"On the determinants of Collusion in Public Procurement: the case of Chile"

by

Juan Francisco Martinez S.*
David Escobar
Claudio Loyola

Working Paper N1, 2nd Version, February, 2009
JEL Codes: D44, D86, L13, L41, L44, H57

(*) All authors belong to the Public Market Division, Research Department, Public Procurement and Contracting Bureau: ChileCompra, Ministry of Finance, Chile

Address: Monjitas 392,8th floor, Santiago, Chile. Tel: +56 2 2904400. Fax: +56 2 2904478
Mail to: juan.martinez@chilecompra.cl.

Abstract

This paper tackles the explanation of collusion determinants and its economic consequences in public procurement. Employing a wide variety of econometric models for collusion, this document finds that collusion is principally driven by the productive sector, the independency of the purchasing institution, the amount involved, sub-contracting possibility, the number of bids and the combinatorial awarding scheme. Following this investigation, a standard cross section OLS, probit and logit econometric approach was implemented to get the determinants, their significance and magnitudes. The independent and dependent variables were chosen by doing a deep bibliographic analysis together with the consultation to the experts in the Chilean procurement agency. The results of the paper are not completely concluding due we are talking about possibilities of collusion, without the judgment of the law.

JEL Codes: D44, D86, L13, L41, L44, H57
Keywords: Procurement, Collusion, Corruption, Competition.

1. Introduction

The Chilean Public Procurement and Contracting Bureau – ChileCompra, is in charge of providing the unique and centralized platform to perform all the purchases needed by the state agencies. In this sense, one of the main objectives of this institution is to provide all the conditions in order to have an efficient and non discriminatory marketplace. Moreover, one of the main strategic objectives of this entity is to provide the means to achieve transparency. Therefore, the question of how provide free competition and non collusive behavior is a crucial one.

By the experience given with the daily work, our personnel know that collusion can affect the processes in two main central lines. On the one hand, collusion does not allow the necessary competition or free trade to get efficient prices, that is, collusion generates serious economic losses, because of unjustified excessive payments, especially in the case of collusion between suppliers. On the other hand, collusion seriously damages the perception of transparency, especially in the case of collusion between supplier and purchaser.

Collusion is prevented and detected using two main tools. Firstly, as prevention tools, purchasing agencies can use *checklists*[1] when they prepare the auction bases and contracts. A second valuable tool is the detection checklist, which is used in any auction process after they are open to perceive any irregularity affecting normal competition. A third method to fight collusion is to detect behavioral patterns using a data mining procedure. Although this procedure is not concluding, it gives valuable insights about which sectors are subject to collusion, allowing the regulator to use scarce resources in an efficient way.

Finally this study provides an initial framework to detect manifestation of collusion events. The aggregate value of this research is based on the use and process of raw data applying standard econometric tests.

[1] Educational instrument conceived to clarify the law and procurement procedures.

2. Collusion stylized facts

Collusion in auctions is produced on two dimensions. The first one is when the enterprises agree to increase their profits in an illicit way. In procurement auctions, they agree increase their offers in order to get extra benefits providing the good or service to be contracted. Suppliers in this case use multiple and evolving mechanisms, therefore the regulation is very difficult. There are various famous examples in the literature (Klemperer, 2006), with millionaire losses for the governments.

The second kind of collusion is the illicit in which the purchaser agrees with the supplier to share extra profits produced by an illegal augment in the awarded price. This phenomenon is often called corruption instead of collusion; however the only things that change are the agents involved in the illicit agreement, and the magnitude of the losses, which amount is smaller. This phenomenon, although its economic losses are smaller, suffers from serious political and indirect economical damages, because it creates a perception of lack of transparency in the system, for that reason the suppliers reduce their participation, decreasing the competition and generating inefficient prices.

Collusion is a serious distortion in any procurement system, because it does not allow competition to get efficient prices. The higher the prices, the more the expenditure the government has to do. The competition in this market generates savings with respect to the situation in which the agents do not have to compete directly, as the standard purchasing processes of an isolated unit without purchasing power. The illicit associations get extra resources from the government, increasing the public expenditure; they also contribute to the inflation, and destroy the confidence in the economy undermining the entire market economy system.

2.1. Market description and some field rules

Market description and some field rules

During 2007 the quantity of purchase orders was 1.5 Million, totaling an amount of USD 4, 458 Million. The number of public auctions was 450,023. The following tables give details of some relevant values.

The following statistics will describe partially the competitiveness of the Chilean procurement market.

Table 1: Purchase Orders by buyer region and supplier size, year 2007.

Region	Micro	Small	Medium	Big	Total
Antofagasta	7,462	9,188	6,029	15,223	37,902
Araucanía	19,359	19,729	11,035	29,428	79,550
Arica y Parinacota	2,106	3,091	1,856	6,222	13,275
Atacama	4,625	5,091	4,450	11,629	25,796
Aysén	3,463	4,690	2,304	5,943	16,401
Bío-Bío	35,853	42,665	23,003	60,590	162,111
Coquimbo	8,690	9,429	7,304	15,363	40,786
Lib. Gral. Bdo. O'Higgins	10,576	12,322	5,488	16,825	45,211
Los Lagos	17,733	20,456	9,527	25,137	72,853
Los Ríos	9,588	9,878	4,248	17,338	41,052
Magallanes y Antártica	6,415	6,606	4,523	12,658	30,202
Maule	17,324	17,178	8,909	27,377	70,787
Metropolitana	114,424	148,274	96,789	312,100	671,587
Tarapacá	3,927	3,397	1,903	7,437	16,663
Valparaíso	28,204	38,054	25,071	75,551	166,880
Total	289,747	350,047	212,441	638,820	1,491,054

Table 2: Desert auctions as percentage of public auctions total

Region	Total	Desert	Desert %
Arica y Parinacota	9,159	1,637	17.9%
Tarapacá	14,932	2,886	19.3%
Antofagasta	12,211	2,295	18.8%
Atacama	12,791	1,780	13.9%
Coquimbo	17,563	3,182	18.1%
Valparaíso	46,024	5,933	12.9%
Metropolitana	138,756	19,940	14.4%
Lib. Gral. Bdo. O'Higgins	16,980	2,336	13.8%
Maule	28,732	4,194	14.6%
Bío-Bío	61,745	8,505	13.8%
Araucanía	28,181	3,900	13.8%
Los Ríos	12,845	1,516	11.8%
Los Lagos	27,179	3,621	13.3%
Aysén	8,459	1,265	14.9%
Magallanes y Antártica	14,467	2,182	15.1%
Total	450,023	65,172	14.5%

Table 3: Percentage of awarded auctions with few offers

Region	% < 3 Bids
Arica y Parinacota	40.60%
Tarapacá	39.26%
Antofagasta	41.25%
Atacama	37.93%
Coquimbo	39.90%
Valparaíso	31.17%
Metropolitana	30.18%
Lib. Gral. Bdo. O'Higgins	30.67%
Maule	31.04%
Bío-Bío	30.60%
Araucanía	34.58%
Los Ríos	31.01%
Los Lagos	37.14%
Aysén	48.54%
Magallanes y Antártica	35.28%
Total	32.67%

2.2. Collusion theoretical framework

In this section we briefly describe the basic economic theory behind the collusion phenomenon giving some rationale to the empiric part of this work. We already know that the processes we are modeling are defined as *auctions*. Therefore, the tools we are going to use are related to auction and game theory.

By the application of standard game theory analysis, collusion agreement is a sub-perfect equilibrium in the case of one shot games, but it is not clearly defined in the case of repeated games (the most realistic case). However, it can be Nash equilibrium in any game specification, depending on the assumptions. In this sense, the game should be solved in the dynamic way.

The solution of this problem is quite intuitive, the profits from collusion should be greater than the punishment in case of betray the agreement. It is easy to follow from this analysis that the more the bids, the better the prices a centralized purchasing agency can obtain, because as the number of bids (bidders in this case) increases, the incentives to collude decrease. However, the assumptions of this analysis are very strong and it does not imply absence of collusion in real cases, although they provide the main theoretical evidence of our study.

On the other hand, collusion is an equilibrium which is very difficult to predict (Bajari & Summers, 2002) or even more difficult to detect, moreover, in certain cases is dynamic, but sometimes very stable. The only thing one can do observing the data is to give possibilities of collusion (as in Porter & Zona, 1992) , based on abnormal patterns of behavior of bidders and bids. Nevertheless, this procedure does not really assure collusion in particular transactions. To have collusion, there is the need of a judge to revise the law and determine it based on proofs and evidence.

Given the ideas of this section, we are going to construct a set of variables representing possibilities of collusion equilibrium, based on abnormal behavior of bidders and bids, where there is a coincidence between theory and practice.

That is, we analyze events with a non competitive component, with abnormally high or dummy prices, repeated winner, extremely lucky newcomers.

The theoretical context for this paper is oligopolistic competition in the case of collusion within suppliers (O-O) and non competitive behavior in the case of O-D collusion. In both cases there is an abnormal, non-competitive and illicit profit to be shared between the players which are inversely proportional to the number of players (Shapiro, 1989).

The amount of the illegal profit can be determined from the aggregate data, comparing the estimated price with the awarded figure, however, to do it imply a titanic work, if we consider that the difference contains elements which are not necessarily related to collusion. However, it has been demonstrated that the effects on (O-O) subjected auctions are tremendous (Klemperer, 2006) in terms of money amount. On the other hand, the effects on (O-D) subjected auctions are lower, but no less important, because the image of transparency and credibility of the system is linked with this irregularities, the more the irregularities, the less transparency is perceived; therefore as transparency increases the intention to participate, it constitutes a very important component for competition, hence to get efficient prices.

Therefore, in both cases of collusion, to get the impact of intrinsic values of the auctions on collusion, the first thing to do is to establish what the conditions which facilitate collusion are (as in Hendricks & Porter, 1989). Once we have the proxy variables, we test the conditions, obtaining the significance of each determinant in the collusion dimension we analyze.

2.3. Collusion proxies

As we described before, we are going to model collusion with proxies related to the possibility of collusion. As we reviewed in the literature (Porter & Zona 1992; Hendricks & Porter, 1989), some of the most common detectable anomalies are: awarded at first offer, repeated winner, excessive dummy offers, and excessively high awarded prices.

The first of those concepts is quite clear, it is a very singular fact that one newly comer supplier wins the first auction she bids; there are serious doubts about the process, although it is only a possibility of collusion, strong, but still a possibility.

The second concept is direct, it is strange that the same supplier is awarded periodically; it definitely could mean collusion between the demander and supplier. Although it does not necessary mean bad intentions, it could mean that one demander got stacked with one favorite supplier, because he trust him without checking the competition information.

The third manifestation is subtler than the previous ones, although no less important. In a process with a lot of bids out of the vicinity of the awarded price, the possibility of the suppliers making arrangements to get an expensive price and split the pie increases dramatically.

The fourth symptom of collusion is very direct but not easy to detect. It uses the estimated price the purchaser establish to compare it to the awarded price. If the difference is abnormally large, the collusion (O-O or O-D) is evident. However, we cannot clean the processes that have a non precise evaluation because of bad management, not necessarily bad intentions.

2.4. Determinants of collusion

Following the literature, the qualitative and some quantitative evidence in public procurement collusion we describe a priory determinants of collusion. That is, some sensitive variables that can affect the possibility of collusion in procurement auction process.

We have constructed a database containing all the relevant available information to determine the collusion in procurement auctions. In our modeling, the atomic data is the auction which has certain attributes described as follows.

We use the *subcontracting* possibility an auction has, as a dummy, given the fact that this degree of freedom can affect the incentives to compete fairly. A second variable is the *publication date* (logs) allows us to control for time trends and also gives us the idea whether the collusion is decreasing or augmenting through time. A third variable is *number of bids*, used to see in what sense the competition affects the possibilities of collusion. A fourth and fifth variables are the *number of awarded suppliers* and the *multi-awarded* category to control for the combinatorial effect in auction competition. A sixth variable is the *auction total amount*, which controls for the incentives taking in account the size of the pie. A seventh variable is the *enterprise size* in terms of amount of sales; this would determine which business group affects more the possibilities of collusion. A eighth variable to consider is the number of *decision days* of an auction from published to awarded, to see if more time generates more competitive environment. We also use a ninth variable of *excess of bids*, which is equal to one if the *number of bids* is greater than eight, this is in order to control for non linearities in the competition process. An tenth variable we used is *number of purchase units* of buyer institution, the rationale here is that the more the purchasing units, the less independent the purchase unit dedicated to make the acquisition, because it has to consult or be ruled by a centralized responsible institution. An eleventh set of variables are *geographic region dummies* to control for region purchasing concentration. A twelfth set of variables is the *size of auction* in terms of the money amount involved; to control for size incentives effects. Finally, we used the *product or service classification* from the UN codes of level one; this is to see which business line affects more the possibilities of collusion due to the intrinsic characteristics of the markets.

3. Empirics

The methodology of this research consists in cross section OLS regressions and binary probability regression analysis. This methodology will be able to explain causal effects related to collusion. We are going to look for the determinants of *possible* collusion describing the explanations for behavioral patterns. This approach is a very simple one; however it gives extremely powerful insights.

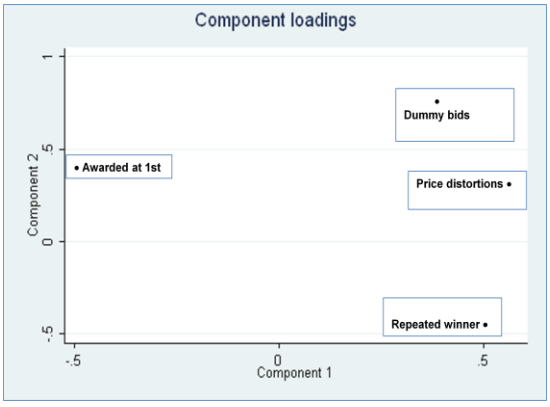
Clearly the concept of collusion within suppliers or between demand and supply is undistinguishable in most of the cases, because is very difficult to extract from the data the motivations to incur in this illicit behavior.

We are going to organize this study into sets of regressions with indicatives of collusion. The first one contains regressions considering percentage of dummy bids being a sign of collusion. The second one considers the processes awarded to a supplier whose first unique offer won at the first attempt. The third one considers the processes that were awarded systematically to the same supplier. The fourth one includes regressions that measure collusion as a difference between the estimated and the awarded prices.

3.1. Discussion of indistinguishableness in terms of data analysis

Principal component analysis and interpretation[2]

Figure 1: Principal component scores collusion



[2] With the first principal component, we explain 31% of the variance.
Including first and second principal components, we explain 56% of the variance.

The creation of proxy collusion variables is subject to the indistinguishableness of the type of phenomenon. In some cases the collusion within suppliers or between supplier and demander could be simultaneous; therefore the proxy would be analyzing both phenomena at the same time.

However, given the graphic analysis represented in Figure 1, the first component could be interpreted as collusion between supplier and purchaser (O-D). On the other hand the second component is closer to variables which are associated to collusion between suppliers. This representation gives us the idea of group the collusion manifestation variables into two big groups (principal components) and obtain further results. Therefore we added two final columns containing those dependent variables regressions.

3.2. Data description:

In this section we describe the aggregate numbers we analyze in this paper. Principally we illustrate with few tables the information of the procurement market which is related to collusion. The aggregate groups are productive sector, region, enterprise size and the possibility of subcontracting.

Table 4: Collusion proxies by enterprise size.

Enterprise size	Dummy bids	Difference adj/eval price	New Prov awarded at 1st	Excessive difference adj/eval price (cases)
BIG	43,1%	15,9%	0,3%	2,0%
	175,3%	21,7%	5,3%	14,0%
MEDIUM	39,2%	15,0%	1,5%	1,7%
	140,9%	20,9%	12,1%	13,1%
MICRO	35,4%	6,6%	10,6%	1,2%
	119,3%	15,7%	30,8%	10,8%
SMALL	40,4%	12,0%	2,4%	1,8%
	131,0%	20%	15%	13%
Total	39,4%	10,7%	4,3%	1,6%
	1,4%	19,0%	20,3%	12,6%

(*) Mean first row, sd second row, all data is percentage of the total.

Table 5: Collusion proxies by geographic region.

Region	Dummy bids	Difference adj/eval price	New Prov awarded at 1st	Excessive difference adj/eval price (cases)
Antofagasta	30,8%	9,8%	5,2%	0,9%
	119,4%	18,9%	22,2%	9,5%
Araucanía	27,8%	14,2%	3,8%	3,0%
	117,6%	21,9%	19,1%	17,1%
Arica y Parinacota	27,7%	10,6%	4,0%	2,4%
	83,0%	18,7%	19,6%	15,4%
Atacama	38,5%	11,8%	4,2%	2,1%
	128,4%	20,3%	20,1%	14,3%
Aysén	26,4%	11,0%	5,5%	1,7%
	83,2%	20,5%	22,8%	13,1%
Bío-Bío	31,8%	12,0%	3,5%	1,6%
	111,2%	20,1%	18,3%	12,5%
Coquimbo	28,3%	4,9%	5,7%	0,5%
	128,1%	12,9%	23,1%	6,8%
Lib. Gral. Bdo. O'H	37,2%	6,7%	4,7%	0,6%
	115,8%	13,4%	21,2%	8,0%
Los Lagos	33,9%	8,7%	5,4%	1,6%
	120,7%	18,0%	22,5%	12,6%
Los Ríos	28,6%	7,3%	4,4%	0,3%
	89,4%	15,0%	20,5%	5,6%
Magallanes y Antárt	31,8%	7,8%	4,2%	1,0%
	105,5%	13,5%	20,1%	10,1%
Maule	27,4%	8,2%	4,2%	1,2%
	94,3%	16,8%	20,1%	10,9%
Metropolitana	65,1%	11,4%	2,6%	1,7%
	245,6%	19,4%	15,8%	13,0%
Tarapacá	33,4%	15,4%	3,9%	3,3%
	100,3%	22,4%	19,3%	17,9%
Valparaíso	34,5%	9,2%	3,8%	1,2%
	140,9%	17,2%	19,0%	10,7%
Total	43,5%	10,7%	3,7%	1,6%
	173,8%	19,0%	18,8%	12,6%

(*) Mean first row, sd second row, all data is percentage of the total.

Table 6: Collusion proxies by possibility of subcontracting.

Possibility of subcontracting	Dummy bids	Difference adj/eval price	New Prov awarded at 1st	Excessive difference adj/eval price (cases)
No	46%	11%	4%	2%
	183%	19%	19%	13%
Yes	30%	10%	4%	1%
	120%	18%	19%	12%
Total	44%	11%	4%	2%
	174%	19%	19%	13%

(*) Mean first row, sd second row, all data is percentage of the total.

Table 7: Collusion proxies by product description.

Enterprise size	Dummy bids	Difference adj/eval price	New Prov awarded at 1st	Excessive difference adj/eval price (cases)
Food beverage	16%	25%	3%	7%
	74%	27%	17%	26%
Fuel lubricant	17%	12%	2%	3%
	69%	21%	13%	16%
Manufacturing comp & supp	25%	11%	1%	0%
	62%	15%	10%	0%
Electronic comp & supp	38%	20%	2%	3%
	90%	19%	12%	16%
Construction Manuf comp & supp	27%	22%	3%	2%
	77%	24%	17%	16%
Education & training services	25%	1%	12%	0%
	100%	6%	33%	0%
Printing, Audio, Visual eq & supp	32%	13%	1%	1%
	93%	22%	9%	11%
Office acc & supp	99%	21%	1%	3%
	349%	24%	7%	16%
Medical eq, acc & supp	71%	23%	1%	2%
	198%	21%	10%	12%
Laboratory eq	60%	19%	1%	2%
	180%	22%	9%	14%
Public defense, safety eq & supp	58%	24%	2%	3%
	143%	23%	13%	16%
Cleaning eq & supp	76%	16%	1%	1%
	189%	22%	9%	8%
Sports eq, supp & acc	53%	18%	2%	2%
	124%	23%	15%	14%
Tools & gral mach	40%	23%	5%	6%
	122%	24%	21%	23%
Musical instr, games & educ eq	35%	12%	2%	1%
	96%	21%	13%	9%
Mining, drilling mach & acc	19%	9%	6%	1%
	78%	18%	24%	12%
Industrial process mach & acc	30%	22%	4%	2%
	76%	20%	20%	13%
Farm, fish, forestry mach & acc	19%	8%	6%	0%
	52%	13%	23%	0%
Construction, building mach & acc	18%	26%	3%	3%
	53%	25%	18%	16%
Power gen, distr, mach & acc	52%	22%	3%	3%
	130%	23%	17%	16%
Mat handling, storage, mach acc & supp	41%	23%	3%	2%
	106%	22%	17%	13%
Service Industr mach, eq & supp	59%	19%	3%	4%
	124%	26%	16%	19%
Live plant/animal mat, acc & supp	34%	12%	8%	1%
	75%	18%	27%	10%
Paper mat & products	56%	22%	1%	4%
	121%	27%	10%	20%
Mineral & textile, plant & animal mat	26%	14%	4%	1%
	83%	15%	19%	7%
Pharmaceutical products	104%	20%	0%	2%
	374%	21%	4%	15%
Furniture and Furnishings	55%	17%	2%	1%
	155%	20%	14%	12%
Domestic appliances & acc	72%	21%	1%	2%
	152%	23%	10%	14%
Organizations & clubs	116%	1%	12%	0%
	11%	5%	32%	0%
Politics and Civic Affairs serv	13%	1%	8%	0%
	87%	7%	28%	5%
Published Products	77%	18%	2%	3%
	199%	26%	13%	17%
Jewlery prod	7%	.	7%	0%
	27%	.	27%	0%
Chemical prod	24%	14%	1%	1%
	72%	23%	8%	12%
Rubber mat	20%	22%	5%	5%
	45%	21%	23%	23%
Baggage % pers care prod	46%	19%	1%	2%
	133%	23%	11%	13%
Healthcare Services	18%	3%	9%	0%
	114%	10%	28%	6%
Farm, fish, forestry contract serv	26%	2%	7%	0%
	193%	8%	25%	4%
Engineering & research serv	76%	9%	3%	1%
	156%	20%	17%	10%
Public utilities & public sector serv	31%	10%	1%	1%
	91%	16%	10%	11%
Construction maintenance serv	7%	0%	10%	0%
	45%	4%	30%	0%
Personal and Domestic serv	20%	9%	5%	1%
	86%	17%	23%	10%
Public defense, safety services	16%	6%	4%	0%
	52%	13%	20%	0%
Industrial Cleaning serv	24%	22%	4%	2%
	78%	23%	20%	15%
Mining and oil and gas serv	30%	12%	6%	0%
	91%	14%	23%	0%
Industrial prod manuf serv	37%	10%	7%	1%
	93%	17%	25%	12%
Transport, storage & mail serv	14%	0%	13%	0%
	40%	0%	33%	0%
Travel, food, lodging & entert serv	20%	14%	5%	1%
	73%	17%	22%	9%
Editorial, graphic & fine art design	25%	9%	6%	2%
	81%	18%	23%	15%
Financial & insurance serv	30%	8%	6%	2%
	96%	18%	24%	13%
Environmental serv	20%	15%	10%	1%
	69%	26%	30%	11%
Business, manag, proff & admin serv	23%	3%	10%	1%
	95%	10%	30%	7%
Distrib, condit systems, eq & comp	37%	20%	3%	3%
	121%	22%	16%	18%
Electric systems, light acc & supp	39%	24%	2%	4%
	92%	27%	12%	19%
IT broadcast & telecomunication	47%	18%	1%	1%
	142%	20%	11%	11%
Vehicles, acc, comp	29%	10%	2%	1%
	114%	18%	14%	8%
Total	44%	11%	4%	2%
	2%	19%	19%	13%

(*) Mean first row, sd second row, all data is percentage of the total.

3.1. Collusion regressions

The model

We run seven set of regressions of ($k = 1,2, \dots ,7$) core dependent variables

$$Coll_i^k = \propto^k + \beta^{jk} X_i^j + \epsilon_i^k$$

Where the *dependent variable* represents collusion through:

$Coll_i^1$: Awarded at First offer (0,1)

$Coll_i^2$: Repeated winner (number of awarded auctions in the same purchase unit)

$Coll_i^3$: Dummy bids (number of bids greater or equal to 2 times the awarded price)

$Coll_i^4$: Price distortions, excessively high awarded prices (as percentage estimated price)

$Coll_i^5$: Price distortions, excessively high awarded prices (when $Coll_i^4$) is greater or equal to 50%.

$Coll_i^6$: First Principal component[3]. (O-D).

$Coll_i^7$: Second Principal component. (O-O).

The *independent variables* are described as follows ($j = 1, . . ,80$):

X^1 : Subcontracting (0,1)

X^2 : Publication date (logs)

X^3 : Number of bids

X^4 : Number of awarded suppliers

X^5 : Multi-awarded (0,1)

X^6 : Auction total amount

[3] Only in the case when we include the product and services classification. The first principal component would be related to collusion between supplier and purchaser (O-D), while the second one would be collusion between providers (O-O). However, this distinction is not totally clear, as we argue in most of the paper. The interpretation will be funded afterwards.

X^7 : Small enterprise (0,1)

X^8 : Medium enterprise (0,1)

X^9 : Big enterprise (0,1)

X^{10} : Decision days

X^{11} : Excess of bids (1 if Number of bids >= 9, 0 else)

X^{12} : Number of purchase units of buyer institution (centralization)

X^{13-26} : Geographic Region dummies (0,1)

X^{27} : Size of auction (1 if in 100-1000 UTM[4] range)

X^{28} : Size of auction (1 if >1000 UTM)

X^{30-84} : Product or service classification (55 level 1 UN)

We run a set of reduced form[5] regressions depending on the characteristics of the dependent variable. If the variable is not binary, we run just OLS regressions, for all the available data. On the contrary, if the variable is binary, we run probit and logit in order to compare how both models fit on the data.

This kind of methodology is in line with the recent literature[6]. Most of the models are quite new and they look for subtle patterns in the data. Our case is a similar one; however, our definition of collusion is a bit different. We define dependent variables as possibilities of collusion, acknowledging the fact that most of the time collusion is an unobservable or it has an important unobserved component. Another difference is the subject of our analysis, instead of working

[4] Tributary monthly unit, it is worth approximately USD $57 (Dec. 2008).

[5] We could have estimated a structural model; it would answer questions related to the optimality of reserve prices or the mark ups realized by bidders. We leave this kind of estimation for future research, because of two main reasons: firstly, our analysis is focused on the collusion part exclusively; secondly, the cross section nature of our data and the complexity of the data generation environment suggest us to avoid a complex structural approach.

[6] As in Patrick Bajari and Garret Summers. "Detecting Collusion in procurement auctions". 2002., among others.

with the bids as individual atomic data; we use the auction process and its characteristics. That is the reason why we use standard OLS, Probit and Logit in cross section data, nonetheless we control for time trend with the independent variable *publication date*. The following table resumes the first set of regressions.

Table 8: Collusion regressions, first estimation

	(1) at1st_probit	(2) at1st_logit	(3) repeated_ols	(4) dummybids_ols	(5) diff_ols	(6) ediff_prob	(7) ediff_log	(8) O-O component	(9) O-D component
Subcontracting (0,1)	0.001	0.063	1.790	0.010	-0.012	-0.002	-0.170	0.054	-0.037
	(0.86)	(1.10)	(2.95)***	(0.59)	(1.40)	(0.96)	(0.95)	(1.41)	(1.01)
Publication date (log number)	-0.224	-11.970	52.216	2.859	-0.638	-0.156	-11.714	-0.489	1.831
	(7.36)***	(7.48)***	(3.23)***	(6.64)***	(2.55)**	(2.44)**	(2.36)**	(0.45)	(1.74)*
Number of Bids	-0.001	-0.077	-0.426	0.032	0.001	-0.000	-0.011	0.015	0.030
	(6.78)***	(7.12)***	(7.14)***	(19.79)***	(0.51)	(0.51)	(0.45)	(2.41)**	(5.08)***
Number of awarded suppliers	0.001	0.066	1.341	-0.027	-0.001	-0.003	-0.230	-0.049	-0.081
	(3.64)***	(4.20)***	(10.92)***	(8.15)***	(0.04)	(0.69)	(0.68)	(2.08)**	(3.61)***
Multi-awarded (0,1)	-0.004	-0.215	10.630	-0.299				0.297	-0.197
	(3.27)***	(2.94)***	(16.30)***	(17.07)***				(4.14)***	(2.86)***
Auction total amount (logs)	0.001	0.068	-0.132	-0.155	0.000	0.004	0.306	-0.033	-0.106
	(4.42)***	(3.85)***	(0.81)	(35.17)***	(0.06)	(4.59)***	(4.63)***	(2.17)**	(7.26)***
Small enterprise (0,1)	-0.015	-0.791	1.941	-0.017	0.023	0.003	0.220	0.189	-0.036
	(28.78)***	(27.04)***	(6.63)***	(2.18)**	(5.59)***	(2.41)**	(2.55)**	(10.04)***	(2.01)**
Medium enterprise (0,1)	-0.012	-0.694	2.336	-0.021	0.023	0.001	0.096	0.163	-0.034
	(23.28)***	(20.75)***	(9.61)***	(3.20)***	(5.88)***	(1.15)	(1.26)	(9.31)***	(2.00)**
Big enterprise (0,1)	-0.015	-0.943	10.196	-0.020	0.018	0.001	0.119	0.199	-0.078
	(27.80)***	(22.82)***	(66.03)***	(4.73)***	(7.32)***	(2.29)**	(2.49)**	(18.13)***	(7.40)***
Decision days	0.000	0.003	-0.567	0.006	0.001	0.000	0.011	0.005	0.006
	(0.69)	(0.53)	(11.96)***	(4.77)***	(1.14)	(0.76)	(0.92)	(1.74)*	(1.97)**
Excess of bids (1 if Number of offers > = 9)	-0.002	-0.040	2.951	0.411	0.004	-0.000	-0.042	0.005	0.049
	(1.08)	(0.35)	(3.70)***	(19.25)***	(0.22)	(0.12)	(0.14)	(0.07)	(0.69)
Number of Purshase units of Institution	-0.000	-0.002	-0.070	-0.001	0.000	0.000	0.003	0.001	-0.000
	(4.15)***	(4.57)***	(18.13)***	(6.86)***	(6.53)***	(2.74)***	(2.84)***	(3.41)***	(0.27)
Tarapacá (0,1)	0.001	0.064	6.417	0.002	-0.028	-0.007	-0.757	-0.025	0.220
	(0.30)	(0.26)	(2.83)***	(0.04)	(0.91)	(1.46)	(1.47)	(0.18)	(1.65)*
Antofagasta (0,1)	0.013	0.528	2.430	-0.046	-0.048	-0.011	-1.559	-0.244	0.017
	(2.29)**	(2.31)**	(1.09)	(0.76)	(1.64)	(2.83)***	(2.75)***	(1.79)*	(0.13)
Atacama (0,1)	0.004	0.236	1.633	0.019	-0.062	-0.011	-1.566	-0.212	0.021
	(0.76)	(0.97)	(0.70)	(0.31)	(2.01)**	(2.46)**	(2.31)**	(1.51)	(0.15)
Coquimbo (0,1)	0.019	0.706	-0.292	-0.013	-0.089	-0.011	-1.821	-0.369	0.078
	(3.16)***	(3.10)***	(0.12)	(0.21)	(2.78)***	(2.47)**	(2.30)**	(2.50)**	(0.55)
Valparaiso (0,1)	0.005	0.271	11.101	-0.002	-0.052	-0.011	-1.160	-0.061	-0.031
	(1.19)	(1.28)	(5.64)***	(0.04)	(2.05)**	(2.87)***	(2.84)***	(0.53)	(0.28)
Metropolitana (0,1)	0.003	0.183	18.626	0.158	-0.042	-0.011	-0.905	-0.103	-0.006
	(0.90)	(0.90)	(9.90)***	(3.13)***	(1.76)*	(2.42)**	(2.48)**	(0.94)	(0.05)
O´Higgins (0,1)	0.009	0.376	-2.408	0.013	-0.093	-0.012	-1.728	-0.198	0.157
	(1.82)*	(1.72)*	(1.13)	(0.24)	(3.39)***	(3.19)***	(3.04)***	(1.57)	(1.29)
Maule (0,1)	0.012	0.516	2.252	-0.135	-0.059	-0.010	-1.114	-0.150	-0.005
	(2.37)**	(2.36)**	(1.07)	(2.40)**	(2.13)**	(2.31)**	(2.23)**	(1.18)	(0.04)
Bio-Bio (0,1)	0.004	0.199	6.073	-0.079	-0.019	-0.009	-0.860	-0.115	-0.002
	(0.90)	(0.95)	(3.11)***	(1.51)	(0.74)	(2.25)**	(2.20)**	(0.99)	(0.02)
Araucania (0,1)	0.005	0.252	-0.034	-0.053	-0.002	-0.001	-0.036	-0.043	0.094
	(1.18)	(1.16)	(0.02)	(0.96)	(0.09)	(0.19)	(0.10)	(0.37)	(0.84)
Los Rios (0,1)	0.014	0.534	-6.610	-0.080	-0.084			-0.370	-0.039
	(2.26)**	(2.18)**	(2.63)***	(1.20)	(2.12)**			(1.99)**	(0.22)
Los Lagos (0,1)	0.014	0.559	-5.695	-0.007	-0.054	-0.009	-0.928	-0.117	0.155
	(2.74)***	(2.65)***	(2.80)***	(0.13)	(2.01)**	(2.14)**	(2.07)**	(0.95)	(1.32)
Magallanes (0,1)	0.009	0.385	0.871	0.006	-0.082	-0.010	-1.365	-0.232	-0.108
	(1.67)*	(1.58)	(0.37)	(0.09)	(2.53)**	(2.32)**	(2.23)**	(1.61)	(0.78)
Aysen (0,1)	0.013	0.552	-4.997	-0.080	-0.008	-0.007	-0.599	-0.181	0.005
	(2.40)**	(2.42)**	(2.15)**	(1.28)	(0.26)	(1.39)	(1.27)	(1.35)	(0.04)
Size of Auction (1 if in 100-1000UTM)	0.003	0.139	-7.283	0.176	-0.039	-0.019	-1.342	-0.132	0.040
	(2.62)***	(2.25)**	(11.64)***	(10.48)***	(3.74)***	(6.36)***	(6.43)***	(2.77)***	(0.87)
Size of Auction (1 if >1000UTM)	0.002	0.105	-6.186	0.299	-0.039	-0.014	-2.104	-0.143	0.261
	(1.06)	(0.86)	(5.22)***	(9.41)***	(1.87)*	(5.04)***	(5.06)***	(1.49)	(2.83)***
Variation Coefficient (bids stdev/mean)	0.004	0.232	2.249	0.560	0.028	0.006	0.416	0.335	0.585
	(5.09)***	(5.13)***	(4.62)***	(42.95)***	(3.05)***	(2.91)***	(2.80)***	(8.25)***	(15.02)***
Constant		113.768	-499.674	-26.698	6.338		108.672	4.530	-17.168
		(7.29)***	(3.17)***	(6.36)***	(2.60)***		(2.25)**	(0.42)	(1.68)*
Observations	63586	63586	63195	63586	3261	15455	15455	3590	3590
R-squared			0.13	0.11	0.08			0.17	0.15

Absolute value of z statistics in parentheses

* significant at 10%; ** significant at 5%; *** significant at 1%

The first and second columns of this set of regressions contains a model where the pattern of collusion is related to the fact that *there are new suppliers that are awarded at the first opportunity they submit a bid*, the dependant variable is a binary one, we run probit and logit model for this set of regressions. The third column gives an estimate of collusion where there are *repeated winners,* the variable takes

the value of the number of awarded process to the same supplier in the specific purchase unit. The fourth column stands for *dummy bids,* here the variable takes the value of number of bids over 2 times the awarded price, only in the case of mono awarded processes. The fifth column represents the regression where the dependant variable is the *difference between the awarded and estimated price* as a percentage of the estimated price of the good or service. The sixth column measures collusion as the *excessive difference between the estimated and awarded price*, the variable takes the value of 1 if the difference percentage of the fifth column is greater than 50% over the estimated.

Most of the results are quite related to the economic intuition; however some of them require a second thought, principally because of the multivariate simultaneous effects.

Column results

The coefficients of the *first and second* columns (at1st probit and logit) imply that this kind of collusion phenomenon is decreasing through time. They also imply that the smaller enterprises are more likely to be associated to collusion between supplier and purchaser (O-D). Clearly and consistent with the literature, the more bids the auction receives the less likely to have collusion; however, the more the awarded suppliers, the more possibilities of collusion. This is due to the common fact that is easier to have hidden arrangements when the universe of suppliers associated to an auction is big, controlling by the other variables, because there are smaller probabilities to detect the illicit. The same argument works with the multi-award (combinatorial) scheme, if it can be multi-awarded, then the possibilities of collusion are smaller. Additionally the more predisposed regions to have this phenomenon are those located on remote geographic areas.

The third column examines the collusion materialization where the supplier is repeatedly awarded in the same purchase unit. This can be related to both types of collusion: between suppliers or between supplier and purchaser. However, given our previous principal components analysis this is probably more related to collusion (O-O). By no surprise, this variable is linked to the possibility to

subcontract the good or service; and the combinatorial or multi-awarded scheme. The effect is highly statistically and economically significant for both variables. This is explained mainly because the more suppliers awarded in a process makes easier to hide any irregularity[7], particularly being awarded repeatedly. This kind of collusion mostly affects the big enterprises. The variables inversely related to collusion in this case are the number of bids (which is not the same as the number of bidders) and the number of purchase units in the institution. The explanations of these facts are that the more bids, the better the competition and the more purchase units, the better the centralization of the purchase unit which has more controls to procure.

The fourth column is linked collusion between suppliers (O-O). The results are counterintuitive in some sense, but a second though clarifies the intuition. In this case the results are contrary to the three first columns, the value of the number of bids and awarded variables is the opposite and still significant. This is explained due to the fact that the more the bids, the more the probabilities to have dummy offers, because the span is greater. On the other hand the fewer the awarded suppliers makes easier to detect dummy offers, for that reason, sellers anticipate the action of the buyer, avoiding this behavior in this case.

The fifth, sixth and seventh column explain the differences between awarded and estimated prices by a percentage or a dummy variable, respectively. It is clear that the higher the difference, the more possibilities of collusion. The results are similar to those presented in the previous paragraph. However, the main differences lie on the effect of the number of purchase units, which has not a clear effect on the collusion possibilities. This is explained because the excessive awarding price phenomenon is occurring all over the territory, affecting even more to entities with extra purchases. Additionally, contrary to the fourth column, using the date variable we could infer that collusion is reducing its effect through time.

[7] Such as subcontracting the competition, hiding an illicit arrangement.

A remarkable fact is that the number of purchase units of an institution is treated as a proxy of independency from the central government or governmental institution with significant results. The more purchase units, the less independent is the institution. In this sense, it is quite impressive that this variable is highly statistically significant and negative related to the possibility of collusion in most of the cases. This could be related with the fact that the more *independent the institution*, the less enforcement can be done to assure transparency. In this case a special treatment has to be done with auctions published by municipalities or small counties. On the other hand this result is minimum or even positive, when considering the differences in price regressions (columns 5, 6 and 7). This could be explained because bigger centralized institutions, with many purchase units and expenditures are more exposed to suffer from O-O collusion in terms of price differences, clearly due to the fact that the bigger the institution, the greater the span of auction processes that can be opportunities to make extra money for any kind of enterprise, especially big ones.

Another notable fact is that a subset of collusion problems (columns 1, 2 and 4) is more probable in smaller firms, but at the same time in medium or big size auctions. On the contrary, auctions of smaller size with big enterprises on them are more probable to suffer from other kinds of collusion, given by columns 3, 5, 6 and 7. That is, when the *abnormal price* or *repetition of the winner* are source of illicit earnings, medium and big enterprises anticipate that the regulator´s revision is harder when the processes are bigger in terms of money involved.

Finally, the geographic effect is unambiguous; the auction is more likely to be affected by collusion (O-D) when the region is more distant to the center. On the contrary, collusion (O-O) is more feasible in the center of the country (near the development poles). The effect is mixed when the collusion (O-O) generates differences in price.

3.2. Alternative analysis and specifications

Including heading (business line) variable

Table 9: Collusion regressions, second estimation

	(1) ala1a_probit	(2) ala1a_logit	(3) repetido_ols	(4) dummybids_ols	(5) diff_ols	(6) ediff_prob	(7) ediff_log	(8) O-O component	(9) O-D component
Subcontracting (0,1)	0.000	0.036	-0.323	0.002	-0.006	-0.001	-0.117	-0.020	0.002
	(0.47)	(0.78)	(0.68)	(0.17)	(1.12)	(0.87)	(0.74)	(0.74)	(0.07)
Publication date (log number)	-0.216	-10.285	52.648	2.117	-0.502	-0.124	-10.924	-1.159	0.746
	(7.60)***	(7.82)***	(4.10)***	(6.18)***	(2.93)***	(2.69)***	(2.50)**	(1.44)	(1.06)
Number of Bids	-0.001	-0.072	-0.488	0.042	0.002	-0.000	-0.016	0.027	0.047
	(7.69)***	(7.87)***	(9.48)***	(30.18)***	(2.04)**	(0.64)	(0.67)	(5.57)***	(11.25)***
Number of awarded suppliers	0.001	0.074	1.013	-0.020	-0.009	-0.004	-0.361	-0.063	-0.059
	(4.49)***	(5.03)***	(9.54)***	(6.85)***	(0.71)	(1.13)	(1.29)	(3.02)***	(3.23)***
Multi-awarded (0,1)	-0.001	-0.010	3.244	-0.102				0.204	0.008
	(0.49)	(0.14)	(5.71)***	(6.70)***				(3.20)***	(0.14)
Auction total amount (logs)	0.000	0.010	-0.323	-0.119	0.008	0.004	0.385	0.006	-0.036
	(1.35)	(0.77)	(2.65)***	(36.30)***	(4.76)***	(6.32)***	(6.48)***	(0.74)	(5.08)***
Small enterprise (0,1)	-0.014	-0.656	0.611	-0.012	0.009	0.001	0.119	0.131	-0.043
	(28.77)***	(27.34)***	(2.61)***	(1.99)**	(3.30)***	(1.42)	(1.61)	(9.76)***	(3.69)***
Medium enterprise (0,1)	-0.011	-0.563	0.532	-0.016	0.009	0.000	0.017	0.102	-0.041
	(22.18)***	(20.12)***	(2.64)***	(2.88)***	(3.42)***	(0.11)	(0.24)	(7.90)***	(3.56)***
Big enterprise (0,1)	-0.015	-0.782	6.468	-0.015	0.004	0.000	0.038	0.109	-0.063
	(27.24)***	(23.05)***	(47.12)***	(4.15)***	(1.98)**	(0.63)	(0.84)	(11.73)***	(7.69)***
Decision days	-0.000	-0.002	-0.425	0.003	0.001	0.000	0.010	0.006	0.003
	(0.70)	(0.59)	(11.11)***	(3.35)***	(1.62)	(0.83)	(0.93)	(2.46)**	(1.45)
Excess of bids (1 if Number of offers > = 9)	0.002	0.124	0.570	0.432	-0.006	-0.000	-0.006	-0.065	-0.032
	(0.91)	(1.13)	(0.80)	(22.67)***	(0.39)	(0.11)	(0.02)	(1.03)	(0.58)
Number of Purshase units of Institution	-0.000	-0.001	-0.043	-0.001	0.000	0.000	0.002	0.000	-0.000
	(2.50)**	(2.88)***	(13.50)***	(6.03)***	(2.48)**	(2.15)**	(2.27)**	(0.43)	(0.38)
Tarapacá (0,1)	0.003	0.132	5.508	-0.001	-0.029	-0.004	-0.325	-0.066	0.127
	(0.63)	(0.72)	(3.11)***	(0.03)	(1.38)	(0.86)	(0.74)	(0.66)	(1.44)
Antofagasta (0,1)	0.013	0.492	4.347	-0.030	-0.035	-0.009	-1.618	-0.274	0.073
	(2.72)***	(2.86)***	(2.51)**	(0.65)	(1.77)*	(3.21)***	(3.07)***	(2.84)***	(0.86)
Atacama (0,1)	0.005	0.237	1.076	0.004	-0.037	-0.007	-1.024	-0.219	0.086
	(1.07)	(1.29)	(0.60)	(0.08)	(1.77)*	(2.00)**	(2.01)**	(2.17)**	(0.97)
Coquimbo (0,1)	0.011	0.423	-0.108	-0.018	-0.049	-0.009	-1.687	-0.273	0.052
	(2.34)**	(2.44)**	(0.06)	(0.37)	(2.36)**	(2.72)***	(2.52)**	(2.69)***	(0.59)
Valparaiso (0,1)	0.005	0.264	9.111	-0.008	-0.036	-0.008	-1.015	-0.087	-0.012
	(1.43)	(1.65)*	(5.91)***	(0.20)	(2.09)**	(2.69)***	(2.63)***	(1.02)	(0.16)
Metropolitana (0,1)	0.003	0.157	14.380	0.136	-0.022	-0.006	-0.553	-0.117	0.028
	(0.86)	(1.02)	(9.78)***	(3.43)***	(1.33)	(1.68)*	(1.60)	(1.45)	(0.40)
O´Higgins (0,1)	0.003	0.154	-1.342	0.003	-0.050	-0.009	-1.486	-0.111	0.146
	(0.83)	(0.92)	(0.81)	(0.08)	(2.68)***	(3.17)***	(2.93)***	(1.22)	(1.82)*
Maule (0,1)	0.007	0.310	-0.587	-0.125	-0.033	-0.006	-0.807	-0.151	0.029
	(1.62)	(1.85)*	(0.36)	(2.82)***	(1.74)*	(1.94)*	(1.81)*	(1.65)*	(0.37)
Bio-Bio (0,1)	0.002	0.130	3.791	-0.066	-0.020	-0.007	-0.716	-0.149	0.017
	(0.55)	(0.82)	(2.48)**	(1.61)	(1.18)	(2.12)**	(1.94)*	(1.77)*	(0.23)
Araucania (0,1)	0.002	0.140	0.826	-0.040	-0.004	-0.000	0.027	-0.094	0.078
	(0.67)	(0.85)	(0.52)	(0.92)	(0.22)	(0.05)	(0.08)	(1.10)	(1.05)
Los Rios (0,1)	0.009	0.364	-5.652	-0.045	-0.061	-0.009	-2.063	-0.362	0.084
	(1.84)*	(1.88)*	(2.86)***	(0.86)	(2.27)**	(2.20)**	(1.95)*	(2.71)***	(0.72)
Los Lagos (0,1)	0.008	0.344	-3.137	-0.003	-0.042	-0.007	-0.778	-0.185	0.153
	(2.12)**	(2.15)**	(1.98)**	(0.06)	(2.32)**	(2.07)**	(1.88)*	(2.11)**	(1.98)**
Magallanes (0,1)	0.008	0.340	2.127	0.016	-0.070	-0.009	-1.606	-0.255	-0.018
	(1.77)*	(1.83)*	(1.16)	(0.33)	(3.28)***	(2.83)***	(2.65)***	(2.47)**	(0.20)
Aysen (0,1)	0.009	0.388	-2.188	-0.069	-0.014	-0.004	-0.364	-0.227	0.055
	(2.03)**	(2.20)**	(1.20)	(1.40)	(0.71)	(1.00)	(0.85)	(2.38)**	(0.66)
Size of Auction (1 if in 100-1000UTM)	0.002	0.073	-7.126	0.127	-0.041	-0.019	-1.566	-0.122	-0.054
	(1.80)*	(1.53)	(14.84)***	(9.86)***	(6.87)***	(8.49)***	(8.62)***	(4.20)***	(2.10)**
Size of Auction (1 if >1000UTM)	0.002	0.085	-7.048	0.197	-0.060	-0.012	-2.422	-0.252	0.031
	(1.06)	(0.87)	(7.67)***	(7.99)***	(4.90)***	(6.59)***	(6.57)***	(4.17)***	(0.58)

cosupconstr	-0.002	-0.118	3.907	0.047	-0.013	-0.005	-0.674	-0.062	0.042
	(0.94)	(0.93)	(3.46)***	(1.56)	(0.72)	(2.06)**	(2.32)**	(0.72)	(0.55)
foreduc	0.037	0.970	-11.324	0.026	-0.197			-0.785	0.006
	(6.25)***	(6.29)***	(5.21)***	(0.45)	(9.86)***			(8.08)***	(0.07)
eqaccsupoffic	-0.012	-0.896	-8.770	0.107	0.006	-0.007	-1.244	0.053	0.490
	(3.96)***	(3.83)***	(6.08)***	(2.77)***	(0.21)	(2.26)**	(2.24)**	(0.41)	(4.28)***
eqaccsupmed	-0.014	-0.991	36.557	0.159	-0.027	-0.004	-0.459	0.133	-0.039
	(6.09)***	(5.85)***	(34.28)***	(5.55)***	(1.40)	(1.41)	(1.48)	(1.51)	(0.50)
labequip	-0.010	-0.726	14.953	0.159	-0.048	-0.006	-0.903	-0.091	0.002
	(2.91)***	(2.80)***	(10.27)***	(4.06)***	(1.89)*	(1.80)*	(1.91)*	(0.79)	(0.02)
eqsupdefsecur	-0.009	-0.553	-6.395	0.223	0.022	-0.004	-0.492	0.030	0.449
	(2.48)**	(2.32)**	(3.66)***	(4.76)***	(0.73)	(1.03)	(1.10)	(0.22)	(3.68)***
eqsupclean	-0.013	-1.128	-6.821	0.341	-0.061	-0.009	-1.796	-0.263	-0.025
	(2.86)***	(2.66)***	(3.06)***	(5.71)***	(1.54)	(1.90)*	(1.74)*	(1.37)	(0.15)
machaccmining	0.014	0.485	-8.139	0.101	-0.122	-0.007	-1.056	-0.665	0.189
	(2.00)**	(1.94)*	(2.61)***	(1.20)	(3.20)***	(1.06)	(1.01)	(3.52)***	(1.14)
machaccconstr	-0.001	-0.036	-1.287	0.105	0.044	-0.004	-0.385	0.020	0.144
	(0.25)	(0.16)	(0.60)	(1.81)*	(1.27)	(0.75)	(0.75)	(0.12)	(0.98)
machaccengen	0.001	0.055	-11.505	0.175	0.010	-0.003	-0.276	-0.099	0.196
	(0.11)	(0.20)	(4.67)***	(2.65)***	(0.27)	(0.48)	(0.49)	(0.57)	(1.30)
machaccmatsto	-0.001	-0.086	-9.005	0.234	-0.007	-0.008	-1.516	0.047	0.080
	(0.15)	(0.29)	(3.41)***	(3.32)***	(0.13)	(1.60)	(1.47)	(0.22)	(0.42)
macheqservind	-0.000	-0.049	-14.637	0.231	-0.039	-0.003	-0.366	-0.180	0.455
	(0.05)	(0.10)	(3.71)***	(2.19)**	(0.97)	(0.46)	(0.48)	(0.91)	(2.62)***
maccplantanim	0.023	0.743	-8.158	0.133	-0.086	-0.008	-1.643	-0.443	0.035
	(3.03)***	(3.20)***	(2.73)***	(1.66)*	(2.26)**	(1.66)*	(1.59)	(2.43)**	(0.22)
matprodpaper	-0.010	-0.774	-9.406	0.136	-0.016	0.000	-0.020	0.096	0.365
	(2.04)**	(2.08)**	(4.45)***	(2.39)**	(0.51)	(0.08)	(0.04)	(0.61)	(2.63)***
matminerplanim	-0.002	-0.048	9.378	0.152	-0.072	-0.009	-1.913	-0.241	-0.032
	(0.49)	(0.25)	(5.15)***	(3.12)***	(2.78)***	(2.76)***	(2.55)**	(1.91)*	(0.29)
pharmprod	-0.016	-1.829	44.074	0.175	-0.064	-0.007	-1.184	0.684	-0.556
	(4.18)***	(3.95)***	(34.31)***	(5.08)***	(2.76)***	(2.45)**	(2.48)**	(6.66)***	(6.16)***
furnit	-0.009	-0.580	-9.877	0.153	-0.058	-0.007	-1.004	-0.335	-0.023
	(2.69)***	(2.64)***	(5.97)***	(3.44)***	(2.28)**	(2.11)**	(2.13)**	(2.72)***	(0.22)
accfurnelectr	-0.012	-0.928	-14.346	0.155	-0.026	-0.006	-0.790	-0.158	0.154
	(2.93)***	(2.77)***	(7.71)***	(3.10)***	(0.97)	(1.57)	(1.55)	(1.22)	(1.35)
socorg	0.062	1.280	-3.467	0.035	-0.197			-0.819	0.036
	(3.32)***	(3.38)***	(0.50)	(0.19)	(4.81)***			(4.04)***	(0.21)
polsocconsult	0.027	0.815	-8.841	0.011	-0.191	-0.010	-3.011	-0.815	-0.021
	(5.56)***	(5.60)***	(4.86)***	(0.22)	(10.06)***	(3.27)***	(2.91)***	(8.87)***	(0.27)
prodpublicpre	-0.010	-0.687	-10.768	0.268	-0.007	-0.000	-0.013	-0.244	0.054
	(2.49)**	(2.37)**	(5.34)***	(4.97)***	(0.20)	(0.03)	(0.03)	(1.45)	(0.37)
healthfood	0.025	0.734	-6.291	0.042	-0.158	-0.009	-2.093	-0.757	0.072
	(5.76)***	(5.58)***	(3.73)***	(0.92)	(6.71)***	(2.20)**	(2.02)**	(6.79)***	(0.74)
fooddrinkser	-0.001	-0.116	2.642	0.118	-0.188	-0.011	-3.418	-0.500	-0.215
	(0.49)	(0.88)	(1.85)*	(3.08)***	(11.07)***	(5.11)***	(4.53)***	(6.14)***	(3.01)***
servagrfish	0.009	0.328	-6.611	0.133	-0.122	-0.009	-1.470	-0.594	0.026
	(2.87)***	(2.72)***	(5.32)***	(3.98)***	(6.80)***	(4.03)***	(4.08)***	(6.87)***	(0.34)
servconstr	-0.004	-0.223	-1.765	0.175	0.003	-0.005	-0.589	-0.010	0.027
	(1.88)*	(1.94)*	(1.60)	(5.92)***	(0.19)	(1.96)**	(2.13)**	(0.12)	(0.37)
servperscare	0.033	0.912	-11.659	-0.015	-0.055	-0.007	-1.169	-0.538	0.049
	(4.75)***	(4.92)***	(4.35)***	(0.20)	(1.33)	(1.05)	(1.13)	(2.61)***	(0.27)
servdefsecur	0.015	0.561	-9.838	0.137	-0.082			-0.247	0.062
	(2.42)**	(2.58)***	(3.59)***	(1.87)*	(1.59)			(0.96)	(0.28)
servindclean	0.013	0.481	-7.398	0.179	-0.106	-0.007	-0.904	-0.553	-0.018
	(3.34)***	(3.34)***	(4.24)***	(3.84)***	(3.55)***	(1.53)	(1.43)	(3.75)***	(0.14)
servperfminoil	0.050	1.074	-7.510	0.088	-0.200			-1.264	0.168
	(2.54)**	(2.42)**	(0.94)	(0.42)	(2.09)**			(2.64)***	(0.40)
servtravel	0.008	0.307	-8.452	0.075	-0.131	-0.006	-0.864	-0.462	0.125
	(2.08)**	(2.08)**	(5.13)***	(1.70)*	(5.57)***	(1.68)*	(1.69)*	(4.04)***	(1.24)
servenviron	0.029	0.851	-12.376	-0.057	-0.208			-0.906	-0.030
	(3.86)***	(4.11)***	(4.21)***	(0.72)	(9.74)***			(8.71)***	(0.33)
servprofconsul	0.023	0.724	-8.801	0.005	-0.183	-0.012	-2.165	-0.795	-0.016
	(7.12)***	(6.64)***	(7.76)***	(0.15)	(11.26)***	(5.59)***	(5.71)***	(10.26)***	(0.23)
supaccelecillum	-0.009	-0.639	-8.074	0.125	0.032	-0.000	-0.008	-0.068	-0.030
	(2.32)**	(2.34)**	(4.18)***	(2.42)**	(1.02)	(0.00)	(0.02)	(0.44)	(0.22)
telecti	-0.010	-0.655	-10.099	-0.136	-0.055	-0.008	-1.176	-0.281	-0.029
	(3.75)***	(3.57)***	(8.06)***	(4.05)***	(2.56)**	(3.04)***	(3.04)***	(2.74)***	(0.32)
vehicles	-0.002	-0.069	-2.277	0.073	-0.113	-0.010	-2.138	-0.552	-0.006
	(0.69)	(0.41)	(1.68)*	(2.01)**	(5.09)***	(3.66)***	(3.42)***	(5.17)***	(0.06)
Constant		97.922	-495.956	-19.699	5.070		101.710	11.355	-7.079
		(7.63)***	(3.96)***	(5.89)***	(3.05)***		(2.40)**	(1.45)	(1.03)
Observations	81846	81846	81318	81846	5628	21022	21022	5950	5950
R-squared			0.20	0.10	0.21			0.27	0.13

Absolute value of z statistics in parentheses
* significant at 10%; ** significant at 5%; *** significant at 1%

In the previous set of regressions, generally we maintain the earlier results. We improve some of the explained variance, because of the addition of more explanatory variables. But the greater improvement is that here one can see which of the headings or business lines is more affected to which kind of collusion.

Here we notice, consequently with the opinion and findings of practitioners that the principal business lines in which collusion can be observed are: construction materials and services; educational consultancy and services of management consulting; pharmaceutical, laboratory and medical equipment, among others. In the following paragraphs we describe the detailed results.

Firstly, for auctions in which the new supplier is awarded in her first offer (columns 1 and 2) the business lines affected by collusion are: educational and formation services, machinery and accessories for the mining industry, accessories and machinery derived from animal of plants (wide variety of products for and from animals and plants, used for environmental and conservation purposes), products for small community organizations, political and social professional consultancies, health and food public services, services of industrial cleaning, services of mining perforation, travel services, environmental consultancies services and professional consulting services.

Secondly, about the kind of collusion when the winner is *extremely lucky* (column 3), the sectors affected are: construction components and supply, medical equipment and accessories, laboratory equipment and accessories, materials from minerals plants or animals (wide variety of materials principally for light construction and municipalities reparation tasks), pharmaceutical products and services of food and beverages.

Thirdly, the type of collusion, when there are excess of dummy bids (column 4), the business lines affected are very wide to be written, although generally they are related to construction and services involving large investments the more important can be seen in the Table 2.

Fourthly, for the kind of auction when there are excessive differences in estimated and awarded prices, the business lines affected by collusion are not clearly defined; moreover, one can say that they are equally affected.

4. Robustness checks and sensitivity analysis

This section is dedicated to check the regression econometric specifications and the statistical robustness of our results.

Firstly, we run regressions without constant, but keeping all the dummy variables, to check whether the constant adds information or not. This analysis is run for all the specifications we have. The regressions do not vary with respect to the results we obtained in the previous section, obviously is even more clear the effect of each dummy variable.

Secondly, we run regressions (see table 8b) adding the bid variation coefficient as an explanatory variable, to detect whether this variable helps us to explain collusion. It turns out that the results confirm the theory, because the more the variation among bids, controlling by the other variables, the more the probabilities of collusion. The results do not vary dramatically with this new specification.

Thirdly, we tested linear regression residuals to check that they are white noise in all the regressions. The graphical analysis is shown in the appendix 2. Clearly there are no worries about biasedness of our regression residuals; they follow the standard linear regression assumptions.

4. Conclusions

By doing a standard OLS analysis, probit and logit approach we can find patterns of behavior indicating collusion, the explained variance is not huge, due to we are dealing with a subtle phenomenon. However, this analysis allows us to get powerful insights to focus efficiently on the more susceptible sectors affected by collusion.

Our analysis is not completely concluding, because it is not based on law judgments or decisions, we are basing the results on the anomalies in the behavior of bids, prices and awarding scheme. To do this, we would need to have a processed uniform database containing the cases where the law has determined the collusion illicit. The construction of such a kind of database is something very involved not done by today.

We have demonstrated the robustness of our results by doing a simple variety of checks, taking into account the econometric assumptions and the rationale of the estimations. In a further analysis we could run a wider variety of tests but we suspect the results wouldn´t vary dramatically.

The collusion clearly can be classified into two categories: collusion between the suppliers or offers (O-O) and between purchaser and demander (O-D), by doing a standard principal components analysis, we determined that, from principal components of the five dependent variables that there are two main dimensions of collusion which relates to the supply and the supply/demand illicit relationship.

The results indicate that the productive sector, the independency of the purchasing institution, the amount involved, the sub-contracting possibility the number of bids and the combinatorial awarding scheme are the determinants of collusion. Therefore, depending on the kind of illicit, there is the necessity of focusing on the independent purchasing organizations, the subcontracting and multi-awarded possibilities.

Further analysis should include a panel data estimation, to capture time trends and group variation. Moreover, under this econometric tool we could infer about seasonality effects. In this sense a still pending analysis is the total economic cost of collusion.

5. References

Bajari, Patrick and Garret Summers. "Detecting Collusion in procurement auctions". Antitrust Law Journal. 2002.

Carpineti et. al. "The variety of procurement practice: evidence from public procurement". Handbook of procurement, 2006.

FNE. "Extractos de documentos OECD (Competition Comitee) sobre competencia en mercados de la construcción"., 2008.

FNE. "Problemas de colusión entre oferentes en licitaciones: Estrategias de Prevención y Detección". 2008.

FNE. "Taller Interno de Difusión: Conductas anticompetitivas en licitaciones públicas". 2008.

Green, "Econometric Analysis", Prentice Hall, 6th Edition, 2008

Hendricks, K., Porter, R. "Collusion in auctions". Annales d´Economie et de Statistique. 1989.

Klemperer, Paul. "What really matters in auction design", Nuffield College, Oxford, 2000.

Klemperer, Paul. "Auction Theory: a guide to the literature", Journal of Economic Surveys, 1999.

Rieko Ishii. "Collusion in repeated procurement auction: A study of a paving market in Japan"., Osaka University, 2008.

Jeannette Brosig et. al. "Collusion Mechanisms in procurement auctions: An experimental investigation".University of Magdeburg and Max Planck Institute of Economics, 2006.

Pinker et. al. "Managing Online Auctions: current business and research issues". Journal of Management Science, 2003.

Porter, Robert; Zona , Douglas. "Detection of bid rigging in procurement auctions". NBER, 1992.

Shapiro, C. "Theories of oligopoly behavior". R Schmalensee & R. Willig (Eds.) , Handbook of Industrial Procurement, volume 1. Amsterdam: North Holland.

Appendix 1

Table 8.b: Collusion regressions, first estimation + bids variation coefficient

	(1) at1st_probit	(2) at1st_logit	(3) repeated_ols	(4) dummybids_ols	(5) diff_ols	(6) ediff_prob	(7) ediff_log	(8) O-O component	(9) O-D component
Subcontracting (0,1)	0.001	0.063	1.790	0.010	-0.012	-0.002	-0.170	0.054	-0.037
	(0.86)	(1.10)	(2.95)***	(0.59)	(1.40)	(0.96)	(0.95)	(1.41)	(1.01)
Publication date (log number)	-0.224	-11.970	52.216	2.859	-0.638	-0.156	-11.714	-0.489	1.831
	(7.36)***	(7.48)***	(3.23)***	(6.64)***	(2.55)**	(2.44)**	(2.36)**	(0.45)	(1.74)*
Number of Bids	-0.001	-0.077	-0.426	0.032	0.001	-0.000	-0.011	0.015	0.030
	(6.78)***	(7.12)***	(7.14)***	(19.79)***	(0.51)	(0.51)	(0.45)	(2.41)**	(5.08)***
Number of awarded suppliers	0.001	0.066	1.341	-0.027	-0.001	-0.003	-0.230	-0.049	-0.081
	(3.64)***	(4.20)***	(10.92)***	(8.15)***	(0.04)	(0.69)	(0.68)	(2.08)**	(3.61)***
Multi-awarded (0,1)	-0.004	-0.215	10.630	-0.299				0.297	-0.197
	(3.27)***	(2.94)***	(16.30)***	(17.07)***				(4.14)***	(2.86)***
Auction total amount (logs)	0.001	0.068	-0.132	-0.155	0.000	0.004	0.306	-0.033	-0.106
	(4.42)***	(3.85)***	(0.81)	(35.17)***	(0.06)	(4.59)***	(4.63)***	(2.17)**	(7.26)***
Small enterprise (0,1)	-0.015	-0.791	1.941	-0.017	0.023	0.003	0.220	0.189	-0.036
	(28.78)***	(27.04)***	(6.63)***	(2.18)**	(5.59)***	(2.41)**	(2.55)**	(10.04)***	(2.01)**
Medium enterprise (0,1)	-0.012	-0.694	2.336	-0.021	0.023	0.001	0.096	0.163	-0.034
	(23.28)***	(20.75)***	(9.61)***	(3.20)***	(5.88)***	(1.15)	(1.26)	(9.31)***	(2.00)**
Big enterprise (0,1)	-0.015	-0.943	10.196	-0.020	0.018	0.001	0.119	0.199	-0.078
	(27.80)***	(22.82)***	(66.03)***	(4.73)***	(7.32)***	(2.29)**	(2.49)**	(18.13)***	(7.40)***
Decision days	0.000	0.003	-0.567	0.006	0.001	0.000	0.011	0.005	0.006
	(0.69)	(0.53)	(11.96)***	(4.77)***	(1.14)	(0.76)	(0.92)	(1.74)*	(1.97)**
Excess of bids (1 if Number of offers > = 9)	-0.002	-0.040	2.951	0.411	0.004	-0.000	-0.042	0.005	0.049
	(1.08)	(0.35)	(3.70)***	(19.25)***	(0.22)	(0.12)	(0.14)	(0.07)	(0.69)
Number of Purshase units of Institution	-0.000	-0.002	-0.070	-0.001	0.000	0.000	0.003	0.001	-0.000
	(4.15)***	(4.57)***	(18.13)***	(6.86)***	(6.53)***	(2.74)***	(2.84)***	(3.41)***	(0.27)
Tarapacá (0,1)	0.001	0.064	6.417	0.002	-0.028	-0.007	-0.757	-0.025	0.220
	(0.30)	(0.26)	(2.83)***	(0.04)	(0.91)	(1.46)	(1.47)	(0.18)	(1.65)*
Antofagasta (0,1)	0.013	0.528	2.430	-0.046	-0.048	-0.011	-1.559	-0.244	0.017
	(2.29)**	(2.31)**	(1.09)	(0.76)	(1.64)	(2.83)***	(2.75)***	(1.79)*	(0.13)
Atacama (0,1)	0.004	0.236	1.633	0.019	-0.062	-0.011	-1.566	-0.212	0.021
	(0.76)	(0.97)	(0.70)	(0.31)	(2.01)**	(2.46)**	(2.31)**	(1.51)	(0.15)
Coquimbo (0,1)	0.019	0.706	-0.292	-0.013	-0.089	-0.011	-1.821	-0.369	0.078
	(3.16)***	(3.10)***	(0.12)	(0.21)	(2.78)***	(2.47)**	(2.30)**	(2.50)**	(0.55)
Valparaiso (0,1)	0.005	0.271	11.101	-0.002	-0.052	-0.011	-1.160	-0.061	-0.031
	(1.19)	(1.28)	(5.64)***	(0.04)	(2.05)**	(2.87)***	(2.84)***	(0.53)	(0.28)
Metropolitana (0,1)	0.003	0.183	18.626	0.158	-0.042	-0.011	-0.905	-0.103	-0.006
	(0.90)	(0.90)	(9.90)***	(3.13)***	(1.76)*	(2.42)**	(2.48)**	(0.94)	(0.05)
O´Higgins (0,1)	0.009	0.376	-2.408	0.013	-0.093	-0.012	-1.728	-0.198	0.157
	(1.82)*	(1.72)*	(1.13)	(0.24)	(3.39)***	(3.19)***	(3.04)***	(1.57)	(1.29)
Maule (0,1)	0.012	0.516	2.252	-0.135	-0.059	-0.010	-1.114	-0.150	-0.005
	(2.37)**	(2.36)**	(1.07)	(2.40)**	(2.13)**	(2.31)**	(2.23)**	(1.18)	(0.04)
Bio-Bio (0,1)	0.004	0.199	6.073	-0.079	-0.019	-0.009	-0.860	-0.115	-0.002
	(0.90)	(0.95)	(3.11)***	(1.51)	(0.74)	(2.25)**	(2.20)**	(0.99)	(0.02)
Araucania (0,1)	0.005	0.252	-0.034	-0.053	-0.002	-0.001	-0.036	-0.043	0.094
	(1.18)	(1.16)	(0.02)	(0.96)	(0.09)	(0.19)	(0.10)	(0.37)	(0.84)
Los Rios (0,1)	0.014	0.534	-6.610	-0.080	-0.084			-0.370	-0.039
	(2.26)**	(2.18)**	(2.63)***	(1.20)	(2.12)**			(1.99)**	(0.22)
Los Lagos (0,1)	0.014	0.559	-5.695	-0.007	-0.054	-0.009	-0.928	-0.117	0.155
	(2.74)***	(2.65)***	(2.80)***	(0.13)	(2.01)**	(2.14)**	(2.07)**	(0.95)	(1.32)
Magallanes (0,1)	0.009	0.385	0.871	0.006	-0.082	-0.010	-1.365	-0.232	-0.108
	(1.67)*	(1.58)	(0.37)	(0.09)	(2.53)**	(2.32)**	(2.23)**	(1.61)	(0.78)
Aysen (0,1)	0.013	0.552	-4.997	-0.080	-0.008	-0.007	-0.599	-0.181	0.005
	(2.40)**	(2.42)**	(2.15)**	(1.28)	(0.26)	(1.39)	(1.27)	(1.35)	(0.04)
Size of Auction (1 if in 100-1000UTM)	0.003	0.139	-7.283	0.176	-0.039	-0.019	-1.342	-0.132	0.040
	(2.62)***	(2.25)**	(11.64)***	(10.48)***	(3.74)***	(6.36)***	(6.43)***	(2.77)***	(0.87)
Size of Auction (1 if >1000UTM)	0.002	0.105	-6.186	0.299	-0.039	-0.014	-2.104	-0.143	0.261
	(1.06)	(0.86)	(5.22)***	(9.41)***	(1.87)*	(5.04)***	(5.06)***	(1.49)	(2.83)***
Variation Coefficient (bids stdev/mean)	0.004	0.232	2.249	0.560	0.028	0.006	0.416	0.335	0.585
	(5.09)***	(5.13)***	(4.62)***	(42.95)***	(3.05)***	(2.91)***	(2.80)***	(8.25)***	(15.02)***
Constant		113.768	-499.674	-26.698	6.338		108.672	4.530	-17.168
		(7.29)***	(3.17)***	(6.36)***	(2.60)***		(2.25)**	(0.42)	(1.68)*
Observations	63586	63586	63195	63586	3261	15455	15455	3590	3590
R-squared			0.13	0.11	0.08			0.17	0.15

Absolute value of z statistics in parentheses

* significant at 10%; ** significant at 5%; *** significant at 1%

Table 9.b: Collusion regressions, second estimation + bids variation coefficient

	(1) ala1a_probit	(2) ala1a_logit	(3) repetido_ols	(4) dummybids_ols	(5) diff_ols	(6) ediff_prob	(7) ediff_log	(8) O-O component	(9) O-D component
Subcontracting (0,1)	0.000	0.024	-0.446	0.011	-0.012	-0.002	-0.119	-0.024	0.013
	(0.19)	(0.41)	(0.76)	(0.68)	(1.45)	(0.73)	(0.64)	(0.64)	(0.36)
Publication date (log number)	-0.188	-11.592	69.708	2.956	-0.695	-0.150	-12.407	-0.285	1.445
	(7.04)***	(7.11)***	(4.47)***	(6.85)***	(2.88)***	(2.49)**	(2.45)**	(0.27)	(1.35)
Number of Bids	-0.001	-0.053	-0.580	0.033	0.001	-0.000	-0.000	0.015	0.031
	(4.79)***	(4.99)***	(9.97)***	(20.08)***	(0.75)	(0.09)	(0.00)	(2.58)***	(5.18)***
Number of awarded suppliers	0.000	0.038	1.169	-0.028	0.009	-0.001	-0.120	-0.057	-0.065
	(1.87)*	(2.36)**	(9.75)***	(8.53)***	(0.48)	(0.33)	(0.35)	(2.56)**	(2.88)***
Multi-awarded (0,1)	-0.001	-0.029	2.572	-0.280	0.000			0.104	-0.160
	(0.62)	(0.38)	(3.98)***	(15.52)***	(.)			(1.51)	(2.30)**
Auction total amount (logs)	0.000	0.019	-0.302	-0.159	0.008	0.004	0.360	-0.009	-0.097
	(1.78)*	(1.13)	(1.87)*	(35.37)***	(2.29)**	(5.13)***	(5.20)***	(0.59)	(6.40)***
Small enterprise (0,1)	-0.011	-0.684	0.591	-0.014	0.009	0.002	0.175	0.131	-0.044
	(23.93)***	(22.71)***	(2.04)**	(1.76)*	(2.19)**	(1.86)*	(1.97)**	(7.12)***	(2.37)**
Medium enterprise (0,1)	-0.009	-0.575	0.546	-0.016	0.009	0.001	0.066	0.101	-0.041
	(18.48)***	(16.71)***	(2.23)**	(2.33)**	(2.26)**	(0.71)	(0.82)	(5.85)***	(2.33)**
Big enterprise (0,1)	-0.011	-0.799	7.006	-0.014	0.005	0.001	0.091	0.116	-0.064
	(22.26)***	(18.86)***	(41.93)***	(3.01)***	(1.89)*	(1.49)	(1.70)*	(9.76)***	(5.30)***
Decision days	-0.000	-0.002	-0.452	0.005	0.001	0.000	0.011	0.007	0.006
	(0.51)	(0.35)	(9.84)***	(4.03)***	(2.03)**	(0.77)	(0.99)	(2.28)**	(2.18)**
Excess of bids (1 if Number of offers > = 9)	-0.001	0.015	0.762	0.415	0.001	-0.001	-0.092	0.002	0.042
	(0.28)	(0.13)	(0.99)	(19.37)***	(0.04)	(0.33)	(0.30)	(0.03)	(0.59)
Number of Purshase units of Institution	-0.000	-0.001	-0.049	-0.001	0.000	0.000	0.002	0.000	-0.000
	(1.62)	(2.05)**	(12.81)***	(6.40)***	(1.52)	(1.41)	(1.43)	(0.12)	(1.06)
Tarapacá (0,1)	0.001	0.088	6.340	0.013	-0.051	-0.007	-0.770	-0.101	0.220
	(0.18)	(0.36)	(2.91)***	(0.21)	(1.75)*	(1.56)	(1.47)	(0.77)	(1.65)*
Antofagasta (0,1)	0.010	0.559	2.659	-0.055	-0.045	-0.010	-1.564	-0.230	0.043
	(2.20)**	(2.42)**	(1.24)	(0.92)	(1.61)	(2.85)***	(2.73)***	(1.77)*	(0.33)
Atacama (0,1)	0.002	0.241	0.850	0.014	-0.058	-0.010	-1.641	-0.209	0.062
	(0.56)	(0.98)	(0.38)	(0.22)	(1.99)**	(2.48)**	(2.39)**	(1.57)	(0.46)
Coquimbo (0,1)	0.015	0.692	-0.705	-0.012	-0.060	-0.010	-1.779	-0.279	0.105
	(2.90)***	(3.01)***	(0.31)	(0.18)	(1.98)**	(2.40)**	(2.24)**	(1.98)**	(0.74)
Valparaiso (0,1)	0.005	0.331	10.750	-0.011	-0.042	-0.009	-1.068	-0.066	0.014
	(1.23)	(1.55)	(5.67)***	(0.20)	(1.76)*	(2.57)**	(2.56)**	(0.59)	(0.12)
Metropolitana (0,1)	0.002	0.208	16.161	0.147	-0.033	-0.009	-0.795	-0.103	0.035
	(0.74)	(1.01)	(8.93)***	(2.92)***	(1.44)	(2.15)**	(2.13)**	(0.98)	(0.33)
O´Higgins (0,1)	0.006	0.357	-1.691	-0.001	-0.079	-0.010	-1.619	-0.195	0.210
	(1.45)	(1.62)	(0.83)	(0.01)	(3.04)***	(2.98)***	(2.81)***	(1.61)	(1.72)*
Maule (0,1)	0.009	0.527	-0.665	-0.149	-0.041	-0.008	-0.972	-0.162	0.043
	(2.12)**	(2.39)**	(0.33)	(2.64)***	(1.56)	(1.97)**	(1.91)*	(1.33)	(0.35)
Bio-Bio (0,1)	0.003	0.241	4.851	-0.085	-0.033	-0.009	-0.866	-0.207	0.051
	(0.83)	(1.14)	(2.58)***	(1.62)	(1.36)	(2.30)**	(2.16)**	(1.87)*	(0.46)
Araucania (0,1)	0.003	0.229	0.913	-0.061	-0.011	-0.002	-0.102	-0.081	0.099
	(0.79)	(1.05)	(0.46)	(1.10)	(0.45)	(0.35)	(0.26)	(0.73)	(0.87)
Los Rios (0,1)	0.011	0.517	-6.647	-0.087	-0.075			-0.390	-0.006
	(2.04)**	(2.08)**	(2.75)***	(1.29)	(2.00)**			(2.21)**	(0.03)
Los Lagos (0,1)	0.010	0.548	-3.802	-0.013	-0.050	-0.008	-0.849	-0.144	0.221
	(2.44)**	(2.56)**	(1.94)*	(0.23)	(1.96)*	(1.97)**	(1.87)*	(1.23)	(1.87)*
Magallanes (0,1)	0.007	0.388	2.350	-0.000	-0.092	-0.010	-1.446	-0.232	-0.107
	(1.48)	(1.58)	(1.04)	(0.01)	(3.02)***	(2.45)**	(2.33)**	(1.69)*	(0.77)
Aysen (0,1)	0.012	0.599	-2.692	-0.088	-0.024	-0.006	-0.641	-0.237	0.031
	(2.37)**	(2.60)***	(1.20)	(1.42)	(0.86)	(1.47)	(1.33)	(1.86)*	(0.24)
Size of Auction (1 if in 100-1000UTM)	0.002	0.100	-7.487	0.170	-0.045	-0.019	-1.460	-0.125	0.021
	(1.80)*	(1.64)	(12.39)***	(10.10)***	(4.51)***	(6.83)***	(6.88)***	(2.76)***	(0.45)
Size of Auction (1 if >1000UTM)	0.003	0.154	-7.894	0.287	-0.063	-0.013	-2.351	-0.221	0.238
	(1.34)	(1.27)	(6.90)***	(9.02)***	(3.17)***	(5.43)***	(5.44)***	(2.42)**	(2.58)***
Variation Coefficient (bids stdev/mean)	0.004	0.226	0.120	0.560	0.011	0.005	0.355	0.244	0.602
	(5.07)***	(4.99)***	(0.25)	(42.35)***	(1.18)	(2.48)**	(2.27)**	(6.16)***	(15.04)***

Table 9.b: Collusion regressions, second estimation + bids variation coefficient (cont.)

cosupconstr	-0.004	-0.353	5.091	0.080	0.015	-0.005	-0.524	0.027	0.062
	(1.97)**	(2.21)**	(3.70)***	(2.10)**	(0.64)	(1.32)	(1.53)	(0.25)	(0.58)
foreduc	0.030	0.970	-10.106	0.087	-0.186			-0.711	0.034
	(4.98)***	(4.95)***	(3.49)***	(1.09)	(6.54)***			(5.43)***	(0.26)
eqaccsupmed	-0.011	-1.134	37.898	0.165	-0.023	-0.006	-0.698	0.176	-0.089
	(5.74)***	(5.71)***	(29.63)***	(4.64)***	(0.92)	(1.76)*	(1.86)*	(1.68)*	(0.83)
labequip	-0.008	-0.731	13.620	0.132	-0.013	-0.006	-0.722	-0.094	0.006
	(2.44)**	(2.39)**	(7.72)***	(2.68)***	(0.39)	(1.21)	(1.36)	(0.67)	(0.04)
eqsupclean	-0.011	-1.571	-6.228	0.335	0.004	-0.009	-1.599	-0.078	-0.139
	(2.77)***	(2.65)***	(2.40)**	(4.65)***	(0.07)	(1.60)	(1.54)	(0.34)	(0.60)
machaccmining	0.017	0.668	-6.287	0.216	-0.127			-0.680	0.185
	(2.04)**	(2.00)**	(1.41)	(1.74)*	(2.60)***			(2.96)***	(0.80)
machaccconstr	-0.003	-0.233	0.631	0.209	0.079	-0.004	-0.347	0.165	0.377
	(0.69)	(0.77)	(0.24)	(2.80)***	(1.61)	(0.57)	(0.53)	(0.75)	(1.70)*
machaccengen	0.000	-0.024	-11.250	0.203	0.055	0.002	0.102	-0.021	0.141
	(0.01)	(0.07)	(3.78)***	(2.46)**	(1.20)	(0.21)	(0.17)	(0.10)	(0.67)
machaccmatsto	0.000	-0.105	-7.969	0.329	0.053	-0.008	-1.083	0.170	0.119
	(0.01)	(0.29)	(2.42)**	(3.61)***	(0.75)	(1.12)	(1.04)	(0.63)	(0.44)
maccplantanim	0.014	0.605	-7.122	0.169	-0.046	-0.008	-1.186	-0.328	0.092
	(1.99)**	(2.06)**	(1.95)*	(1.67)*	(0.84)	(1.14)	(1.13)	(1.35)	(0.38)
matminerplanim	-0.002	-0.138	8.168	0.272	-0.041	-0.009	-1.435	-0.163	0.091
	(0.61)	(0.59)	(3.66)***	(4.38)***	(1.18)	(1.96)*	(1.87)*	(1.03)	(0.57)
pharmprod	-0.012	-1.734	43.689	0.094	-0.051	-0.008	-1.204	0.740	-0.605
	(3.86)***	(3.70)***	(28.80)***	(2.23)**	(1.67)*	(2.05)**	(2.13)**	(5.95)***	(4.81)***
furnit	-0.008	-0.839	-8.833	0.193	-0.045	-0.007	-0.907	-0.283	-0.035
	(3.13)***	(3.13)***	(4.59)***	(3.60)***	(1.40)	(1.67)*	(1.71)*	(1.93)*	(0.23)
accfurnelectr	-0.009	-0.988	-14.701	0.145	-0.008	-0.006	-0.633	-0.120	0.036
	(2.69)***	(2.62)***	(6.86)***	(2.43)**	(0.24)	(1.17)	(1.19)	(0.82)	(0.24)
socorg	0.046	1.184	-0.227	0.139	-0.160			-0.353	-0.197
	(1.84)*	(1.76)*	(0.02)	(0.40)	(0.89)			(0.41)	(0.23)
polsocconsult	0.031	1.010	-8.508	0.053	-0.174	-0.010	-2.204	-0.901	0.066
	(5.76)***	(5.66)***	(3.48)***	(0.78)	(6.41)***	(2.22)**	(2.10)**	(7.24)***	(0.53)
prodpublicpre	-0.009	-0.961	-10.986	0.223	0.056	0.002	0.087	-0.099	0.019
	(2.68)***	(2.68)***	(4.67)***	(3.42)***	(1.17)	(0.21)	(0.15)	(0.47)	(0.09)
rubmat	0.039	1.097	1.097	0.074	-0.127			-0.300	-0.149
	(1.96)**	(1.73)*	(0.13)	(0.31)	(0.71)			(0.35)	(0.17)
healthfood	0.015	0.599	-5.640	0.032	-0.147	-0.009	-1.472	-0.744	-0.053
	(3.84)***	(3.59)***	(2.55)**	(0.52)	(4.16)***	(1.42)	(1.40)	(4.74)***	(0.33)
fooddrinkser	0.004	0.135	2.056	0.198	-0.170	-0.012	-2.994	-0.463	-0.159
	(1.38)	(0.84)	(1.06)	(3.68)***	(7.09)***	(3.19)***	(2.86)***	(4.31)***	(1.46)
servagrfish	0.009	0.381	-5.666	0.232	-0.109	-0.009	-1.280	-0.510	0.086
	(2.93)***	(2.61)***	(3.60)***	(5.30)***	(4.50)***	(2.84)***	(2.93)***	(4.65)***	(0.78)
servconstr	-0.003	-0.209	-1.131	0.274	0.023	-0.004	-0.386	0.071	0.084
	(1.27)	(1.51)	(0.83)	(7.25)***	(1.02)	(1.04)	(1.17)	(0.70)	(0.81)
servperscare	0.019	0.743	-10.849	-0.024	0.015	-0.004	-0.629	-0.352	-0.091
	(2.87)***	(2.95)***	(2.98)***	(0.23)	(0.22)	(0.39)	(0.60)	(1.13)	(0.29)
servindclean	0.010	0.432	-6.297	0.133	-0.088	-0.007	-0.835	-0.583	-0.184
	(2.72)***	(2.55)**	(2.97)***	(2.25)**	(2.23)**	(1.20)	(1.08)	(3.15)***	(0.98)
servpublicit	-0.005	-0.356	-9.429	0.335	-0.093	-0.008	-1.135	-0.279	0.254
	(2.03)**	(2.07)**	(6.02)***	(7.69)***	(3.56)***	(2.38)**	(2.49)**	(2.34)**	(2.11)**
servfinan	-0.007	-0.669	-19.816	0.143	-0.069	-0.006	-0.758	-0.447	0.076
	(1.92)*	(1.93)*	(8.13)***	(2.11)**	(1.76)*	(0.91)	(0.98)	(2.52)**	(0.42)
servenviron	0.033	1.047	-11.106	0.060	-0.203			-0.857	0.012
	(3.78)***	(3.91)***	(2.66)***	(0.52)	(6.55)***			(5.98)***	(0.08)
servprofconsul	0.018	0.709	-8.086	0.059	-0.167	-0.012	-1.945	-0.681	0.005
	(5.91)***	(5.34)***	(5.69)***	(1.49)	(7.73)***	(4.07)***	(4.22)***	(7.06)***	(0.06)
supaccelecillum	-0.007	-0.749	-8.262	0.142	0.043	0.004	0.232	-0.090	-0.063
	(2.04)**	(2.19)**	(3.55)***	(2.20)**	(1.06)	(0.52)	(0.49)	(0.49)	(0.34)
vehicles	-0.003	-0.256	-0.159	0.156	-0.081	-0.010	-1.770	-0.341	0.128
	(1.20)	(1.18)	(0.10)	(3.40)***	(2.65)***	(2.84)***	(2.74)***	(2.49)**	(0.92)
Constant		110.346	-663.155	-27.731	6.936		115.874	2.861	-13.565
		(6.94)***	(4.36)***	(6.59)***	(2.96)***		(2.35)**	(0.28)	(1.30)
Observations	63501	63501	63195	63586	3261	14676	14676	3590	3590
R-squared			0.20	0.12	0.21			0.28	0.18

Absolute value of z statistics in parentheses
* significant at 10%; ** significant at 5%; *** significant at 1%

Appendix 2

Graphic X: Regression Tests: