there would be economic reasons for it. In auction environments with AVP value paradigm, the English auction yields higher revenues to the auctioneer based on the fact that bidders reveal information on their valuation in the dynamic bidding procedure and, therefore, these iterative price signals encourage further competition.

To a certain extent, the price signal issued by the buyer with the requirement of the bank guarantee in the auction environment of the research fulfills the same purpose of revealing information about the valuation of the tendered lot. However, this effect would be limited considering an auction environment with bidder's asymmetries, because the common signal from the buyer is static and would be interpreted differently in the bidder's valuation process by bidders in different categories.

Arguably, thus, including a dynamic mechanism in the auction design with the English format would increase the buyer's revenue in the tender procedure of the research, considering that the most likely bidders' value paradigm is the APV.

Moreover, the mechanism through which auction designs that promote the disclosure of information on the valuation of the auctioned good generates auctioneer's revenues is the effect that information disclosure has on increasing the level of competition (Milgrom and Weber, 1982a). This is precisely the challenge faced by Europe Aid supply tenders based on the empirical results of the research: the need to increase the level of competition.

This potential change in the auction design should be addressed considering practical aspects as well, and the different performance indicators intended with ODA financial instruments.

Europe Aid tenders fulfill in many cases collateral purposes, like aspects of good governance. This means that supporting decentralized contracting authorities is another important aim of ODA funds, in particular in the budget support funding modality, which is the modality connected to the IPA and ENI instruments studied in the thesis. The current sealed-bid auction format on Europe Aid tenders is simple and relatively affordable to implement in a similar manner in multiple market places, because the bidding procedure involves a single round and bidders do not need to act in synchronicity with the contracting authorities.

Hence, the feasibility of the implementation of the English auction in this auction environment would be associated to the introduction of online bidding methods, which would simplify the procedure to conduct multiple bidding rounds. Significant savings in the procurement costs of the tendered lots induced by a higher competition would contribute to fund the investments in the technological system required for the implementation of this improvement measure.

The last aspect to consider in the auction design is the possibility to incorporate a different price rule. Specifically, the auction design may be modified to award the lot at the second price (the second most economic bid), instead of the first price (the lowest bid). According to auction theory, this would entail that bidders' best strategy is to bid for their true individual valuation. Auction designs promoting bidding according to the true valuations are advisable because they are efficient. This means that the lot is awarded to the bidder who values it the most.

Modifying Europe Aid price rules to a second-price format is advisable, provided that other measures promoting competition are applied in conjunction. For the relatively low competition observed in Europe Aid supply auction environment in this research the benefits of a more efficient design may be easily offset by the reduction of the buyer's revenue.

The fact that the public information in the tender dossiers does not include the full set of bids, but just the winning bid, does not allow to conclude on a clear recommendation on this potential change. It is certainly an interesting field for further research and an argument for making public the data on the outcomes of the tender procedures.

I finalize this section with a brief summary of other suggestions on this topic found in procurement auction literature, and more precisely those focusing on increasing the level of competition of ODA procedures. I discuss how these suggestions relate to the empirical results of the research.

Previous works suggested reforms in the auction procedure for ODA funded projects to address the limited level of competition, for instance (Iimi, 2006). The initial recommendations of such a reform would involve reducing the qualification requirements to bid, which would encourage the participation of additional local bidders.

The empirical result of the research related to the more competitive pattern in bidding for furniture goods would support this suggestion. The high proportion of contract awards to local suppliers for this kind of goods would point in the direction of this higher competitiveness. Actions in this field require precautions to avoid lowering the qualification level to an extent that may bring quality at risk.

8.2 INNOVATIVE CONTRIBUTIONS OF THE RESEARCH

Three main innovative contributions have been achieved with this research. I summarize them in this section.

Subsection 8.2.1 emphasizes the relevance of the creation of the dataset as one of the key methodological steps of the research. The absence of public data in the context of ODA expenditures is a hindrance for broader research in this field and for establishing qualified recommendations based on them.

Subsection 8.2.2 analyzes the importance of price signaling in this auction environment. The specification of a consistent reference price across tenders, and the construction of this variable as an indicator of the private reserve price of the contracting authority is the main methodological innovative aspect of this research with regards to previous publications in this field.

Finally, subsection 8.2.3 discusses the innovative approach of the research regarding the treatment of the broad auction environment. The multiplicity of beneficiary countries and supplied goods requires a relevant effort to control the heterogeneity of this global market. This effort extends from the creation of the dataset to the correct estimation of the identified models for inference purposes.

8.2.1 *Design and creation of the dataset*

To obtain the results of the research, the first challenge I faced was the absence of public databases in Europe Aid contracts. This is a common characteristic of ODA funds and explains the few papers in this field to be found in the literature.

The dataset I created for the purpose of the research provides an added-value to the work conducted in this thesis[2]. The method to create the dataset from the official tenders published by Europe Aid is innovative. It requires a thorough work for fetching the relevant documents from the tender dossiers, looking up the relevant information contained in them and transforming the information in the variables that are included in the estimated models.

The dataset includes information from 220 tender dossiers. They are listed in annex B in the Appendix.

The data curation process involved to identify the relevant data in the specific documents of the tender dossier and create the dataset to be used in the identification and estimation of the models. The main documents of the tender dossiers are formatted according to official templates. These templates are included in sections A.1, A.2 and A.3 in the Appendix and the information retrieved in them fully described in section 4.1.

Notwithstanding the effort in the dataset creation, the information publicly available in the tender dossiers is limited. In particular, the information on the bidding process allows identifying the winning bid only. Bidders' information also restricts to the winner. These data restrictions have conditioned the scope of the research. I have focused primarily on eliciting the evolution of an estimated procurement savings rate with increased levels of competition, following a comparative approach of three different models empirically consistent with the dataset. Deciding which of them responds to the real auction environment would require additional data on the features of such auction environment.

2 It is accessible at Mendeley repository: data.mendeley.com, under a Creative Commons license.

In general, access to data in ODA procurement auction is restrictive. The legitimate interest to protect sensitive information, often connected with political implications, and the attempts to avoid collusive behaviors by restricting tendering information for bidders are two powerful reasons against a higher transparency. These reasons are argued by key multilateral institutions[3]. However, limiting transparency of details in the tender procedures restricts useful information for potential bidders. As a consequence, and in accordance with auction theory, the restricted information plays against higher competition in this field, in particular for less informed bidders.

8.2.2 *The importance of price-signaling in the tender environment*

In many procurement auction environments the buyer's reserve price is private and it does not appear in the information publicly available of the tender procedure. In some cases, the reason is that the goods or services to be acquired are complex and the estimation of their price is difficult to estimate. In other cases, this fact is simply a deliberate strategy to stimulate more aggressive bidding.

In the supply tenders analyzed in the research, this is also the case. The tender dossier does not include any explicit limit to the price of the tendered good. This means that bidders do not count, *a priori*, with a reference price with which they could compare the cost that they estimate they will incur to supply the tendered good. This also implies that for the purpose of this research I do not count either with an *a priori* reference price to calculate the savings obtained in each awarded lot.

However, the contracting authority requires usually a participation guarantee to enter the bidding procedure. In section 4.2.5, I have discussed how to define homogeneously a reference price for the supply tenders that require the participation tender guarantee, by using the amount of this tender guarantee as a price signal. The use of this price signal in the estimation of the savings obtained by the effect of increased competition is innovative in the procurement auction literature. Previous research works in procurement auction count with the private information on the contracting authority's reserve price, or this reserve price must be assumed to be known.

I explain with more precision in this section the innovative method. The amount of the tender guarantee in the auction environment of this research signals publicly a high and a low price thresholds based on the contracting authority's engineered value of the lot.

I have calculated the reference price using the symmetric central value between the thresholds for symmetry reasons. This reference price estimated for each tendered lot is an indicator of the contracting authority's unknown reserve price. By construction, under the assumption that the buyer cares minimally about acquiring the lot, the estimated reference price is lower than the reserve price.

3 See for instance the OECD Recommendation on Public Procurement

Under the mentioned assumption, the buyer needs to follow a strategy with two consecutive aims. The first aim is to secure the acquisition of the lot with her allocated private budget. The second aim is to acquire the lot obtaining the highest benefit, or revenue. In this case, the benefit is the savings she obtains with regard to her reserve price, which is the maximum price she can pay.

In the introduction of Europe Aid ODA in section 1.1.1, I explain that its funding instruments operate with the modality of non-reimbursable budget support. In this context, it is reasonable to accept that the assumption holds. If the buyer does not acquire the lot, she must return the funds. Thus, logically, she will prioritize the acquisition, over the price, provided that the price does not exceed her budget. The higher the risk she perceives in a void tender, the higher she will signal her reserve price with the tender guarantee.

Figure 8.6 represents the concepts used in this innovative approach to replace the buyer's unknown reserve price.

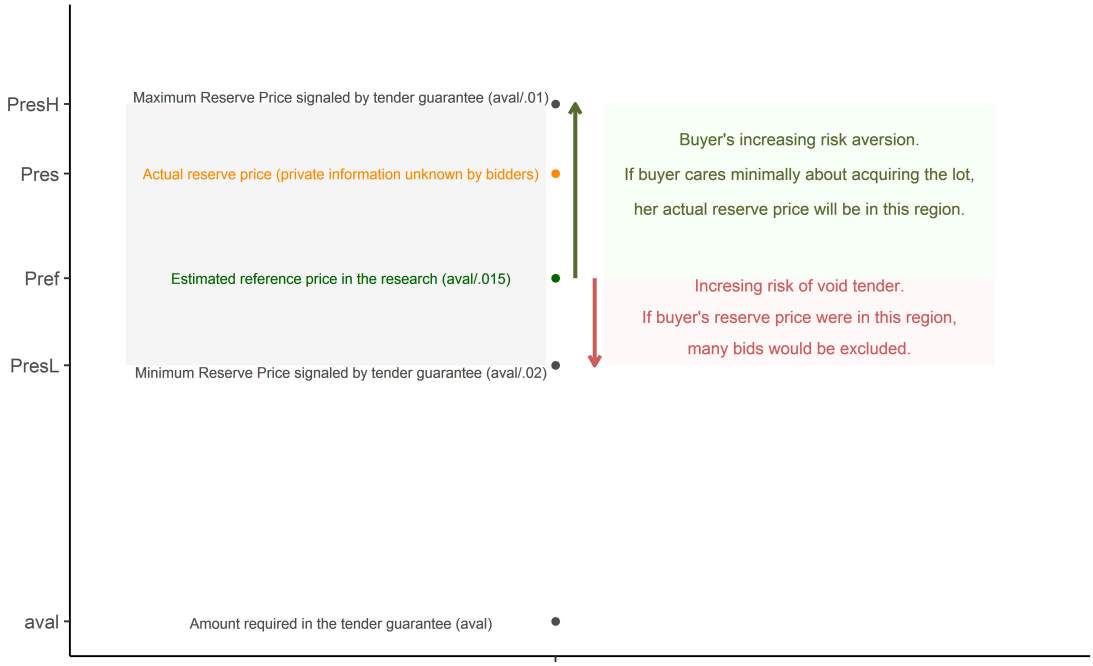


Figure 8.6: Representation of the estimated reference price to be used in replacement of the buyer's unknown reserve price in the calculation of the savings rate

The estimated reference price enables addressing the aim of this thesis. In the research, I estimate the effect of competition on the procurement costs, by measuring this effect with a relative magnitude, a savings rate. I am interested in obtaining a pattern on the evolution of the savings rate for each level of competition, waiving the possibility to determine absolute savings owing to the missing information about the buyer's reserve price.

The methodology I have used for the research identifies the price of the winning bid with the procurement cost because this is essentially the cost that changes across tenders.

Hence, the results obtained with the empirical models provide a consistent normalized procurement cost, with a dependent variable calculated as the division between winning bid and the estimated reference price. The normalized procurement cost is directly related with the procurement cost savings rate, which is an immediate manner to interpret the results of the research. The savings rate expresses the percentage reduction with regards to the reference price obtained with the entry of new bidders.

The comparative approach of the research is useful to support this method. Each of the three consistent empirical models identified in the results of this thesis responds essentially to a set of assumptions on the unknown information about the bidders' characteristics. Notwithstanding these different underlying assumptions, the three models exhibit similar estimations of the savings rate up to four bidders, which is a range of competition that encompasses the average number of bidders per tender. This fact reinforces the consistency and robustness of the average savings rate calculated as the main result of the research.

8.2.3 *Treatment of the heterogeneity of the market*

The third innovation in the methodology of the research is the econometric treatment of a multilateral market of different products and different market places. Most of the literature related to auction procurement focuses on specific economic sectors or on single geographic markets.

The reasons most frequently argued in previous works are: the restriction of the scope of the particular research to a specific economic sector of interest and the availability of data from a particular sector or from a particular country only. In other cases, often related to more theoretical research purposes, the restriction to a particular sector in the research enables to impose restrictive assumptions, and to use them to test properties or estimation methods for simplified structural models.

With the broad scope of the research in this thesis, I have achieved the goal to compare the behavior of buyers and bidders across a variety of geographic regions and for a extensive type of products subject of ODA, and to draw conclusions on the similarities and differences among them, based on the empirical results.

This research approach required in the fist place to focus on an homogeneous class of Europe Aid tenders to approximate to the principle of identically distributed observations for inference purposes. The addressed tenders were those related with supplies.

Subsequently, I needed to control for factors of heterogeneity in the different markets in which the supply tenders took place, establishing categories of beneficiary countries from the IPA and ENI financial instruments, and categories of products according to general typologies used in this tender environment. I have managed to incorporate these categories in the dataset by using the public information in the tender dossiers and following a thorough work of product classification.

One of the main outcomes of the research is that the empirical results do no show any particular difference between the bidders' behavior in the geographic areas where the supply tenders are implemented, because the regressors representing market place categories are not significant in the identified empirical models. This is a relevant result because the contracting authorities belong to different countries, although they must observe the same rules for the tender procedure. The economic interpretation is that there is no evidence that some of the geographic markets are more competitive than others for this type of supply tenders.

On the other hand, and regarding the tendered products, the empirical results indicate that the category of furniture goods shows a different pattern in the empirical models than the rest of product categories. Bidders show a more competitive behavior when bidding for furniture goods, because this category is significant in our models to a certain degree, and enters them with a negative sign. This effect is reasonable in economic terms because furniture goods would not require very sophisticated production processes and could be furnished by several local providers.

Finally, the mentioned conclusions are robust because the three different consistent empirical models that I have estimated as a result of the research respond to a variety of situations that the unknown information about the bidders' value paradigm and the effects of bidders' asymmetry may introduce in the analyzed procurement auction environment. The relevant consequence of the comparative approach between the three models is that the three of them point at the same result regarding the influence of the market. None of the models indicate differences between the competitiveness of the geographic markets, and all of them indicate that the market of furniture goods is significantly more competitive than the markets of the rest of the procured goods.

8.3 FUTURE RESEARCH LINES

I finish this last chapter on the conclusions of the thesis with suggestions for further related areas of research. These areas of research include:

- The extension to other Europe Aid tender typologies like those of works and services, which would complement the characterization of the competitive behavior of this auction environment for all the range of exchanged goods.

- The analysis of similar data for the current EU budgetary period (2021-2027) is another interesting field of research. This is directly connected with the work carried out in this thesis and would enable estimating the impact of the implementation of the third phase of the Instrument of EU Pre-accession (IPA III) and the Neighbourhood component of the Europe Global instrument (NDICI) on procurement cost reduction for supply tenders. This temporal comparison would be innovative in the ODA sector, and it is a frequent approach in other related economic fields, like the economic convergence of the development countries with regard to the EU standards.

- Providing the research with a broader geographic context is another interesting research line. For instance, to extend it to more distant regions from Europe, where ODA funds are also extensively provided, like Sub-Saharan Africa and Latin America. The biggest challenge to face in this case is the likely lack of representativeness of the data sample, owing to the lower number of documented procedures in individual countries and the potential higher heterogeneity of the markets, both with influence in the statistical treatment of data. This challenge, which has a important technical component, would be offset by the achievement of a more global view of the effectiveness and efficiency of the allocation mechanism in these markets.

- Finally, more ambitious research objectives focusing on the characterization of Europe Aid competitors are also envisaged. This line of research would require institutional involvement to provide the access to private complementary information about the bidders entering competition in the tenders and their bids. The direct use of the results of this new research line would be related to the justification of potential improvements in the rules governing the current tender procedure, which is analyzed in this thesis.

Part III

APPENDIX

The Appendix of this thesis include four annexes with extensions on the following elements related to the research.

Annex A presents the official templates of the relevant documents of the tender dossiers that were used to create the dataset.

Annex B lists the 220 tender dossiers that were used as source of data.

Annex C includes the descriptor of all the variables used in the research.

Annex D discusses the estimation methods for the models identified in the research.

A

OFFICIAL TEMPLATES OF THE TENDER DOSSIERS

In this annex, I present the official templates used in the tender dossiers published by Europe Aid that are more relevant for the research. They include the main information that is used in the creation of the dataset.

In particular, the official templates collected in this appendix are:

- Supply contract notice (c2_contractnotice_en.doc).

  This template is the public notice available for all tenders that includes the identification of the tender, the contract specifications, the terms of participation and the award criteria.

- Supplies contract award notice (c9a_awardnotice_internationalcalls_en.doc).

  It includes all the relevant data for the research regarding number of participants in the tender and award price. This document is used when the contract notice was published in the Official Journal of the European Union. The procedure is called in this case *Open International call*.

- Supplies contract award notice (c9b_awardnotice_en.doc).

  It includes all the relevant data for the research regarding number of participants in the tender and award price. This document is used when there was no prior contract notice published in the Official Journal of the European Union. The procedure is called in this case *Open local call*.

The templates are presented in the official version of 2015 for the purpose of illustration. They appear as annexes to the PRAG, the Practical Guide on EU External Action Contract Procedures, which is a document updated with a regular frequency of about one year. Versions of these documents for the whole period covered by the research (2014 to 2017) do not include significant differences.

A.1 SUPPLY CONTRACT NOTICE TEMPLATE

Public document to be completed by the Contracting Authority

SUPPLY CONTRACT NOTICE

<**Contract title**>

<**Location -** Area/region and country/countries >

[Only in case of suspension clause

Please note that the awarding of the contract is subject to the condition of:

[the prior adoption of a financing decision and the prior conclusion of a financing agreement]

[the prior adoption of a financing decision]

[the prior conclusion of a financing agreement]

which does not modify the elements of the procurement procedure (this will be the case, for instance, if the budget initially foreseen is different or if the timeframe, the nature or the condition of the implementation are altered). If the precedent condition is not met, the contracting authority will either abandon the procurement or cancel the award procedure without the candidates or tenderers being entitled to claim any compensation.]

1. **Publication reference**

   <Publication reference of the corresponding prior information notice >

2. **Procedure**

   Open

3. **Programme title**

   < Please specify the programme title mentioned in the applicable financing agreement/ financing decision>

4. **Financing**

   < Budget line / Financing agreement / Other >

5. **Contracting authority**

   For direct management [European Union, represented by the European Commission on behalf of and for the account of < the partner country/countries >]

   For indirect management [<The partner country>]

CONTRACT SPECIFICATIONS

6. **Description of the contract**

<Recommended maximum: 10 lines>

7. **Number and titles of lots**

[One lot only]

[If more than one lot: (min =2 max=20) < number> lots

Lots Titles:

01 <title>

02 <title>

<no. and title>]

TERMS OF PARTICIPATION

8. **Eligibility and rules of origin**

[BUDGET for calls where the CIR applies: Participation is open to all natural persons who are nationals of and legal persons (participating either individually or in a grouping – consortium - of tenderers) which are effectively established in a Member State of the European Union or in a eligible country or territory as defined under the Regulation (EU) N°236/2014 establishing common rules and procedures for the implementation of the Union's instruments for external action (CIR) for the applicable Instrument under which the contract is financed (see also heading 22 below). Participation is also open to international organisations.

[If the estimated budget is above or equal to EUR 100 000: All supplies under this contract must originate in one or more of these countries.]

[If the estimated budget (of the tender procedure as a whole or if divided into lots, per lot) is below EUR 100 000: All supplies under this contract may originate from any country.]]

[BUDGET for calls where the CIR does not apply (e.g. for IPA I), Participation is open to all legal persons (participating either individually or in a grouping – consortium - of tenderers) which are established in a Member State of the European Union or in a country or territory of the regions covered and/or authorised by the specific instruments applicable to the programme under which the contract is financed (see item 22 below). All goods supplied under this contract must originate in one or more of these countries. Participation is also open to international organisations. Participation of natural persons is directly governed by the specific instruments applicable to the programme under which the contract is financed].

[10th EDF/11th EDF: Participation in tendering is open on equal terms to natural and legal persons (participating either individually or in a grouping – consortium - of tenderers)

which are established in one of the Member States of the European Union, ACP States or in a country or territory authorised by the ACP-EC Partnership Agreement under which the contract is financed (see also item 22 below). Participation is also open to international organisations. All goods supplied under this contract must originate in these countries.]

[**Other (including 9th EDF, which may apply different eligibility rules)** : <…>]

9. **Grounds for exclusion**

Tenderers must submit a signed declaration, included in the Tender Form for a Supply Contract, to the effect that they are not in any of the situations listed in point 2.3.3 of the Practical Guide.

10. **Number of tenders**

Tenderers may submit only one tender per lot. Tenders for parts of a lot will not be considered. Any tenderer may state in its tender that it would offer a discount in the event that its tender is accepted for more than one lot. Tenderers [may] [may not] submit a tender for a variant solution in addition to their tender for the supplies required in the tender dossier.

11. **Tender guarantee**

[Tenderers must provide a tender guarantee of < Amount to be specified within the range 1% - 2% of the budget available for the contract ; specify separate lots where necessary> when submitting their tender. This guarantee will be released to unsuccessful tenderers once the tender procedure has been completed and to the successful tenderer[s] upon signature of the contract by all parties. This guarantee will be called upon if the tenderer does not fulfil all obligations stated in its tender.]

OR [No tender guarantee is required.]

12. **Performance guarantee**

[The successful tenderer will be asked to provide a performance guarantee of <insert percentage between 5 and 10%> of the amount of the contract at the signing of the contract. This guarantee must be provided together with the return of the countersigned contract no later than 30 days after the tenderer receives the contract signed by the Contracting Authority. If the selected tenderer fails to provide such a guarantee within this period, the contract will be void and a new contract may be drawn up and sent to the tenderer which has submitted the next cheapest compliant tender.]

OR [For amounts of EUR150 000 or below, on the basis of objective criteria such as the type and value of the contract, the Contracting Authority may decide not to require such a guarantee: No performance guarantee is required.]

13. **Information meeting and/or site visit**

[No information meeting is planned]

OR [[A mandatory] [An optional] information [meeting] [and] [or] [site visit] will be held on < Date, venue and contact details to confirm attendance to be specified>]

14. **Tender validity**

Tenders must remain valid for a period of 90 days after the deadline for submission of tenders.

15. **Period of implementation of tasks**

< Specify the period in days, from contract signature, or alternative date, until the provisional acceptance >

SELECTION AND AWARD CRITERIA

16. **Selection criteria**

The selection criteria should be clear and non-discriminatory and may not go beyond the scope of the contract. The reference period for financial capacity may not go beyond the last 3 years for which accounts have been closed. The reference period for professional and technical capacities may not go beyond the past 3 years from the submission date. Consideration has to be made that the criteria chosen below correspond to data requested from the tenderer in the tender form. Furthermore, please verify that the tenderer can submit documentary evidence to prove the relevant selection criteria. See point 2.4.11 of the Practical Guide. If appropriate for the project and subject to the principle of equal treatment separate criteria for natural persons may be requested.

The following selection criteria will be applied to tenderers. In the case of tenders submitted by a consortium, these selection criteria will be applied to the consortium as a whole:

1) Economic and financial capacity of tenderer *(*based on i.a. item 3 of the Tender Form for a Supply Contract). In case of tenderer being a public body, equivalent information should be provided. The reference period which will be taken into account will be the last three years for which accounts have been closed.

The objective of this criterion is to examine whether or not the tenderer (i.e., the consortium as a whole, in the case of a tender from a consortium):

- will not be economically dependent on the Contracting Authority in the event that the contract is awarded to it; and
- has sufficient financial stability to handle the proposed contract.

Examples of financial criteria for legal persons:

- the average annual turnover of the tenderer must exceed the annualised maximum budget of the contract; and
- Current ratio (current assets/current liabilities) in the last year for which accounts have been closed must be at least 1. In case of a consortium this criterion must be fulfilled by each member.

Criteria for legal persons:

1-< reference criterion>

2-< reference criterion>

< etc>

Examples of financial criteria for natural persons:

- the available financial resources of the tenderer must exceed the annualised maximum budget of the contract and

- the financial situation of the tenderer should not be in deficit, taken into account debts, at the beginning and end of year.

Criteria for natural persons:

1-< reference criterion>

2-< reference criterion>

< etc>

2) Professional capacity of tenderer (based on i.a. items 4 and 5 of the Tender Form for a Supply Contract). The reference period which will be taken into account will be the last three years from submission deadline.

The objective of this criterion is to examine whether or not the tenderer (i.e., the consortium as a whole, in the case of a tender from a consortium) has sufficient ongoing staff resources and expertise to be able to handle the proposed contract

Examples of professional criteria for legal persons:

- has a professional certificate appropriate to this contract, such as <specify>;
- at least <number related to the quantity of expertise required for this contract> staff currently work for the tenderer in fields related to this contract; and

Criteria for legal persons:

1-< reference criterion>

2-< reference criterion>

< etc>

Examples of professional criteria for natural persons:

- has a professional certificate appropriate to this contract, such as <specify>;
- is currently working/has worked during the past 3 years < as manager/team-leader etc. > with <number related to the quantity of expertise required for this contract> collaborators in fields related to this contract.

Criteria for natural persons:

1-< reference criterion>

2-< reference criterion>

< etc>

3) Technical capacity of tenderer *(*based on i.a. items 5 and 6 of the Tender Form for a Supply Contract). The reference period which will be taken into account will be the last three years from submission deadline.

The objective of this criterion is to examine whether or not the tenderer (i.e., the consortium as a whole, in the case of a tender from a consortium) has sufficient expertise and experience to be able to handle the proposed contract

Example of technical criterion for legal and natural persons:

- the tenderer has delivered supplies under at least < insert number > contract[s] with a budget of at least <specify budget> EUR in < specify fields> which were implemented during the following period: < 3 years from the submission

deadline, please specify the dates>.

This means that the contract the tenderer refers to could have been started or completed at any time during the indicated period but it does not necessarily have to be started and completed during that period, nor implemented during the entire period. Tenderers are allowed to refer either to projects completed within the reference period (although started earlier) or to projects not yet completed. In the first case the project will be considered in its whole if proper evidence of performance is provided (statement or certificate from the entity which awarded the contract, final acceptance). In case of projects still on-going only the portion satisfactorily completed during the reference period will be taken into consideration. This portion will have to be supported by documentary evidence (similarly to projects completed) also detailing its value.

Criteria for legal persons:

1-< reference criterion>

2-< reference criterion>

< etc>

Criteria for natural persons:

1-< reference criterion>

2-< reference criterion>

< etc>

An economic operator may, where appropriate and for a particular contract, rely on the capacities of other entities, regardless of the legal nature of the links which it has with them. Some examples of when it may not be considered appropriate by the Contracting Authority are when the tender rely in majority on the capacities of other entities or when they rely on key criteria. If the tender rely on other entities it must prove to the Contracting Authority that it will have at its disposal the resources necessary for performance of the contract, for example by producing an undertaking on the part of those entities to place those resources at its disposal. Such entities, for instance the parent company of the economic operator, must respect the same rules of eligibility and notably that of nationality, as the economic operator. Furthermore, the data for this third entity for the relevant selection criterion should be included in the tender in a separate document. Proof of the capacity will also have to be furnished when requested by the Contracting Authority.

17. **Award criteria**

Price (or, if appropriate after derogation, the best value for money which is a combination of quality and price)

TENDERING

18. **How to obtain the tender dossier**

The tender dossier is available from the following Internet address: https://webgate.ec.europa.eu/europeaid/online-services/index.cfm?do=publi.welcome. The tender dossier is also available from the Contracting Authority. Tenders must be submitted

using the standard Tender Form for a Supply Contract included in the tender dossier, whose format and instructions must be strictly observed.

Tenderers with questions regarding this tender should send them in writing to <insert specific e-mail and postal addresses> (mentioning the publication reference shown in item 1) at least 21 days before the deadline for submission of tenders given in item 19. The Contracting Authority must reply to all tenderers' questions at least 11 days before the deadline for submission of tenders. Eventual clarifications or minor changes to the tender dossier shall be published at the latest 11 days before the submission deadline on the EuropeAid website at https://webgate.ec.europa.eu/europeaid/online-services/index.cfm?do=publi.welcome

19. **Deadline for submission of tenders**

<Time and date to be specified- must be a working day at least 60 calendar days (30 days for local tenders) after the date of publication of this contract notice *(e.g., 10:00 Central European Time on [date])*. The deadline for submission of tenders should if possible be combined with the public opening session.>

Any tender received by the Contracting Authority after this deadline will not be considered.

20. **Tender opening session**

<Date and venue of tender opening session >

21. **Language of the procedure**

All written communications for this tender procedure and contract must be in English.

22. **Legal basis**[1]

[BUDGET: for calls where the CIR applies: Regulation (EU) N°236/2014 of the European Parliament and of the Council of 11 March 2014 laying down common rules and procedures for the implementation of the Union's instruments for financing external action and <please introduce here the reference of the Regulation or other instrument under which this contract is to be financed (e.g. DCI, ENPI, ENI, Ifs) > See Annex A2 of the Practical Guide]

[BUDGET: for calls where the CIR does not apply (e.g. for IPA I): Regulation or other instrument under which this contract is to be financed - See Annex A2 of the Practical Guide]

[EDF: Annex IV to the Partnership Agreement between the members of the African, Caribbean and Pacific Group of States of the one part, and the European Community and its Member States, of the other part, signed in Cotonou on 23 June 2000 as amended in Luxembourg on 25 June 2005 and in Ouagadougou on 22 June 2010. Reference is made to Annex IV as revised by Decision 1/2014 of the ACP-EU Council of Ministers of 20 June 2014.]

23. **Additional information**

<As appropriate>

[1] Please state any specificity that might have an impact on rules on participation (such as geographic or thematic or long/short term).

A.2 SUPPLIES CONTRACT AWARD NOTICE. OPEN INTERNATIONAL CALLS

Document to be completed by the Contracting Authority and made public after award of a contract

To be used in case of prior publication in the EUOJ

SUPPLIES CONTRACT AWARD NOTICE

<Contract title>
<Location - Area/region and country/countries >, <ISO code>

1. Publication reference

< Publication reference of the corresponding prior information notice & contract notice >

2. Publication date of the contract notice

< Date >

3. Lot number and lot title

< As appropriate >

4. Contract number and value

< contract number > [EUR] [<ISO code of national currency> only for indirect management] < Amount >

5. Date of award of the contract

< Date >

6. Number of tenders received

< Number >

7. Name, address and nationality of successful tenderer

< Name and address, with the leader shown in bold type in the case of a consortium >

< ISO code of country>

8. Duration of contract

<Months>

9. Contracting Authority

[For direct management: European Union, represented by the European Commission on behalf of and for the account of <the partner country/countries>]

[For indirect management: < The partner country >]

10. Legal basis

[BUDGET: for calls where the CIR applies: Regulation (EU) N°236/2014 of the European Parliament and of the Council of 11 March 2014 laying down common rules and procedures for the implementation of the Union's instruments for financing external action and <please introduce here the reference of the Regulation or other instrument under which this contract is to be financed (e.g. DCI, ENPI, ENI, Ifs) > See Annex A2 of the Practical Guide]

[BUDGET: for calls where the CIR does not apply (e.g. for IPA I) : Regulation or other instrument under which this contract is to be financed - See Annex A2 of the Practical Guide]

[EDF: Annex IV to the Partnership Agreement between the members of the African, Caribbean and Pacific Group of States of the one part, and the European Community and its Member States, of the other part, signed in Cotonou on 23 June 2000 as amended in Luxembourg on 25 June 2005 and in Ouagadougou on 22 June 2010. Reference is made to Annex IV as revised by Decision 1/2014 of the ACP-EU Council of Ministers of 20 June 2014.]

Point 11 to be included only in direct management.

[11. DAC code

<Code>.]

A.3 SUPPLIES CONTRACT AWARD NOTICE. OPEN LOCAL CALLS

Document to be completed by the Contracting Authority and made public **after** award of a contract

To be used when no prior OJ publication has been made

SUPPLIES CONTRACT AWARD NOTICE

<Contract title>
<Location - Area/region and country/countries **>, <ISO code>**

1. Type of procedure

< Local open tender, negotiated… >

2. Publication reference and date of the contract notice

< Date, reference (if applicable) >

3. Lot number and lot title

< As appropriate >

4. Contract number and value

< Contract number > [EUR] [<ISO code of national currency> only for indirect management]
<Amount>

5. Date of award of the contract

< Date >

6. Number of tenders received

< Number >

7. Name, address and nationality of successful tenderer

< Name and address, with the leader shown in bold type in the case of a grouping (consortium) of tenderers >

< ISO code of country>

8. Duration of contract

<Months>

9. Contracting Authority

[European Community, represented by the European Commission on behalf of and for the account of

<the partner country/countries> (direct management)]

[< The partner country > (indirect management)]

10. Legal basis

[BUDGET: for calls where the CIR applies: Regulation (EU) N°236/2014 of the European Parliament and of the Council of 11 March 2014 laying down common rules and procedures for the implementation of the Union's instruments for financing external action and <please introduce here the reference of the Regulation or other instrument under which this contract is to be financed (e.g. DCI, ENPI, ENI, Ifs)> - See Annex A2 of the Practical Guide]

[BUDGET: for calls where the CIR does not apply (e.g. for IPA I): <Regulation or other instrument under which this contract is to be financed> - See Annex A2 of the Practical Guide]

[EDF: Annex IV to the Partnership Agreement between the members of the African, Caribbean and Pacific Group of States of the one part, and the European Community and its Member States, of the other part, signed in Cotonou on 23 June 2000 as amended in Luxembourg on 25 June 2005 and in Ouagadougou on 22 June 2010. Reference is made to Annex IV as revised by Decision 1/2014 of the ACP-EU Council of Ministers of 20 June 2014.]

Point 11 to be included only in case of direct management.

[11. DAC code

<Code>]

B

LIST OF TENDER DOSSIERS USED TO CREATE THE DATASET

In this annex, I present the list of tender dossiers I have used to create the dataset. The list indicates the following information:

- The unique six-digit code that identifies each tender procedure.
- The date in which the tender was officially published
- The country where tender was called.
- The instrument that funded the acquisition of the supplied lot, whether IPA or ENI. In the case of Kosovo, some of the supplied lots were funded by the specific instrument EULEX, and this instrument is specified as well.
- The title of the supply contract.

Each tender dossier in the list consists of several documents. The most relevant documents for the purpose of the research are described in section 4.1. The official templates that are standard across tenders for those documents are included also in the Appendix, in sections A.1, A.2, and A.3.

The tender dossiers in the list consist of one or several lots. Different lots in the same supply tender dossier generally refer to different kind of products, often belonging to several categories.

Num	code	publication	country	Instrum	Title
1	128615	17/11/2015	Turkey	IPA	Supply of IT Equipment for Management Information System (MIS)
2	131326	11/08/2017	Turkey	IPA	Supply of Strengthening the Infrastructure for Furniture Production (MOBITEK)
3	131546	01/12/2015	Turkey	IPA	Supply of Equipment for the operation of 'My Bee, My Honey, My Honeycomb'
4	131547	13/08/2015	Turkey	IPA	Supply of Equipment for the Operation of 'Big Partnership of Small Industrialists'
5	131754	04/11/2015	Turkey	IPA	Supply of Laboratory and Sampling Equipment for Şanlıurfa Cereals Exchange and Licensed Warehouse
6	131769	24/06/2015	Turkey	IPA	Supply of Equipment for Establishment of Common-Use Processing Facility for Industrial Forestry Products in Kastamonu
7	132275	17/06/2016	Turkey	IPA	Supply for Regional Industrial Collaboration In Cotton Fibre Manufacturing
8	132367	05/01/2016	Turkey	IPA	Supply of equipment for the operation of 'Handmade in Hatay'
9	132543	14/04/2015	Turkey	IPA	Supply of Equipment for Business Incubator Buildings in Kastamonu, Malatya and Tokat
10	133365	12/07/2016	Turkey	IPA	Supply of Equipment for Samsun Metals Metrology and Calibration Laboratory
11	133560	16/05/2015	Turkey	IPA	Supply of Equipment for Natural Stone Manufacturing And Marketing Support Centre In Bayburt
12	133730	14/04/2015	Turkey	IPA	Supply of Equipment for Establishment of Giresun Hazelnut Licensed Warehouse and Spot Exchange
13	133791	23/09/2014	Kosovo	IPA	Supply of laboratory equipment and accessory tools for the Department of Forensic Medicine, Kosovo
14	133974	19/12/2014	Kosovo	IPA	Support to customs – provision of an integrated law enforcement system
15	134213	15/04/2015	Turkey	IPA	Supply for 'Maraş Pepper Cluster' in the South-east Anatolia Region

Num	code	publication	country	Instrum	Title
16	134233	17/06/2017	Turkey	IPA	Supply of Water and Wastewater System Supportive Equipment for Diyarbakir Municipality
17	134326	18/06/2015	Turkey	IPA	Supply of Technological Border Surveillance Equipment for the Cleared Regions
18	134932	23/07/2016	Turkey	IPA	Supply of equipment for establishment of a common use facility (furniture and auto mechanics) and small business advisory services unit in Amasya
19	134936	15/12/2015	Turkey	IPA	Supply for Gaziantep Regional Industrial Design and Modelling Centre (GETAM)
20	135117	03/05/2016	Turkey	IPA	Supply for Şanlıurfa Cotton Exchange and Licensed Warehouse
21	135158	22/09/2016	Turkey	IPA	Supply of Equipment and Software for Siverek Water and Wastewater Project
22	135289	30/09/2015	Turkey	IPA	Supply of Equipment for Witness Protection Capacities Phase-II
23	135407	21/01/2014	Kosovo	EULEX	Supply of miscellaneous Security equipment
24	135432	14/02/2015	Tunisia	ENI	Fourniture, installation, la mise en service et le service après-vente d'équipements biomédicaux et mobiliers médicaux
25	135445	02/04/2014	Bosnia and Herzegovina	IPA	Supplies for animal disease control and eradication
26	135520	08/04/2015	Serbia	IPA	Strengthening the capacity of the sector for emergency management in the field of unexploded ordnance (UXO) and other hazardous materials
27	135612	12/09/2014	Turkey	IPA	Supply of Equipment for Erzincan Water and Wastewater Project
28	135620	22/04/2015	Serbia	IPA	Suppy of vaccines for erradication of rabies in wildlife population
29	135627	04/01/2017	Serbia	IPA	Procurement of Srbijagas Gas Management SCADA System
30	135634	14/06/2016	Serbia	IPA	Laboratory for analysis of evidence required for crime case processing

Num	code	publication	country	Instrum	Title
31	135636	18/10/2016	Serbia	IPA	Improving Capacities for Training, Education and Employment of the Convicted Persons
32	135654	18/02/2015	Turkey	IPA	Supply for Mobile Inspections for Modernization of Turkish Customs Administration
33	135662	21/03/2014	Serbia	IPA	Supply of IT equipment for the strengthening capacities of Central Financing and Contracting Unit
34	135702	22/04/2015	FYROM	IPA	Supply of vehicles (vans), office furniture, hardware and software and other equipment for strengthening the capacity of the Public Revenue Office
35	135741	27/03/2014	Kosovo	EULEX	Supply of Communications Equipment No. 6
36	135784	02/04/2014	Montenegro	IPA	Supply of Rabies vaccine baits and aerial distribution
37	135806	04/03/2015	Turkey	IPA	Supply of Equipment for Strengthening the National Nature Protection System for Implementation of Natura 2000 Requirements
38	135853	05/07/2014	Lebanon	ENI	Supply of Equipment for the SSP Programme
39	135867	12/09/2014	Montenegro	IPA	Supply of equipment for Strengthening the Capacities of Diplomatic-Consular Network of the Ministry of Foreign Affairs and European Integration
40	135881	31/07/2014	Lebanon	ENI	Supply and Delivery of vehicles and equipment for waste collection for the municipalities of Beddawi (Tripoli), El Minieh (Akkar), Dalhamieh and ElQaa (Bekaa)
41	135882	23/07/2014	Kosovo	IPA	Supplies and Equipment to Schools throughout Kosovo
42	135892	03/09/2014	FYROM	IPA	Supply of equipment for data collection and management information and reporting system for inspections and selected municipalities
43	135893	28/04/2016	Turkey	IPA	Supply for Capacity Building on European Pollutant Release and Transfer Register
44	135916	13/08/2015	Albania	IPA	Supply of Live Scanner Fingerprint Equipment for the Albanian State Police
45	135921	01/09/2015	Turkey	IPA	Supply of Hardware and COTS Software for Efficiency in Anti-Money Laundering and Counter Terrorist Financing

Num	code	publication	country	Instrum	Title
46	135972	22/04/2015	Turkey	IPA	Capacity Building on Safety and Security Training Requirements of the Turkish Civil Aviation
47	135992	13/08/2014	Lebanon	ENI	Supply of Measurement Equipment to the Ministry of Environment
48	135997	13/07/2014	FYROM	IPA	Supply Contract for strengthening the capacities of the State Labour Inspectorate
49	136015	23/12/2014	Algeria	ENI	Acquisition d'équipements pour l'inventoriage des biens culturels immobiliers et immatériels et pour la conservation et l'archivage du patrimoine audiovisuel
50	136053	02/06/2015	Turkey	IPA	Supply for Strengthening the Institutional Capacity of Probation Services in Transition to Electronic Monitoring System
51	136062	25/02/2015	FYROM	IPA	Supply of Rabies Vaccines
52	136086	16/05/2015	Bosnia and Herzegovina	IPA	Technical strengthening of the capacities of the Ministry for Human Rights and Refugees and the social service providers
53	136150	02/09/2014	Kosovo	EULEX	Framework Contract for the Supply of Medicaments and Consumables
54	136156	31/07/2014	Kosovo	EULEX	Supply of Microsoft and Symantec Licenses
55	136166	16/12/2014	Bosnia and Herzegovina	IPA	Consolidation and further development of the Judicial communication and Information System
56	136187	20/08/2014	Kosovo	IPA	Supplies and Equipment to Schools throughout Kosovo
57	136239	18/10/2014	FYROM	IPA	Supply contract for strengthening the capacities of the Employment Service Agency
58	136311	07/07/2015	FYROM	IPA	Supply of equipment for the System for Monitoring Media Content (SMMC) for the purposes of the Agency for Audio and Audiovisual Media Services
59	136343	26/04/2016	Turkey	IPA	Supply of Equipment for the Operation "Growing and Prospering the Entrepreneurship Ecosystem in Ankara to Increase Young Employment"
60	136346	03/10/2014	Kosovo	EULEX	Framework contract for the Supply of Spare Parts and Maintenance of Vehicles - Mercedes

Num	code	publication	country	Instrum	Title
61	136369	22/04/2015	Turkey	IPA	Supply of Equipment for Improving the Adaptability of Employers and Employees in TR33 Region
62	136371	16/12/2014	Lebanon	ENI	Supply, Delivery and Installation of Solid Waste Treatment Equipment for the Municipalities of Bar Elias, Qab Elias and El Marj
63	136387	12/06/2015	Turkey	IPA	Supply of Equipment for Provision of Career Services Through Multi-Stakeholder Partnership Model
64	136397	23/07/2015	Morocco	ENI	Fourniture de 6 véhicules neufs de type "tout terrain"
65	136448	29/04/2015	Turkey	IPA	Supply of Equipment for “Increasing Employability of People with Disabilities”
66	136462	25/07/2015	Bosnia and Herzegovina	IPA	Supply of equipment for conducting exhumation
67	136463	27/11/2014	Tunisia	ENI	Acquisition d'équipements informatiques au profit de la Cour des Comptes
68	136467	14/07/2015	Jordan	ENI	Supply of testing equipment for market surveillance purposes for Jordan Standards & Metrology Organization (JSMO)
69	136481	27/11/2014	Lebanon	ENI	Provision of nine (9) Skid Steer Loaders for nine (9) municipalities in Bekaa, North and Mount Lebanon
70	136519	23/01/2015	Lebanon	ENI	Provision of twenty one (21) pick-up trucks for municipalities in South Lebanon, Mount Lebanon, Bekaa and North Lebanon
71	136529	12/09/2015	Turkey	IPA	Supply of Equipment for the Operation “Strengthening National Vocational Qualifications System"
72	136542	26/04/2016	Turkey	IPA	Supply of Equipment for Increasing Adaptability of Employees and Employers with a Social Dialogue Approach
73	136555	26/09/2015	Turkey	IPA	Supply of Equipment for “Garment Training and Entrepreneurship Initiative (GATE for Women)”
74	136579	16/12/2014	Kosovo	EULEX	Supply of Spare Parts for IT Equipment and Ancillary Installation Services
75	136617	23/02/2016	Bosnia and Herzegovina	IPA	Improve Technical Working Conditions of Court Police

Num	code	publication	country	Instrum	Title
76	136619	24/12/2014	Jordan	ENI	Supply of Networking and Security Solutions for the Enhancement of the Cadastral System of the Department of Land and Survey
77	136631	31/12/2016	Turkey	IPA	Supply of Equipment for “Capacity Development of Employees and Employers via Information and Communication Technologies (ICT)”
78	136649	14/06/2016	Turkey	IPA	Supply for Improving the Crime Scene Investigation Capacity of Turkey
79	136660	03/06/2015	Lebanon	ENI	Supply of Equipment for the project "Security and Rule of Law"
80	136683	26/01/2015	Kosovo	IPA	Supply of IT, Office Equipment and Accessories for the Department of Forensic Medicine, the National Agency for Protection of Personal Data and the Labour Inspectorate
81	136740	23/10/2015	Algeria	ENI	Fourniture, livraison d’équipements et de véhicules pour les dispositifs mis en place dans le cadre du PAJE
82	136763	18/02/2015	Kosovo	EULEX	Medicaments, Immunizations Drugs and Consumables FWC No.3
83	136776	25/04/2015	Kosovo	EULEX	Spare Parts and Maintenance of Vehicles No. 4
84	136777	18/02/2015	Kosovo	EULEX	Framework Contract for the Supply of Drinking Water No. 5
85	136779	19/02/2015	Bosnia and Herzegovina	IPA	Procurement of ICT equipment and software for the Competition Council of BiH
86	136838	22/07/2015	Serbia	IPA	Joint Forest fire monitoring and suppression in Western Serbia
87	136868	21/05/2015	Kosovo	EULEX	Framework Contract for the Fuel Supply no.4
88	136883	20/03/2015	Kosovo	EULEX	Supply of Communications Equipment No. 7
89	136890	09/07/2016	Turkey	IPA	Supply of Equipment for Bulancak Water and Wastewater Project
90	136905	02/06/2015	Jordan	ENI	Supply of Complete Training Rooms & Media Production Center for the Peace Keeping Forces and Human Rights Training Institute

Num	code	publication	country	Instrum	Title
91	136906	24/10/2015	Jordan	ENI	Supply of Traffic Safety Training Equipment for Jordan Traffic Institute
92	136937	20/03/2015	Kosovo	EULEX	Framework Contract for the Supply of Stationery and Office Supplies
93	136964	19/05/2015	Bosnia and Herzegovina	IPA	IPA 2011: Strengthening Public Revenues Supply of IT equipment, software and licenses
94	136965	27/03/2015	Kosovo	IPA	Supply of Equipment for the Department for Criminal Investigation of Kosovo Police
95	136975	25/05/2015	Morocco	ENI	AVIS DE MARCHÉ DE FOURNITURE DE PLANTS POUR LES COOPERATIVES ET ASSOCIATIONS AGRICOLES AU NIVEAU DE LA PROVINCE D'AL HOCEIMA
96	136996	03/04/2015	Bosnia and Herzegovina	IPA	Procurement of ICT equipment for information-educational centres for intellectual property rights in Bosnia and Herzegovina- Phase II
97	137014	10/04/2015	Albania	IPA	Supply of IT equipment for the Centre of Openness and Dialogue, at the Prime Minister Office
98	137031	04/09/2015	Albania	IPA	Control and eradication of rabies – Phase II
99	137033	12/09/2015	Turkey	IPA	Supply for Support to Turkey in Providing Assistance to Syrians under Temporary Protection
100	137067	21/04/2015	Kosovo	EULEX	Supply of IT Equipment No 9
101	137104	25/08/2015	Egypt	ENI	Supply of Laboratory and IT Equipment to the Ministry of Industry, Trade and SMEs
102	137107	14/11/2015	Kosovo	IPA	Supply of ICT equipment, supplies and consumables for the schools and educational institutions
103	137114	31/07/2015	Jordan	ENI	Supply of Networking and Security Solutions for the Enhancement of the Cadastral System of the Department of Land and Survey
104	137118	22/08/2016	Serbia	IPA	Supply of Road Weather Information System (RWIS) equipment, software and training
105	137122	29/06/2016	Serbia	IPA	Supply of equipment necessary for establishing the secondary/ backup Treasury Data Centre

Num	code	publication	country	Instrum	Title
106	137124	14/06/2016	FYROM	IPA	Supply contract for strengthening the capacities of the Social Work Centers (SWC), State Labour Inspectorate (SLI) and Employment Service Agency (ESA)
107	137186	10/08/2016	Turkey	IPA	Supply of Equipment for Adıyaman WW Project
108	137249	31/07/2015	Jordan	ENI	Supply of PhytoSanitary Laboratory Equipment & IT and Office Equipment to the Ministry of Agriculture
109	137257	10/01/2017	Turkey	IPA	Supply of Equipment for Ceyhan Wastewater and Stormwater Project
110	137260	07/04/2016	FYROM	IPA	SUPPLY OF EQUIPMENT FOR THE DIRECTORATE FOR PERSONAL DATA PROTECTION
111	137274	29/02/2016	Turkey	IPA	Supply of Vehicles for Improving the maritime customs surveillance capacity and operational procedures of TCA
112	137309	04/08/2015	Serbia	IPA	Strengthening the Serbian Statistical System by Upgrading Methodologies and Standards and by the appliance of Good Practice
113	137320	10/11/2015	Kosovo	IPA	Support to the Implementation of the Unified Address System in Kosovo
114	137331	25/02/2016	Bosnia and Herzegovina	IPA	Police Education Equipment
115	137339	19/09/2015	Morocco	ENI	AQUISITION D'EQUIPEMENT MOBILIER ET CONSOMMABLE POUR LES CLASSES DU PRESCOLAIRE AL HOCEIMA -MAROC
116	137374	07/06/2016	Serbia	IPA	Equipment and vehicles
117	137465	14/02/2017	Albania	IPA	Supply and installation of an audio-visual system for plenary sessions of the Parliament
118	137471	14/08/2015	Kosovo	IPA	Supply of IT equipment and accessories for Kosovo Correctional Services (KCS) and Kosovo Probation Services (KPS), Kosovo
119	137473	13/10/2015	Turkey	IPA	Supply of Equipment for Strengthening Forensic Capacity of Turkey
120	137533	01/12/2015	Morocco	ENI	FOURNITURE ET INSTALLATION DE PANNEAUX SIGNALETIQUES TOURISTIQUES AU NIVEAU PARC NATIONAL D'AL HOCEIMA

Num	code	publication	country	Instrum	Title
121	137535	18/09/2015	Tunisia	ENI	Acquisition d'équipements informatiques au profit du Ministère du Développement de l'Investissement et de la Coopération Internationale
122	137546	03/10/2015	Egypt	ENI	Supply of equipment to TVET Institutions
123	137568	09/10/2015	Morocco	ENI	Fourniture de 6 véhicules neufs de type "tout terrain" et 1 Moto Neige
124	137569	05/10/2015	FYROM	IPA	Supply of hardware, software and other equipment/items for Ministry of Justice web-based systems
125	137573	07/10/2015	Kosovo	EULEX	Framework Contract for the Supply of Personal Protective Equipment , Clothing and Uniforms
126	137582	11/11/2015	Turkey	IPA	Supply of Equipment for Strengthening the Probation Services Institutional Capacity in Transition to Electronic Monitoring System
127	137587	19/10/2015	Morocco	ENI	EDITION DE MANUELS EDUCATIFS AU NIVEAU DE LA PROVINCE D'AL HOCEIMA
128	137594	09/10/2015	Egypt	ENI	Supply of Laboratory equipment to the Ministry of Trade and Industry
129	137598	08/03/2016	FYROM	IPA	Supply of equipment for official controls for Food and Veterinary Agency and equipment for Border Inspection Posts Blace and Tabanovce
130	137599	09/10/2015	Egypt	ENI	Supply and Delivery of Visibility Products with design for " TDMEP" Logo
131	137621	25/03/2016	Bosnia and Herzegovina	IPA	Software Solution and ICT equipment for the State Aid System of BiH
132	137628	18/02/2017	FYROM	IPA	Supply of equipment for National Qualification Framework - Management and Information System
133	137646	23/02/2016	Bosnia and Herzegovina	IPA	Police Data Management and Protection
134	137648	04/11/2015	Kosovo	EULEX	Supply of Construction Materials under a Framework Contract No.4
135	137651	29/04/2016	Serbia	IPA	Supply of vehicles to cope effectively with increased mixed migration flows

Num	code	publication	country	Instrum	Title
136	137655	06/11/2015	Turkey	IPA	Supply of Equipment for Upgrading Information and Communication Technologies Services of TurkStat Phase 2
137	137656	19/12/2015	FYROM	IPA	Supply of vehicles to support the relevant government offices for effective and efficient response to the migration crisis
138	137678	18/02/2016	Bosnia and Herzegovina	IPA	Supply and distribution of rabies vaccination baits for autumn 2016 and spring 2017 campaigns
139	137777	13/05/2016	Lebanon	ENI	Equipment for Municipal Solid Waste Treatment Facilities in Three Lots
140	137788	06/01/2016	Kosovo	EULEX	Secondary Containerized Data Center
141	137811	28/06/2016	FYROM	IPA	Supply of various equipment, office furniture and vehicles to the relevant authorities for management and audit of EU funds
142	137853	15/05/2016	Montenegro	IPA	Supply of Rabies vaccine baits and aerial distribution for autumn 2016, spring 2017, autumn 2017 and spring 2018 vaccination campaigns
143	137888	19/05/2017	Turkey	IPA	Supply of Equipment for Çorum Solid Waste Management Project
144	137911	22/11/2016	Turkey	IPA	Supply of Equipment for Samsun Logistics Centre
145	137937	23/07/2016	FYROM	IPA	Contract title: Supply of Equipment for the Continuation of the Interoperability within the Government Institutions
146	137948	29/07/2016	FYROM	IPA	Supply of equipment for further expanding of the One-stop-shop system for business licenses and permits
147	137965	06/05/2016	FYROM	IPA	Supply of equipment for ISRM
148	138006	23/07/2016	FYROM	IPA	Supply of appropriate equipment to exchange and manage information and monitoring for water, waste, air management, nature and climate change
149	138031	22/11/2016	Turkey	IPA	Supply of Equipment for Gümüşhane Traditional and Organic Products Business Development Centre
150	138039	15/04/2017	Serbia	IPA	Supply contract for general ICT network

Num	code	publication	country	Instrum	Title
151	138044	02/11/2016	Serbia	IPA	Supply and installation of equipment for navigation monitoring system on the Danube River
152	138047	14/02/2017	Serbia	IPA	Supply contract for AIS and AES Equipment
153	138049	28/12/2016	Turkey	IPA	SUPPLY OF EQUIPMENT FOR KONYA SOLID WASTE MANAGEMENT PROJECT
154	138051	29/10/2016	Turkey	IPA	Supply of Passport Entry-Exit Stamping Device
155	138060	11/10/2016	Montenegro	IPA	Supply of equipment which is in line with modernised educational programmes for schools
156	138065	29/04/2016	Bosnia and Herzegovina	IPA	Supply to the State level Prosecutor Office
157	138090	01/07/2016	FYROM	IPA	Supply of IT equipment, queuing system, video surveillance system and other equipment for strengthening the capacity of the Public Revenue Office
158	138100	12/10/2016	Turkey	IPA	Supply of Equipment for Seydişehir Water and Wastewater Project
159	138120	21/08/2016	Jordan	ENI	Supply, installation and upgrade of hardware and DocuWare solution for the Electronic Document Management System of the Civil Status and Passport Directorate
160	138127	26/05/2016	Turkey	IPA	Supply of Equipment for Improvement of the Shared Industrial Infrastructure of the Pistachio Processing Sector
161	138150	13/05/2017	FYROM	IPA	Supply of Laboratory Equipment for the Customs Administration
162	138162	13/08/2016	Algeria	ENI	Fourniture et livraison de matériel informatique
163	138163	13/08/2016	Algeria	ENI	Fourniture et livraison d'équipements et matériels de laboratoires
164	138168	12/01/2017	Turkey	IPA	Supply for Development of Winter Tourism Corridor in Erzurum, Erzincan and Kars
165	138232	14/07/2016	Turkey	IPA	Supply of Equipment for "Bafra Business and Export Development Unit (BEDU)"

Num	code	publication	country	Instrum	Title
166	138256	12/10/2016	Montenegro	IPA	Establishment of hardware, software infrastructure and provision of ortho-photos in view of establishing LPIS in Montenegro
167	138257	12/12/2016	Turkey	IPA	Supply for Sivas Enterprise Development Centre and Osmaniye Enterprise Development Centre
168	138265	12/10/2016	Albania	IPA	Supply of vaccines and other material for the control and eradication of zoonotic diseases
169	138271	15/07/2016	Turkey	IPA	Supply of IT Equipment for Şanlıurfa Cereals Exchange and Licensed Warehouse
170	138293	26/05/2017	Albania	IPA	Supply and installation of equipment for workshops and laboratories for multifunctional Vocational Education Training centers
171	138312	09/08/2016	Turkey	IPA	Supply of Equipment for Improving the Quality of Vocational Education and Training in Turkey (IQVET)
172	138323	17/08/2017	Kosovo	EULEX	Renewal of Microsoft Software Assurance Symantec Antivirus and Veritas Backup Exec Licenses
173	138333	14/04/2017	Turkey	IPA	Supply of Equipment for Şanlıurfa Wastewater Treatment Plant Project
174	138345	31/08/2016	Turkey	IPA	Supply for Fırat Rainbow Surrounding Enterprise Taskforce (FIRASET)
175	138364	07/03/2017	Turkey	IPA	Supply for development of the research and technological infrastructure of Gaziantep Technopark
176	138375	08/09/2016	Turkey	IPA	Supply of Equipment for the Operations of Revitalisation of History in Şanlıurfa
177	138377	08/09/2016	Turkey	IPA	Supply for Bingöl Enterprise Development Centre and Van Enterprise Development Centre
178	138382	31/03/2017	Turkey	IPA	Supply for 'Maraş Pepper Cluster' in the South-east Anatolia Region
179	138386	28/12/2016	Turkey	IPA	Supply of Water and Wastewater System Supportive Equipment for Akşehir Municipality
180	138453	07/01/2017	Lebanon	ENI	Equipment for the Lebanese Armed Forces and General Directorate of General Security

Num	code	publication	country	Instrum	Title
181	138464	25/08/2017	Turkey	IPA	Supply of Equipment for Merzifon Water and Wastewater Project
182	138468	09/06/2017	FYROM	IPA	Supply of IT equipment and vehicles for Agriculture and Rural development
183	138478	28/01/2017	Turkey	IPA	Supply of Equipment for Mardin Wastewater Project
184	138524	10/02/2017	Morocco	ENI	Fournitures de matériel informatique à la Chambre des Représentants du Maroc
185	138541	24/01/2017	Turkey	IPA	Supply of Mobile Surveillance Units for Increasing Border Surveillance Capacity of Borders between Turkey and EU
186	138545	23/11/2016	Turkey	IPA	Supply of Equipment for the Operations of Expansion of Elazığ Enterprise Development Centres (ISGEM)
187	138564	23/05/2017	Turkey	IPA	Supply of Equipment for Soma Water and Wastewater Project
188	138568	21/02/2017	Bosnia and Herzegovina	IPA	Support to the Fight against Money laundering in BiH
189	138577	16/12/2016	FYROM	IPA	Supply of IT equipment for State Statistical Office
190	138620	18/08/2017	FYROM	IPA	Contract title: Supply of Equipment for the National Population Register in the Ministry of Information Society and Administration
191	138632	20/12/2016	Kosovo	EULEX	Framework Contract for the Supply of Automotive Spare Parts No. 4
192	138637	21/12/2016	Kosovo	EULEX	Supply of Workshop and Vehicle Consumable Items under Framework Contract
193	138650	08/08/2017	Jordan	ENI	Supply of Lighting Testing System for Jordan Standards & Metrology Organization
194	138652	19/08/2017	Albania	IPA	Supply for the food safety laboratory equipment in the Food Safety and Veterinary Institute (FSVI) and National Food Authority (NFA) Regional Directorates
195	138684	24/03/2017	Turkey	IPA	Supply of Equipment for Bartin Water and Wastewater Project

Num	code	publication	country	Instrum	Title
196	138718	03/03/2017	FYROM	IPA	Supply of Rabies Vaccines
197	138739	21/03/2017	Kosovo	EULEX	Framework Contract for the Fuel Supply no.5
198	138747	08/04/2017	Lebanon	ENI	Provision of Equipment and Supplies for Agricultural Cooperatives
199	138757	09/09/2017	FYROM	IPA	Supply of equipment for the institutions in the area of justice and home affairs
200	138764	17/06/2017	Jordan	ENI	Supply, installation and upgrade of hardware and DocuWare solution for the Electronic Document Management System of the Civil Status and Passport Directorate
201	138798	22/02/2017	Kosovo	EULEX	Framework Contract for the Supply of Drinking Water No. 6
202	138804	27/06/2017	FYROM	IPA	Supply of laboratory equipment, equipment for official controls, IT equipment and vehicles for Phytosanitary Authorities
203	138814	02/03/2017	Kosovo	EULEX	Medicaments and Consumables under Framework Contract No. 4 Pristina, Kosovo
204	138820	10/05/2017	Tunisia	ENI	Acquisition d'équipements pour le programme d'Appui aux Médias en Tunisie
205	138844	20/03/2017	Turkey	IPA	Supply of Equipment for Erciş Drinking Water Supply Project
206	138883	10/04/2017	Lebanon	ENI	Installation of a solar powered pumping system for the hill lakes and well in Jbaa El Chouf, Lebanon
207	138911	12/04/2017	FYROM	IPA	Supply of air conditioners for the Social Work Centers (SWC), State Labour Inspectorate (SLI) and Employment Service Agency (ESA)
208	138913	28/04/2017	FYROM	IPA	Supply of IT equipment for strengthening the capacity of the PRO – Contact Centre/Call Centre
209	138921	24/04/2017	Turkey	IPA	Supply for Gaziantep Regional Industrial Design and Modelling Centre (GETAM)
210	138949	15/05/2017	Tunisia	ENI	Acquisition de matériel roulant (Dix véhicules automobiles) au profit du Ministère du Développement, de l'Investissement et de la Coopération Internationale

Num	code	publication	country	Instrum	Title
211	138971	18/05/2017	Kosovo	EULEX	Spare Parts and Maintenance of Vehicle FWC_ Nissan &Mercedes
212	138984	16/06/2017	Montenegro	IPA	Supply of AIS transponders class a for fishing fleet of Montenegro
213	139009	12/06/2017	FYROM	IPA	Supply of IT equipment for the Social Work Centres and for the Operating Structure for Human Resources Development Component of IPA
214	139082	05/07/2017	Turkey	IPA	Supply of Equipment and Software for Siverek Water and Wastewater Project
215	139083	05/07/2017	Turkey	IPA	Supply of Equipment for Adıyaman WW Project
216	139096	23/08/2017	FYROM	IPA	Supply of IT equipment for State Audit Office
217	139157	31/07/2017	Kosovo	EULEX	Renewal of Microsoft Software Assurance, Symantec Protection Suite and Veritas Backup Exec Licenses & New Microsoft Software Licenses
218	139161	02/08/2017	Turkey	IPA	Supply of Equipment for Bulancak Water and Wastewater Project
219	139215	30/08/2017	Tunisia	ENI	Acquisition de matériel roulant (Neuf véhicules automobiles) au profit du Ministère du Développement, de l'Investissement et de la Coopération Internationale
220	139227	06/09/2017	Kosovo	EULEX	Spare Parts and Maintenanve of Heavy, Speciaalized Vehicles

C

DESCRIPTOR OF THE VARIABLES IN THE COMPLETE DATASET

In this annex, I present the descriptor of the variables that integrate the dataset. The descriptor includes the main variables taken and transformed from the tender dossiers, and the auxiliary variables needed to specify and to estimate the models used in the research.

The descriptor includes only two fields. The first one is the name of each variable as it appears in the different sections of this thesis. The second one is the description of the variable.

The following conventions have been followed:

- Numeric variables are expressed in small letters. The first letter may be a capital letter when this helps a better interpretation.
- Categorical variables are expressed in small letters and they begin with the prefix "cat".
- Binary variables and dummy variables to select single categories are expressed in capital letters. They start with the letter "D".
- Dates are expressed in small letters and they begin with the prefix "date".
- Instrumental variables are included at the end of the dataset and they are expressed in capital letters. Indication of the external source used to retrieve their values is indicated.
- Other variable like names of categories or codes are expressed in small letters.

The dataset includes 40 variables. Some of the variables do not appear explicitly in the thesis, but they have been used for the purpose of classification of the tender dossiers (for instance, the date of publication), or as regressors that did not proved to be statistically significant in the estimation of the specified models (for instance, the binary variable indicating whether the tendered lot originated in a tender dossier with one single lot or with several lots).

code	It is the reference of the tender. A unique number for each tender called by Europe Aid.
DLOTS	Binary variable. When the tender includes more than one lot it takes value 1. It takes 0 otherwise.
Nlot	Specific number of the tendered lot in each tender. When several individual lots are decided jointly with a single contract and a single award price, Nlot indicates the lower number of the merged lots.
aval	It is the amount of the tender guarantee required to bid for the tendered lot. If no tender guarantee is required it takes the value 0.
DAVAL	Binary variable. When a tender guarantee is required to participate in the bidding procedure, it takes value 1. Otherwise it takes value 0.
datep	Date of publication of the tendered lot. (Format: day-month-year in the csv version of the dataset).
countryp	It is the name of the country where the lot is procured. Name after United Nations status and denomination at the end of 2017.
countryp_code	It is the code of the country where the lot is procured.
finstr	It is the name of the financial instrument used to fund the acquisition of the tendered lot.
bids	It is the number of valid bids received for the tendered lot. The number of bids is the same as the number of bidders.
DBIDS	Binary variable. When there are valid bids it takes value 1. If there are no valid bids (void procedure) it takes the value 0.
BIDS0	Dummy based on variable bids. It takes the value 1 when the number of bidders is 0. It takes the value 0 otherwise.
BIDS1	Dummy based on variable bids. It takes the value 1 when the number of bidders is 1. It takes the value 0 otherwise.
BIDS2	Dummy based on variable bids. It takes the value 1 when the number of bidders is 2. It takes the value 0 otherwise.

BIDS3	Dummy based on variable bids. It takes the value 1 when the number of bidders is 3. It takes the value 0 otherwise.
BIDS4	Dummy based on variable bids. It takes the value 1 when the number of bidders is 4. It takes the value 0 otherwise.
BIDS5	Dummy based on variable bids. It takes the value 1 when the number of bidders is 5. It takes the value 0 otherwise.
BIDS6	Dummy based on variable bids. It takes the value 1 when the number of bidders is 6. It takes the value 0 otherwise.
BIDS7	Dummy based on variable bids. It takes the value 1 when the number of bidders is 7. It takes the value 0 otherwise.
BIDS8	Dummy based on variable bids. It takes the value 1 when the number of bidders is 8. It takes the value 0 otherwise.
BIDS9	Dummy based on variable bids. It takes the value 1 when the number of bidders is 9. It takes the value 0 otherwise.
BIDS10_	Dummy based on variable bids. It takes the value 1 when the number of bidders is 10 or more than 10. It takes the value 0 otherwise.
DNEGOTIATED	Dummy variable. It takes the value 1 when the award corresponds to a negotiated procedure (after a void open procedure). Otherwise it takes the value 0.
DSCOPE	It is a binary variable. It takes the value 1 for local tenders and 0 otherwise.
Pref	It is the reference price of the tendered lot signalled by the tender guarantee. It is calculated as: aval/0.015.
pcost	It is the awarded price of the tendered lot, which is identified with the procurement cost. We refer usually to it as P*.
indpago	It is an index calculated as the ratio between the procurement cost (pcost) and the reference price (Pref) signaled by the tender guarantee. We refer usually to it as normalized procurement cost.
datea	It is the date on which the official resolution on the awarded lot is published. (Format: day-month-year in the csv version of the dataset)

catpro	It is a categorical variable we have established accordingly to the product description. (0 = medical and laboratory equipment; 1 = furniture; 2 = hardware and software; 3 = industrial equipment and machinery; 4 = vehicles).
DCATPRO1	Dummy variable based on variable catpro for the lots related to furniture (1 = furniture; 0 = rest of lots)
DCATPRO2	Dummy variable based on variable catpro for the lots related to hardware and software (1 = hardware & software; 0 = rest of lots)
DCATPRO3	Dummy variable based on variable catpro for industrial equipment and machinery (1 = industrial equipment and machinery; 0 = rest of lots)
DCATPRO4	Dummy variable based on variable catpro for the lots related to vehicles (1 = vehicles; 0 = rest of lots)
catmar	It is a categorical variable for the geographic markets according to the financial instrument used (finstr) and the geographic position: (0 = ENI beneficiaries; 1 = Turkey; 2 = IPA beneficiaries (no Turkey or Kosovo), 3 = Kosovo)
DCATMAR1	Dummy based on variable catmar for Turkey geographic market (1= Turkey; 0 = rest of countries)
DCATMAR2	Dummy based on variable catmar for IPA geographic market (no Turkey or Kosovo) (1= Albania, Bosnia & Herzegovina, Serbia, FYROM and Montenegro); 0 = rest of countries)
DCATMAR3	Dummy based on variable catmar for Kosovo geographic market (1 = Kosovo; 0 = rest of countries)
GDP_1	Annual Gross Domestic Product of the country where the lot is tendered, lagged one year regarding the date of publication of the tender. In 2000 constant $US billions. As published by the World Bank.
DTF_1	Distance to Frontier indicator of the country where the lot is tendered, lagged one year regarding the date of publication of the tender. As published by the World Bank.
EXPORTS_1	FOB Exports of the country where the lot is tenderd to the European Union lagged one yeard regarding the date of publication of the tender. Deflated to 2010 constant $US million from souce in current $US million, as published by the International Monetary Fund.

D

DISCUSSION OF ESTIMATED MODELS IN THE RESEARCH

D.1 MODELS ASSUMING NUMBER OF BIDDERS AS AN EXOGENOUS DISCRETE VARIABLE

In this section I discuss the estimation of the the models presented in section 6.1 of the thesis and I specify the tests that I conducted to select the best-fitting one.

D.1.1 *Normalized procurement cost in level form*

Model 1 - OLS estimation, using observations 1–370

Dependent variable: *indpago*
Heteroskedastic - Robust Standard Errors, HC0 variant

	Coefficient	Std. error	t - statistic	p - value
const	1.1512	0.0415	27.7306	0.0000
DCATPRO1	−0.1535	0.0880	−1.7449	0.0819
BIDS2	−0.1321	0.0542	−2.4388	0.0152
BIDS3	−0.1655	0.0565	−2.9290	0.0036
BIDS4	−0.1924	0.0668	−2.8800	0.0042
BIDS5	−0.2767	0.0567	−4.8807	0.0000
BIDS6	−0.2359	0.0912	−2.5862	0.0101
BIDS7	−0.2424	0.1276	−1.8987	0.0584
BIDS8	−0.4089	0.1741	−2.3484	0.0194
BIDS9	−0.2087	0.0730	−2.8596	0.0045
BIDS10+	−0.2049	0.0765	−2.6774	0.0078

R^2	0.06056	Adjusted R^2	0.03439
$F(10, 359)$	3.18759	p - value (F)	0.00061
AIC	286.588	Res. Var. ($\hat{\sigma}^2$)	0.12270

Variables (*DCATPRO1* and *BIDS7*) are included in the model although their confidence level is lower than 95%. These variables are included as they improve the overall fitting of the model. They are statistically significant at the 90% of confidence.

I chose the natural heteroskedastic variant for the standard errors, since the sample used for the research has a relevant number of observations. This ensures asymptotic convergence with other variants like HC1, HC2, HC3 and HC4.

RESET specification test:
Null hypothesis: *Model specification is adequate*
Statistic: $F(2, 357) = 0.2399$
p-value = $P(F(2, 357) > 0.2399) = 0.7868$

Since the p-value associated to the RESET test statistic is significantly higher than 0.05, we cannot reject the null hypothesis of adequate specification of the model.

D.1.2 *Normalized procurement cost in log form*

Model 2 - OLS estimation, using observations 1–370

Dependent Variable: *l_indpago*
Heteroskedastic-Robust Standard Errors, variant HC0

	Coefficient	Std. error.	t - statistic	p - value
const	0.1071	0.0395	2.7130	0.0070
DCATPRO1	−0.2002	0.1041	−1.9238	0.0552
BIDS2	−0.1339	0.0521	−2.5714	0.0105
BIDS3	−0.1993	0.0633	−3.1477	0.0018
BIDS4	−0.2353	0.0746	−3.1526	0.0018
BIDS5	−0.2829	0.0602	−4.7004	0.0000
BIDS6	−0.3045	0.0932	−3.2688	0.0012
BIDS7	−0.2985	0.1006	−2.9686	0.0032
BIDS8	−0.5271	0.2198	−2.3975	0.0170
BIDS9	−0.1722	0.0733	−2.3493	0.0193
BIDS10+	−0.1693	0.0787	−2.1502	0.0322

R^2	0.07276	Adjusted R^2	0.04693
$F(10, 359)$	3.73221	p - value (de F)	0.00009
AIC	358.39	Res. Var. ($\hat{\sigma}^2$)	0.14898

RESET specification test:
Null hypothesis: *The specification of the model is adequate*
Test statistic: $F(2, 357) = 0.1782$
p - value = $P(F(2, 357) > 0.1782) = 0.8368$

We cannot reject in this case either the null hypothesis of an adequate specification of the model. Using only a RESET test does not allow discriminating the best-fitting model between Model 1 and Model 2.

D.1.3 *Comparison of the determination coefficients*

The following test enable us to select the best-fitting model for section D.1.

Since both models estimate a different dependent variable we cannot compare directly the determination coefficients of both regressions. However, as they share the same independent variables, we can compare the determination coefficient of model Model 1 with the statistic related to Model 2 calculated as follows (Wooldridge, 2012):

1.- To estimate $\widehat{indpago}$ in Model 2 with the unbiased estimator defined by:

$$\widehat{indpago}_{M2} = exp(\hat{\sigma}^2_{M2}/2).exp(\widehat{l\_indpago}_{M2}) \tag{D.1}$$

$\hat{\sigma}_{M2} = 0.38598$ is the standard deviation of the regression for Model 2.

2.- To calculate the squared correlation coefficient between variable $indpago$ and the estimation $\widehat{indpago}$ as calculated in step 1.

$$r^2_{(indpago, \widehat{indpago}_{M2})} = [corr(indpago, \widehat{indpago}_{M2})]^2 = 0.0579 \tag{D.2}$$

After comparing R^2=0.0606 of Model 1 with the equivalent statistic of Model 2, r^2=0.0579, according to the calculations above, I selected Model 1 with dependent variable in level form as the best-fitting regression model when the number of bidders is considered as a set of discrete variables in a flexible non-linear model.

D.1.4 *Outliers diagnosis*

The last validation test of the best-fitting model for section 6.1 in the thesis is the outliers diagnosis. The dataset has been drawn from official publications from Europe Aid and I consider all the observations valid *a priori*. With this test I try to identify observations that may have a significant influence on the estimation of the model and, in addition, may not behave like the rest of the procurement auctions we are studying. I have followed the methodology to look up the information of the tender resolution for any potential outlier and then decide whether suppressing it would be advisable for a more consistent estimation of our model. My exploratory analysis is based on the concepts of leverage and influence as defined, for instance, in (Davidson and MacKinnon, 2003).

1.- Leverage effect. I define for each of the observations the statistic calculated with equation (D.3):

$$\alpha_i = \hat{u}_i/(1 - h_i) \tag{D.3}$$

Where i represents each of the observations, α_i is the measure of the leverage effect of each observation i, $\hat{u}$ are the residuals of the regression model 1, and h_i represents the i element of the Hat Matrix diagonal.

The threshold for the leverage points is usually defined between $2k/n$ and $3k/n$, where k is the number of regressors and n the number of observations (370 in the estimation of our model). I have chosen the threshold at the value 2 k/n, as defined in (Belsley, Kuh, and Welsh, 1980). With the data of the research this threshold yields 0.059. Leverage points tend to be influential in the regression, but are not necessarily regression outliers.

2.- To diagnose influential observations, I use Cook's distance (Cook, 1977), defined by the equation D.4:

$$D_i = (\hat{e}_i^2/k).(h_i/(1 - h_i)) \tag{D.4}$$

Where D_i represents Cook's distance for each observation i and $\hat{e}_i$ represents the studentized residual of observation i. k is the number of regressors and h_i represents the i element of the Hat Matrix diagonal.

There are different approaches about the observations that must be considered as influence points based on Cook's distance, but none of them is determinant to discard observations without further analyzing them. Software packages like Stata usually take the threshold satisfying $D_i > 4/n$ as the one determining the observations that must be studied. Cook suggests the cut-off value of 1 to consider rejecting observations as outliers.

In our model, Cook's distances are far less than 1 and we have taken 0.5 as the threshold for observations that may by regression outliers with high probability. I have used the threshold used in Stata as well. Figures D.1 and D.2 represent the two potential outliers in the regression.

From figure D.1, we notice that there are different observations above the Cook's distance influence lower threshold. But two of them stand out from the rest: the one in position 351 and the one in position 360 of the sample of 370 observations used in the estimation of this model[1].

Figure D.2 allows conducting the deeper analysis suggested on the two observations that are potentially regression outliers.

Points on the left of the leverage threshold correspond to observations in which the independent variables of the model show little dispersion. On the right of the leverage threshold lay the infrequent observations based on the dispersion of independent variables.

1 These positions correspond to the records number 541 and number 551 of our full dataset. Record 541 refer to the second lot of tender dossier 136964 with 7 bids received. And record 551 refers to the sixth lot of tender dossier 134936 with 8 bids received.

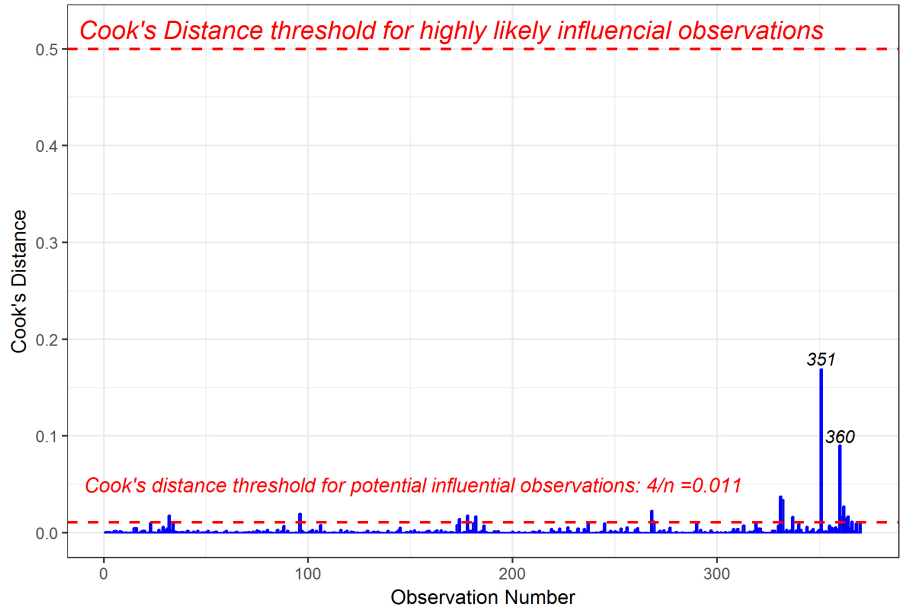


Figure D.1: Indicator of influential observations. Cook's distance

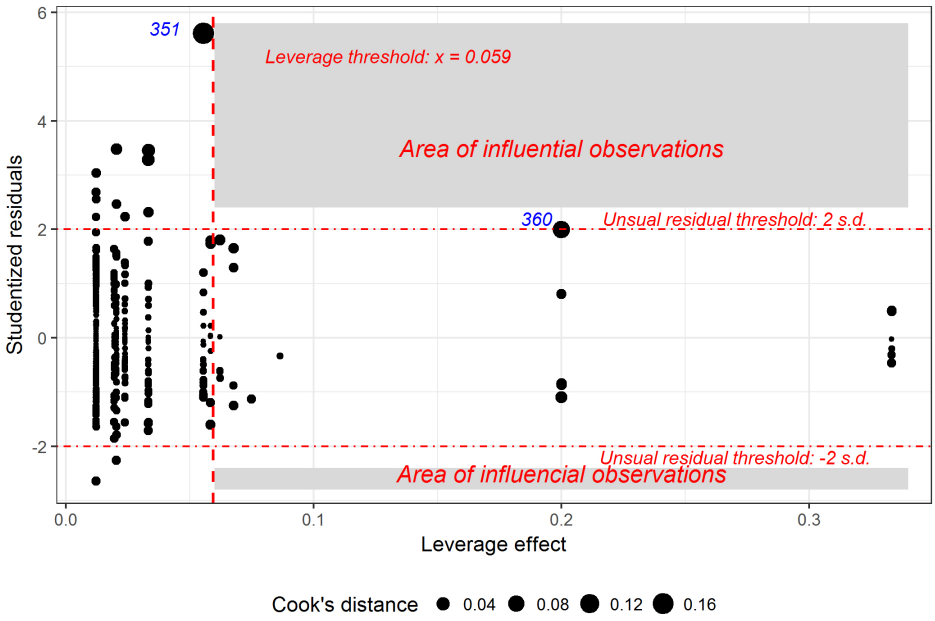


Figure D.2: Indicator of influential observations: Cook's distance with leverage and residuals thresholds

On the other hand, above and below the 2 studentized deviations lines (2 s.d.), we find the observations with residuals anomalously higher and lower than the rest of the observations. Regression outliers appear when there are leverage points that additionally yield residuals with a high dispersion from the rest. That is, inside the external areas limited by the threshold lines colored in gray.

In the selected regression, observation 351 is potentially influential because it yields a residual anomalously high. And observation 360 is influential because it yields a high residual on a regressor associated to a low-represented category of independent variables. However, neither of these observations crosses both thresholds simultaneously.

After this analysis, I checked the tender dossiers concerning these two observations. No particular comments from the contracting authority or any other document in the resolution of both tenders indicate any different procedure than the rest of tenders in the dataset, therefore I decided not to suppress any of the observations from the sample in our fitted model.

D.2 ESTIMATION OF THE STRUCTURAL EQUATION IN MODELS CONSIDERING *bids* AS A CONTINUOUS AND EXOGENOUS VARIABLE

I discuss in this section the different models in which the number of bidders enters as a continuous independent variable, *bids*, under the three functional forms indicated in section 5.4. I estimate the structural equation of the models disregarding any potential endogeneity of the variable *bids*. A summarized estimation of these models is presented in table 6.2.

D.2.1 *Structural equation with bids in quadratic form*

Model 3 - OLS estimation method, using observations 1–370

Dependent variable: *log(indpago)*
Heteroskedastic - Robust Standard Errors, HC0 variant

	Coefficient	Std. error	t - statistic	p - value
DCATPRO1	−0.1595	0.1050	−1.5196	0.1295
bids	−0.0370	0.0095	−3.9160	0.0001
$bids^2$	0.0016	0.0011	1.4504	0.1478

R^2	0.09359	Adjusted R^2	0.08618
$F(3, 367)$	11.50628	p - value (F)	0.00000
AIC	353.273	Res. Var. ($\hat{\sigma}^2$)	0.15008

RESET test:

Null hypothesis: *Model specification is adequate*
Statistic: $F(2, 365) = 2.8905$
p-value = $P(F(2, 365) > 2.8903) = 0.0568$

Since the p-value associated to the RESET test statistic is significantly low and very close to 0.05, I assume that this model may be misspecified even when it is over the threshold of 5% significance. Only bids is a statistically significant variable in this model at the usual 95% of confidence. Other functional forms for the model present a better goodness of fit.

D.2.2 *Structural equation with bids in linear form*

Model 4 - OLS estimation method, using observations 1–370

Dependent variable: *log(indpago)*
Heteroskedastic - Robust Standard Errors, HC0 variant

	Coefficient	Std. error	t - statistic	p - value
DCATPRO1	−0.1721	0.1046	−1.6456	0.1007
bids	−0.0271	0.0052	−5.1711	0.0000

R^2	0.09071	Adjusted R^2	0.08577
$F(2, 368)$	16.0776	p - value (F)	0.00000
AIC	352.445	Res. Var. ($\hat{\sigma^2}$)	0.15015

RESET test:
Null hypothesis: *Model specification is adequate*
Statistic: $F(2, 366) = 1.8762$
p-value = $P(F(2, 365) > 1.8762) = 0.1546$
Since the p-value associated to the RESET test statistic is higher than 0.05, we cannot reject the null hypothesis that it is adequately specified. It presents a better goodness of fit than the model with `bids` in quadratic form. The quadratic term does not significantly improve the adjusted R^2 statistic in the model, and it makes worse the AIC criteria (AIC statistic is lower in the model with `bids` in linear form only).

D.2.3 *Structural equation with bids in log form*

Model 5 - OLS estimation method, using observations 1–370

Dependent variable: *log(indpago)*
Heteroskedastic - Robust Standard Errors, HC0 variant

	Coefficient	Std. error	t - statistic	p - value
DCATPRO1	−0.1635	0.1038	−1.5754	0.1160
log(bids)	−0.0950	0.0171	−5.5633	0.0000

R^2	0.10044	Adjusted R^2	0.09555
$F(2, 368)$	18.1649	p - value (F)	0.00000
AIC	348.467	Res. Var. ($\hat{\sigma^2}$)	0.14854

RESET test:

Null hypothesis: *Model specification is adequate*

Statistic: $F(2, 366) = 0.4748$

p-value = $P(F(2, 365) > 0.4748) = 0.6224$

Since the p-value associated to the RESET test statistic is higher than 0.05, we cannot reject the null hypothesis that it is adequately specified. It presents a better goodness of fit than the other two functional forms. Adjusted R^2 statistic in this model is the highest, and AIC statistic is the lowest.

D.3 INSTRUMENTAL METHODS TO TEST FOR ENDOGENEITY OF VARIABLE *bids*

I discuss in this section the instrumented versions of the best-fitting models presented in section 6.2.1 of the thesis, controlling for potential endogeneity of variable *bids* in them. They correspond to the models RM4 and RM5 in chapter 6. I present the estimation with 2SLS together with the relevant endogeneity test, and the estimations of the same models with the GMM method that confirm the consistency of the results. In addition, I include a test to verify robustness of the instrumented values by replicating the estimation method with another combination of instruments according to models RM4v2 and RM5v2 in chapter 6.

D.3.1 *2SLS Method for model with bids in linear form*

Model 6 - 2SLS estimation method, using observations 1–370

Dependent Variable: $\log(\mathrm{indpago})$
With instruments for: *bids*
Instruments: GDP_{-1} *and* $\mathrm{GDP}_{-1} * \mathrm{DTF}_{-1}$
Heteroskedasticity-robust Standard Errors, variant HC0

	Coefficient	Std. error.	t - statistic	p - value
DCATPRO1	−0.1758	0.1066	−1.6490	0.1000
bids	−0.0257	0.0101	−2.5367	0.0116

R^2	0.09050	Adjusted R^2	0.08556
$F(2, 368)$	5.8440	p - value (F)	0.00318

The regressor of interest in this model is the number of bidders in linear form, *bids*, which is the instrumented variable.

The instruments used in this first variant are the variable GDP_{-1}, which represents the GDP of the country launching the tender, lagged one year. And a composite variable resulting of multiplying GDP_{-1} by the variable DTF_{-1}, which is an index scoring the regulatory economic environment of the country, lagged one year as well. In section 5.2.3 of the thesis I discuss the economic arguments of choosing these instruments.

In addition, I must include the control instrument DCATPRO1, which appears in the first step of the 2SLS method as a regressor.

I have conducted the following specification tests and present their interpretation:

Overidentification Wooldridge's robust score test:
Null hypothesis: *All instruments are valid*
Statistic = 0.59499
p-value = $P(\chi^2(1) > 0.59499) = 0.44050$
Given the high p-value of the test statistic we cannot reject the null hypothesis and we conclude that both instruments are valid instruments for the potentially endogenous variable *bids*.

Weak instrument test:
Null hypothesis: *Instruments are weak*
Statistic $F(2, 367) = 293.631$
p-value = 0.0000
With this test I verify the relevance of the instruments for the variable we intend to instrument. Values of the F statistic lower than 10 indicate that the instruments may be weak and irrelevant. Since the value of F is much higher, I reject the null hypothesis and consider that instruments are relevant for our model.

Hausman robust endogeneity test:
Null hypothesis: *OLS estimators are consistent*
Statistic: $F(1, 367) = 0.02698$
p-value = 0.86963
Since the p-value of the test statistic is greater that 0.05, we cannot reject the null hypothesis. OLS estimation is consistent and this means that *bids* does not show relevant endogeneity in this model.

The instruments used in the second variant are the variable $EXPORTS_{-1}$, which represents the exports to the European Union of the country launching the tender, lagged one year. And a composite variable resulting of multiplying $EXPORTS_{-1}$ by the variable DTF_{-1}, which is the same approach used in the first variant. In section 5.2.3 I also discuss the economic arguments of choosing the figures of Exports in replacement of those of GDP.

In addition, we must include the control instrument DCATPRO1, which appears in the first step of the 2SLS method as a regressor.

Model 7 - 2SLS estimation method, using observations 1–370

Dependent Variable: $log(indpago)$
With instruments for: *bids*
Instruments: $EXPORTS_{-1}$ *and* $EXPORTS_{-1} * DTF_{-1}$
Heteroskedasticity-robust Standard Errors, variant HC0

	Coefficient	Std. error.	t - statistic	p - value
DCATPRO1	−0.1788	0.1060	−1.6860	0.0926
bids	−0.0245	0.0099	−2.4830	0.0135

R^2	0.09002	Adjusted R^2	0.08507
$F(2, 368)$	5.582	p - value (F)	0.00409

I have conducted the following specification tests and present their interpretation:

Overidentification Wooldridge's robust score test:
Null hypothesis: *All instruments are valid*
Statistic = 0.00940
p-value = $P(\chi^2(1) > 0.00940) = 0.92274$
Given the high p-value of the test statistic we cannot reject the null hypothesis and we conclude that both instruments are valid instruments for the potentially endogenous variable *bids*.

Weak instrument test:
Null hypothesis: *Instruments are weak*
Statistic $F(2, 367) = 272.162$
p-value = 0.0000
With this test I verify the relevance of the instruments for the variable we intend to instrument. Values of the F statistic lower than 10 indicate that the instruments may be weak and irrelevant. Since the value of F is much higher, I reject the null hypothesis and consider that instruments are relevant for our model.

Hausman robust endogeneity test:
Null hypothesis: *OLS estimators are consistent*
Statistic: $F(1, 367) = 0.09484$
p-value = 0.75829
Since the p-value of the test statistic is greater that 0.05, we cannot reject the null hypothesis. OLS estimation is consistent and this means that *bids* does not show relevant endogeneity in this model.

I finish this section with the estimation of the same model with the GMM method. I use the two-step variant with the quadratic spectral kernel to calculate the HAC matrix in the second step. The coefficients of the 2SLS and GMM methods are basically the same, which is a proof of estimation consistency. The heteroskedastic treatment for the standard errors is different in each method, which may contribute to the small difference in their estimation.

Model 8 - GMM estimation method, using observations 1–370

Dependent Variable: log(indpago)
With instruments for: *bids*
Instruments: GDP_{-1} *and* $GDP_{-1} * DTF_{-1}$
Two-step variant with HAC quadratic spectral kernel

	Coefficient	Std. error.	t - statistic	p - value
DCATPRO1	−0.1758	0.0925	−1.9006	0.0573
bids	−0.0257	0.0105	−2.4488	0.0143

Model 9 - GMM estimation method, using observations 1–370

Dependent Variable: log(indpago)
With instruments for: *bids*
Instruments: $EXPORTS_{-1}$ *and* $EXPORTS_{-1} * DTF_{-1}$
Two-step variant with HAC quadratic spectral kernel

	Coefficient	Std. error.	t - statistic	p - value
DCATPRO1	−0.1788	0.0920	−1.9438	0.0519
bids	−0.0245	0.0097	−2.5292	0.0114

D.3.2 *2SLS Method for model with bids in log form*

Model 10 - 2SLS estimation method, using observations 1–370

Dependent Variable: log(indpago)
With instruments for: *log(bids)*
Instruments: $\log(GDP_{-1})$ *and* $\log(DTF_{-1})$
Heteroskedasticity-robust Standard Errors, variant HC0

	Coefficient	Std. error.	t - statistic	p - value
DCATPRO1	−0.1787	0.1045	−1.7096	0.0882
log(bids)	−0.0763	0.0186	−4.1114	0.0000

R^2	0.09726	Adjusted R^2	0.09235
$F(2, 368)$	11.20076	p - value	0.00002

For the estimation of this second model the reasoning is similar. The dependent variable is the natural log of the variable *indpago*. The regressor of interest is the number of bidders in logarithmic form, *log(bids)*.

The instruments used in the regression are the same variables than in the previous model, but in this case the best instrumental value is achieved expressing them in logarithmic form: $\log(GDP_{-1})$ and $\log(DTF_{-1})$.

I also include the control instrument: DCATPRO1.

I have conducted the following specification tests and present their interpretation:

Overidentification Wooldridge's robust score test:
Null hypothesis: *All instruments are valid*
Statistic = 0.08049
p-value = $P(\chi^2(1) > 0.08049) = 0.77663$
Given the high p-value of the test statistic we cannot reject the null hypothesis and we conclude that both instruments $\log(GDP_{-1})$ and $\log(DTF_{-1})$ are valid instruments for the potentially endogenous variable *log(bids)*.

Weak instrument test:
Null hypothesis: *Instruments are weak*
Statistic $F(2, 367) = 593.034$
p-value = 0.0000
With this test I verify the relevance of the instruments for the variable we intend to instrument. Values of the F statistic lower than 10 indicate that the instruments may be weak and irrelevant. Since the value of F is much higher, I reject the null hypothesis and consider that instruments are relevant for our model.

Hausman robust endogeneity test:
Null hypothesis: *OLS estimators are consistent*
Statistic: $F(1, 367) = 6.62006$
p-value = 0.01048
Since the p-value of the test statistic is lower than 0.05, I reject the null hypothesis. This means that *log(bids)* exhibits relevant endogeneity in the structural equation of the model and estimation of its coefficient with OLS is not consistent. The coefficient estimated with the IV method must be used instead.

In a similar way that I have proceeded in section D.3.1, I have estimated a second instrumental model to test the robustness of the coefficient of the instrumented variable log(bids). The instruments used in the second variant are: $\log(\text{EXPORTS}_{-1})$ and $\log(\text{DTF}_{-1})$. I also include the control instrument: DCATPRO1.

Model 11 - 2SLS estimation method, using observations 1–370

Dependent Variable: log(indpago)
With instruments for: *log(bids)*
Instruments: $\log(\text{EXPORTS}_{-1})$ *and* $\log(\text{EXPORTS}_{-1})$
Heteroskedasticity-robust Standard Errors, variant HC0

	Coefficient	Std. error.	t - statistic	p - value
DCATPRO1	−0.1789	0.1045	−1.7115	0.0878
log(bids)	−0.0761	0.0186	−4.0874	0.0000

R^2	0.09717	Adjusted R^2	0.09226
$F(2, 368)$	11.09652	p - value	0.00002

I have conducted the relevant specification tests and present their interpretation.

Overidentification Wooldridge's robust score test:
Null hypothesis: *All instruments are valid*
Statistic = 0.00659
p-value = $P(\chi^2(1) > 0.00659) = 0.93528$
Given the high p-value of the test statistic we cannot reject the null hypothesis and we conclude that both instruments $\log(\text{EXPORTS}_{-1})$ and $\log(\text{DTF}_{-1})$ are valid instruments for the potentially endogenous variable *log(bids)*.

Weak instrument test:
Null hypothesis: *Instruments are weak*
Statistic $F(2, 367) = 599.549$
p-value = 0.0000
With this test I verify the relevance of the instruments for the variable we intend to instrument. Values of the F statistic lower than 10 indicate that the instruments may be weak and irrelevant. Since the value of F is much higher, I reject the null hypothesis and consider that instruments are relevant for our model.

Hausman robust endogeneity test:
Null hypothesis: *OLS estimators are consistent*
Statistic: $F(1, 367) = 6.81859$
p-value = 0.00939
Since the p-value of the test statistic is lower than 0.05, we reject the null hypothesis. This means that *log(bids)* exhibits relevant endogeneity in the structural equation of the model and estimation of its coefficient with OLS is not consistent. The coefficient estimated with the IV method must be used instead.

I finish this section with the estimation of the same model with the GMM method using the same variant explained in the previous section. Also in this case the coefficients calculated with 2SLS and GMM methods are basically the same, which is a proof of estimation consistency.

Model 12 - GMM estimation method, using observations 1–370

Dependent Variable: log(indpago)
With instruments for: *log(bids)*
Instruments: $\log(GDP_{-1})$ *and* $\log(DTF_{-1})$
Two-step variant with HAC quadratic spectral kernel

	Coefficient	Std. error.	t - statistic	p - value
DCATPRO1	−0.1787	0.0896	−1.9934	0.0462
log(bids)	−0.0763	0.0187	−4.0845	0.0000

Model 13 - GMM estimation method, using observations 1–370

Dependent Variable: log(indpago)
With instruments for: *log(bids)*
Instruments: log(EXPORTS$_{-1}$) *and* log(DTF$_{-1}$)
Two-step variant with HAC quadratic spectral kernel

	Coefficient	Std. error.	t - statistic	p - value
DCATPRO1	−0.1789	0.0896	−1.9958	0.0460
log(bids)	−0.0761	0.0187	−4.0765	0.0000

BIBLIOGRAPHY

Armantier, O. and E. Sbaï (2006). "Estimation and comparison of treasury auction formats when bidders are asymmetric." In: *Journal of Applied Econometrics* 21.6, pp. 745–779.

Bajari, P. (2001). "Comparing competition and collusion: a numerical approach." In: *Economic Theory* 18.1, pp. 187–205.

Belsley, D. A., E. Kuh, and R. E. Welsh (1980). *Regression Diagnostics: Identifying Influential Data and Sources of Collinearity*. John Wiley and Sons, Inc.

Brannman, L. et al. (1987). "The Price Effects of increased Competition in Auction Markets." In: *The Review of Economics and Statistics* 69.1, pp. 24–32.

Campo, I. et al. (2003). "Asymmetry in first-price auctions with affiliated private values." In: *Journal of Applied Econometrics* 18.2, pp. 179–207.

Chapela, J. et al. (2019). "Further econometric evidence on the extent and sources of cost savings in competitively tendered contracts." In: *Empirical Economics* 56.2, pp. 679–701.

Chernomaz, K. (2012). "On the effects of joint bidding in independent private value auctions: An experimental study." In: *Games and Economic Behavior* 76.2, pp. 690–710.

Cook, R. D. (1977). "Detection of Influential Observation in Linear Regression." In: *Technometrics* 19, pp. 15–18.

Copas, J. B. and H. G. Li (1997). "Inference for Non-Random Samples." In: *Journal of the Royal Statistical Society* 59.1, pp. 55–95.

Davidson, R. and J.G MacKinnon (2003). *Econometric Theory and Methods*. Oxford University Press.

DEVCO (2018). *Procurement And Grants for European Union external actions: A Practical Guide*. URL: http://ec.europa.eu/europeaid/prag/.

Dufwenberg, M. and U. Gneezy (2002). "Information disclosure in auctions: an experiment." In: *Journal of Economic Behavior and Organization* 48.4, pp. 431–444.

EC (2021). *Commmission Implementing Decision of 10 December 2021 adopting the Instrument for Pre-Accession Assistance (IPA III) Programming Framework for the period 2021-2027*.

Flambard, V. and I. Perrigne (2006). "Asymmetry in Procurement Auctions : Evidence from Snow Removal Contracts." In: *The Economic Journal* 116.514, pp. 1014–1036.

García, L.M and A. Mochón (2021). "Competition effects in EU external aid supply tenders funded with the Pre-accession and Neighbourhood instruments." In: *Empirica*. DOI: 10.1007/s10663-021-09518-5. URL: https://link.springer.com/article/10.1007/s10663-021-09518-5.

Hendricks, K. and R. Porter (1992). "Joint Bidding in Federal OCS Auctions." In: *The American Economic Review* 82.2, pp. 506–511.

Hill, J. B. and Artyom Shneyerov (2013). "Are there common values in first-price auctions? A tail-index nonparametric test." In: *Journal of Econometrics* 174.2, pp. 144–164.

Hubbard, T. P. et al. (2012). "Semiparametric estimation in models of first-price, sealed-bid auctions with affiliation." In: *Journal of Econometrics* 168.1, pp. 4–16.

Hubbard, T. P. et al. (2013). "Using Economic Theory to guide Numerical Analysis: Solving for Equilibria in Models of Asymmetric First-Price Auctions." In: *Computational Economics* 42.2, pp. 241–266.

Iimi, A. (2006). "Auction Reforms for Effective Official Development Assistance." In: *Review of Industrial Organization* 28.2, pp. 109–128.

Klemperer, P. (1999). "Auction Theory: a Guide to the Literature." In: *Journal of Economic Surveys* 13.3, pp. 227–286.

Li, S. and P. Phillips (2012). "Construction Procurement Auctions: Do entrant bidders employ more aggressive strategies than incombent bidders?" In: *Review of Industrial Organization* 40.3, pp. 191–205.

Li, T. (2005). "Econometrics of first-price auctions with entry and binding reservation prices." In: *Journal of Econometrics* 126.1, pp. 173–200.

Mares, V. and J. M. Swinkels (2014). "On the analysis of asymmetric first price auctions." In: *Journal of Economic Theory* 152.1, pp. 1–40.

Maskin, E. and J. Riley (2000). "Asymmetric Auctions." In: *The Review of Economic Studies* 67.3, pp. 413–438.

Matoso, R. and M. Rezende (2014). "Asymmetric information in oil and gas lease auctions with a national company." In: *International Journal of Industrial Organization* 33.1, pp. 72–82.

Milgrom, P. (2004). *Putting Auction Theory to Work*. Cambridge University Press.

Milgrom, P. and R. Weber (1982a). "A Theory of Auctions and Competitive Bidding." In: *Econometrica* 50.5, pp. 1089–1122.

Milgrom, P. and R. Weber (1982b). "The value of information in a sealed-bid auction." In: *Journal of Mathematical Economics* 10.1, pp. 105–114.

OECD (2017). *Resolution of the Council renewing and revising the Mandate of the Development Assistance Committee*. URL: https://one.oecd.org/document/C(2017)134/en/pdf.

OECD (2018). *OECD Development Co-operation Peer Reviews: European Union 2018*. OECD.

OECD (2021a). *COVID-19 spending helped to lift foreign aid to an all-time high in 2020 Detailed Note*. URL: https://www.oecd.org/dac/financing-sustainable-development/development-finance-data/ODA-2020-detailed-summary.pdf.

OECD (2021b). *What is ODA?* URL: https://www.oecd.org/dac/financing-sustainable-development/development-finance-standards/What-is-ODA.pdf.

Onur, I. and R. Özcam (2012). "Public Procurement Auctions and Competition in Turkey." In: *Review of Industrial Organization* 40.3, pp. 207–233.

Paarsch, H. (1992). "Deciding between the common and private value paradigms in empirical models of auctions." In: *Journal of Econometrics* 51.1-2, pp. 191–215.

Parliament, The European and the Council (2021). "Regulation (EU) 2021/947 of the European Parliament and of the Council of 9 June 2021 establishing the Neighbourhood, Development and International Cooperation Instrument – Global Europe." In: *Official Journal of the EU* 64.L209, pp. 1–78. URL: https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=OJ:L:2021:209:TOC.

Pinkse, J. and G. Tan (2005). "The Affiliation Effect in First-Price Auctions." In: *Econometrica* 73.1, pp. 263–277.

Rezende, L. (2008). "Econometrics of auctions by least squares." In: *Journal of Applied Econometrics* 23.7, pp. 925–948.

Rosar, F. (2014). "Secret reserve prices in first-price auctions." In: *International Journal of Industrial Organization* 37.1, pp. 65–74.

Silva, D. G. De et al. (2008). "The impact of public information on bidding in highway procurement auctions." In: *European Economic Review* 52.1, pp. 150–181.

Silva, D. G. De et al. (2009). "Entry and Bidding in Common and Private Value Auctions with an Unknown Number of Rivals." In: *Review of Industrial Organization* 35.1, pp. 73–93.

Tsanana, P. and C. Katrakilidis (2014). "Do Balkan economies catch up with EU? New evidence from panel unit root analysis." In: *Empirica* 41.4, pp. 641–662.

UN (1970). *International Development Strategy for the 2nd United Nations Development Decade*. URL: https://digitallibrary.un.org/record/201726.

USAid (2019). *The Greenbook: U.S. Overseas Loans and Grants*. URL: https://www.usaid.gov/open/greenbook/2019.

Vickrey, W. (1961). "Counterspeculation, Auctions, and Competitive Sealed Tenders." In: *The Journal of Finance* 16.1, pp. 8–37.

Wooldridge, J. M. (2012). *Introductory Econometrics: A Modern Approach*. South-Western.