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Cartel Damages to the Economy:

An Assessment for Developing Countries

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Abstract

To date, whether competition law enforcement is indeed beneficial for the economy still remains a questionable topic. In the majority of jurisdiction collusive practices that aim at fixing either prices or market shares are considered as damaging per se as firms get an opportunity to block the entry of new rivals or to overcharge for their products or services without adapting the quality. Nevertheless, developing countries still struggle to find the supportive evidence that would help them to create or reinforce their antitrust divisions - research on the topic appears not to be not only limited, but also mainly of a qualitative nature. The principal goal of the preset study is to provide the missing evidence by assessing the potential economic harm caused by cartels in developing countries. For this purpose we have created a dataset that contains information on more than 200 major 'hard-core' cartels prosecuted in more than 20 developing countries from 1995 to 2013. We have also developed an original and relatively simple methodology that we employed to estimate the cartel's economic harm - in terms of price overcharges and consumers' welfare losses - when sufficient data were available. Obtained results confirm that cartels` economic impact can indeed be substantial. For example, in terms of affected sales related to GDP the maximal rate reaches up to 6.38%. The actual harm in terms of cartels' excess profits resulting from price overcharges can also significant - with the maximal rate reaching almost 1% when those profits are related to GDP. Furthermore, as we estimate the maximal annual probability of uncovering an existing cartel to be around 24%, we suggest that the actual damage could appear at least 4 times bigger.

Key words: hard core cartel, developing countries, damages, antitrust, cartel deterrence, overcharge

JEL classifications: L12, L42, K22, B14, F29

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1. Introduction

Detecting and castigating cartels come first on the agenda of anti-trust authorities in developed countries because of their potential harm to consumers' welfare and the economy as a whole. Collusive practices are considered as damaging *per se* as firms overcharge their customers for their products or services or block the entry of new rivals. From a sample of international cartels in primary product markets covering the last twenty years, Connor (2011a) shows that cartels' prices have been at least twenty-five percent higher than their competitive benchmark.

As implementation of the antitrust enforcement requires substantial investments, it can be questioned to which extent those expenditures are compensated in terms of prevented consumers' damages. Especially this is relevant for developing competition authorities that often experience tough budget constraints. Nevertheless, they often struggle to find the supportive evidence that could advocate their efforts. The research on these questions in developing countries is scarce and has mainly followed a qualitative approach. Among the few relevant studies, e.g. those of Jenny (2006), Connor (2011a) and Levenstein, Suslow and Oswald (2003), only the latter offers a relatively comprehensive quantitative assessment of the aggregate economic impact of cartels' agreements. Based on the international trade flows data and a list of forty-two detected international cartels prosecuted in the U.S. and the EU in 1990s and operating on developing markets, authors estimated that imports affected by cartel agreements constitute 3.4-8.4% of total imports. When those affected imports are compared to the corresponding GDP, the percentage raises up to 0.6-1.7%. Due to hidden and sometimes tacit nature of cartels and various methodological problems that did not allow authors to take all the observations into account, it is suggested that the actual impact could be much more significant.

Taking into account both international and local cartels and having measured the aggregated cartel excess profits resulting from price overcharges could provide a clearer picture of the actual damage suffered by consumers in developing countries. These estimations can in turn be employed to advocate the introduction or reinforcement of the antitrust control in the concerned economies. Present study aims at providing the required evidence.

The paper will stick to the following outline. **Section 2** comprises a description of the data mining process and a discussion over the descriptive statistics of the collected sample of

cartels. We also present our original methodology that was developed to recover the missing price overcharges. While being quite simple and intuitive, its' main advantage is that it requires a very limited data to be implemented. In Appendix C we illustrate the application of this methodology on one of the cases from our database. Overall, collected data do not bring any strong evidence to the widespread idea that cartel overcharges in developing countries are more significant than those in developed countries. We show, however, that the anticompetitive impact in terms of price overcharges is at least of a similar scale, which calls for adequate antitrust measures. We believe that stronger results are achieved by looking at the aggregate measures of cartelization harm that we present in **Section 3.** We focus on several aggregate indicators. To estimate the cartels' impact on the country level, as in Levenstein, Suslow and Oswald (2003) we find it appropriate to consider aggregated sales affected by collusive practices and, more innovatively, aggregated cartels' excess profits that result from price overcharges. Both measures related to GDP. We find that in terms of affected sales related to the GDP the maximal rate reaches up to 6.38%. The actual harm to consumers in terms of cartels' excess profits can be also significant, with the maximal rate reaching almost 1% of the GDP. We supplement the discussion with a simplified cost-benefit-like analysis of the antitrust enforcement by relating aggregated cartels' excess profits to the budget of the corresponding competition authority. Our results demonstrate that in majority of considered countries price overcharges significantly exceed budget expenses aimed at preventing them. Overall, obtained estimates reflect the very minimal bound for the economic harm caused by collusive behaviour because data on detected cartels in developing countries are very limited, but mostly because some of them remain uncovered. To assess how far (or how close) our aggregated estimates are from the reality, in **Section 4** we adopt the methodology proposed in Combe et al (2008) to estimate the deterrence rate, i.e., the annual probability of a cartel to be uncovered. We find that at least three out of four existing cartels remain undetected. To our knowledge this is the first attempt to apply this methodology on a sample of cartels detected in developing countries. **Section 5** concludes the paper.

Competition authorities in developing countries could have a practical interest in the respective results for the advocacy of their efforts. Furthermore, they may wish to take advantage of the proposed methodology for their own cartel investigations as it will reduce the data required to estimate the damages caused by cartelization, in terms of, for instance, price overcharges and output losses.

2. Collected data: cartels' profile in developing countries

Data collection process

Our analysis is based on the original dataset containing information on 249 major 'hard-core' cartels that were prosecuted in more than 20 developing countries from 1995 to 2013.[1] In Appendix A we provide a reduced version of this dataset that contains the list of countries, identified cartel cases and their respective periods of existence. We restrict our attention to the chosen period because many of developing countries have established their competition authorities just recently, if at all; hence no or very poor data could be collected for earlier years. Nevertheless, we find it sufficiently long to obtain a representative sample.

The list of countries chosen to participate in the study was created according to the active state of their competition authorities and sufficiency of their experience. For this reason many of the developing economies were excluded from consideration. Nevertheless, they could still profit of the current study results to advocate the introduction of the competition law or its enforcement.

Given the complexity of possible reasons for collusive behavior and consequent welfare effects, we only focus on so-called 'hard core' cartels, i.e. when cartel participants aim at increasing their profits by the means of collective price or market share fixing. These agreements between firms are assumed to be harmful for consumers *per se* and, therefore, are illegal in the majority of antitrust jurisdictions. Hence, we do not include in the database buyers' cartels, collective predatory pricing cases or collusive agreements that were given an exemption by competition authorities.[2]

For every defined 'hard core' cartel, we aimed at collecting quite substantial descriptive data, including relevant market(s), number of colluding firms, cartel duration, cartel's sales, applied penalties and estimated price overcharges. Given the absolute lack of data on losses in output or welfare, we have chosen price overcharges as a measure of the economic damage. When a cartel operated on several relevant markets we considered those episodes separately, if available data allowed doing so. When no exact date or month but only year of cartel's

[1]The chosen countries are considered as developing economies according to the International Monetary Fund's World Economic Outlook Report, April 2010.

[2]Collusive behavior could be given an exemption by competition authority if it is proven to be beneficial for consumers or necessary in given economic conditions. This was, for instance, the case of the cartel in the mixed concrete industry in South Korea in 2009.

creation or breakdown was known, we assumed that cartel's duration comprises the complete year from January to December, similar for months. Cartel's sales were calculated as revenues of all colluding firms during the considered period on the relevant market only. Data on penalties include all applied fines (both for companies and executives) as well as finalized settlements. In some cases inputs were provided in different currencies. Therefore, when needed, cartel's sales were converted by using average exchange rates corresponding to the period of cartel's existence, while for penalties we used the exchange rate that corresponded to the period when the final decision on the case was made. To be able to perform the cost-benefit analysis we also looked for budgets of competition authorities.

The data were obtained from numerous sources such as competition authorities' websites, companies' annual reports, reports of international organizations such as OECD, UNCTAD, etc. A significant piece of information came from the existing database on international cartels.[3] However, our sample would not be so rich without cooperation with local competition authorities.[4] For this purpose, they were asked to fill out a special questionnaire. (See Appendix B.) In addition to the mentioned above target data this questionnaire requests for some additional inputs required for our original methodology that we developed to estimate the price overcharges. The minimal data that are necessary to for this purpose are quite limited and include only prices, market shares and sales of colluding companies at least for one period of cartel existence. All the other cartel-specific information requested in the questionnaire is not mandatory to implement the methodology, but helps to better calibrate market parameters and, eventually, improve the estimation results. We explain the methodology in more detail and report obtained estimates later in the section.

Our database makes a substantial contribution in summarizing and, most importantly, enriching the existing knowledge on price overcharges caused by cartels. It comprises not only international cartels (as, for instance in Levenstein et al. (2003)), but also cartels formed by domestic firms only. Cartels' industrial profile in our sample is similar to the one described extensively by Jenny (2006), therefore we do not go deeper in this aspect but instead focus on the quantitative assessment.

[3] Private International Cartels spreadsheet by John M. Connor, Purdue University, Indiana, USA (March 2009).

[4]We wish to thank for a fruitful cooperation competition authorities from Brazil, Chile, Colombia, Indonesia, Peru, South Africa, Russia, Mexico,Ukraine, Pakistan, Zambia and South Koreaand Mauritius, as well as UNCTAD RPP initiative coordinators.

Descriptive statistics of the sample

We provide some descriptive statistics of the collected data in Table 1.

Table 1: Descriptive statistics of the collected sample

Variable	#obs.	Mean	Median	St. dev.	Min	Max
Duration, months	185	46	27	50	1	420
Number of cartel members	200	15	5	37	2	300
Price overcharge, %	83	23.1	20.0	14.6	2.4	75.0
Penalties/Excess profits ratio, %	72	51.8	19.0	118.2	0.0	950.5

Table 1: We measure the price overcharge as % of the cartel price. Whether minimal and maximal bounds for the price overcharge are both known , we used the average between the two.

The median number of colluding firms and median cartel's duration in months are equal to 5 and 27 correspondingly.[5] Analogous calculations for developed economies (see Connor (2011b)) indicate similar results for the number of cartel participants but, surprisingly, a higher level of median cartel duration - around 50 months in the North America and 70 in the E.U. These results may seem to be in conflict with the popular opinion that in developing countries collusion is sustainable for longer periods because of stronger market imperfections and a weaker antitrust enforcement. However, this observation can be supported by theoretical results that demonstrate that on unstable but growing markets deviation from cartel agreement can indeed be very attractive. (See Motta (2004)).

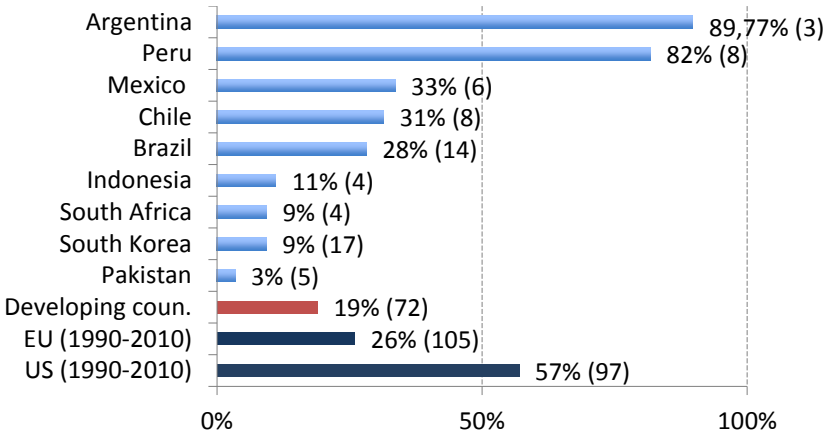
We do not provide descriptive statistics for the absolute values of cartels' sales and penalties because considered countries, their economies and, eventually, cartels are diversified in scale. Instead, we find it important to report descriptive statistics of some relative measures, such as penalties-excess profits ratio and price overcharges that we measure with respect to the cartel price. We define cartel's excess profits as the extra margin resulting from sales at higher prices, taking cartel unit sales as a basis.

We observe that the penalties-excess profits ratio for our sample has quite extreme ends – it varies from 0% to 950%. The former can be explained by the fact that not all of the detected cartels were subject to the fine. The reason for the latter is that penalties were

[5]Median values are more convenient to consider because the data are skewed and contain a few outliers with number of cartel participants more than 200 and duration of more than 150 months thatrenders mean values uninformative.

sometimes calculated as percentage of the total sales of cartel members instead of sales on the relevant market only. Nevertheless, the average for developing countries ratio remains very low compared to the U.S. level (19% against 57%) and is just slightly below the E.U. level of 26% (see Graph 1).

Graph 1: Comparison of penalty-excess profits ratios, %



*Graph 1:*In brackets we provide the number of observations used. Country-level data is given only when number of observations is more than 2. Data on the E.U. and the U.S. is obtained from Connor (2011b).

Remarkably, even in developed countries competition authorities on average do not recuperate excess profits gained by cartel members. Moreover, if one would appropriately discount overcharges and penalties to account for money depreciation, those rates would be even lower. According to Hammond (2005) and Connor (2011a) such a situation should be characterized as 'under-punishment' because optimal deterrence of cartels formation requires penalties to be higher than extra profits resulted from collusive arrangements. At the same time, Allain et al. (2011) argue that the E.U. penalty rules can be considered as 'optimal', even if eventual penalty–excess profits ratio is relatively low. They demonstrate that the dynamic effects together with an appropriate estimation of price overcharges (i.e. corrected for model and estimation error and publication bias) have a significant impact on the determination of the optimal dissuasive penalties, i.e. penalties that wipe out all the expected profits resulting from the anticompetitive infringement. The optimality of a penalty rule that does not require a 100% recuperation of the excess cartel profits can be also supported by the following intuition. On one hand, by imposing fines competition authorities try to deter formation of cartels or make it more risky for existing collusion to continue, expecting that a more severe penalty rule to result in a stronger deterrence effect. On the other hand, too high penalty can undermine the firm's ability to be an efficient market player that goes against the

initial goal of restitution of the fair competition. If cartel was operating on the market for many years, it might be impossible for the firms to pay back all the extra profits that they have obtained by overcharging. The fact that competition authorities try to balance these two effects in different ways justifies the diversification of the penalty-excess profits ratios among countries.

The present study does not aim at assessing whether penalty rules in developing countries are optimal or not, nor it claims that they should follow the example of developed antitrust jurisdictions. What we want to highlight here, is that factors that define the optimal antitrust policy are quite numerous, starting from the very definition of the optimality that every competition authority decides on its own. Therefore, the effective penalty rule indeed can (and, most probably, should) be country-specific.

It could be expected that a weaker antitrust enforcement provides cartels with incentives to set higher prices. Our collected sample does not provide any strong support to this intuition. As can be seen from Table 2 below, the median price overcharge rate for our sample is of the same range as the one experienced by the E.U. countries (20% versus 19.5-22.48%) and is only slightly higher than 16.7-19% estimated for the U.S. and Canada.

Table 2: Comparison of cartel price overcharges from existing studies (in %)

Country/group	**# obs.**	**Mean**	**Median**
Developing countries (our sample), 1990-2013[6] :	83	23.1	20.0
Developing countries (Connor (2010b)), 2000-2009:	33	n/a	n/a
China	2	17.42	17.42
Egypt	4	20.26	19.61
India	1	16.67	16.67
Korea	22	24.01	14.89
Mexico	1	15.25	15.25
Pakistan	1	42.53	42.53
Turkey	2	53.49	53.49
EU (Connor (2011b), 1990-2010	105	n/a	19.5
EU (Connor (2010b), 1990-2009	11	28.16	22.48
US (Connor (2011b), 1990-2010	97	n/a	19
US and Canada, (Connor, 2010b), 1990-2009	29	39.61	16.67

Table 2: Estimates from Connor (2010b) were originally provided with respect to a 'but-for' prices, therefore

[6]Our sample contains cases that were *prosecuted* from 199 0 to 2013, but could have existed before.

they were recalculated with respect to the cartel price to be comparable with the other data from the table.

Estimation of price overcharges –methodology and results

In our study data on price overcharges constitute a departure point towards the measure of the aggregated economic harm induced by cartelization. We acknowledge that in the context of developing countries estimations of price overcharges appear to be very scarce. One of the reasons is that this kind of estimations might be very demanding in terms of time and expertise that represent a serious constraint for a young competition authority. Besides, to condemn a cartel they mostly rely on the evidence on coordination activities (such as phone calls, meeting notes etc.) rather than the economic one (such as parallel pricing or constant market shares, etc.). To address this issue and to fill some of the missing estimates out, we have developed an original methodology that is simple enough to implement while well economically grounded.

The methodology employs the following approach that is applied on a case-by-case basis. Based on the collected cartel data one first performs the calibration of the supply and demand parameters on the cartelized market. If cartel operates on several markets calibration should be performed for each of them separately, if collected data allow doing so. Having the estimated parameters at hand, one then proceeds with the simulation of hypothetical (counterfactual) competitive equilibrium, i.e. market state absent cartelization. Finally, by comparing cartelized and counterfactual (competitive) states, one can calculate price overcharges and corresponding losses in the output and the consumers' welfare.

To perform the calibration of market parameters, we consider a model that describes the equilibrium outcomes on the differentiated product market, where firms compete in prices (differentiating product characteristics are assumed to be fixed). Demand and supply are modeled separately in order to recover equilibrium outcomes.

Precisely, market demand is derived from a general class of discrete choice models of consumer behavior. LOGIT specification that we have chosen is simple and good enough to obtain the desirable structure of demand and, most importantly, it allows explicit calculation of the consumers' surplus in money terms. We assume that there are N potential consumers on the market, each of them considers buying one unit of the product from one of J firms that form a cartel. Consumer can also choose the so called 'outside option', denoted with index

"0". Outside option may represent a substitute offered by other firms (not participating in the cartel) as well as consumer's decision not to buy at all.

The utility of consumer *i* buying product j is defined as $U_{ij} = \delta_j - \alpha p_j + \upsilon_i$, where $\delta_j, j = \overline{1, J}$ are parameters of differentiation (e.g. quality of the product or services offered) that are specific to each product and p_j is the price of product j. α is the marginal utility of money common for all products and consumers that reflects the sensitivity of consumers to the price relative to how they value quality. Higher α would mean that consumers take their decision mostly according to the price of the product, rather than its quality characteristic. υ_{ij} is the consumer *i*'s idiosyncratic utility component that is specific to product j. It is assumed to be identically and independently distributed across consumers and products.

Consumer *i* chooses product *j* if it maximizes her expected utility, such that $U_{ij} > U_{ij'} \forall j' \neq j$. According to Berry (1994), demand associated with the alternative *j* can, therefore, be represented by the following equation:

$$\ln(s_j(p)) = \ln(s_0(p)) + \delta_j - \alpha p_j \qquad (1)$$

where s_j is a market share of the firm *j* and s_0 is the share of the outside option and $p = (p_1, p_2, ..., p_J)$ is the price vector.

Or, eventually, by

$$s_j(p) = \frac{\exp(\delta_j - \alpha p_j)}{1 + \sum_{i=1}^{J} \exp(\delta_i - \alpha p_i)}, \quad \forall j = \overline{1, J} \qquad (2)$$

where the utility of the outside option is normalized to zero ($U_{0i} = 0, \forall i = \overline{1, N}$)

Note, that since the size of the market is fixed to N, market shares can be easily interpreted in terms of sold quantities and vice versa.

In such framework, profit of each firm *j* is defined by the function $\pi_j(p) = (p_j - c_j) * s_j(p) * N$, where c_j are marginal costs that are assumed to be constant.

Further we employ several hypotheses that help to simplify the model and recover unknown market parameters. We first presume that cartel participants act under perfect collusion, choosing prices that maximize the joint profit of the cartel. Second, we assume that

cartel members agree to fix their gross margins to a certain value that is constant for all firms, such that $(p_j - c_j) = const, \forall j = \overline{1, J}$. Under these assumptions, from the cartel's joint profit maximization problem it is easy to obtain the following cartel equilibrium condition:

$$(p_j - c_j) = 1/\alpha s_0, \forall j = \overline{1, J} \quad (3)$$

System of equations that includes (2) and (3), therefore, fully describes the cartelized market equilibrium $(p_j^{cartel}, s_j^{cartel}), \forall j = \overline{1, J}$. Cartel's prices and market shares one can recover from factual market data related to the period of cartelization. Note, however, that market shares that are employed in the model (s_j^{cartel}) are not the same as those observed from the market data (denoted as $\bar{s}_j^{cartel}$). The latter ones stand for the market shares within the cartel, while the former take into account the presence of the outside option, such that $\bar{s}_j^{cartel} = \frac{s_j^{cartel}}{(1 - s_0)}$ and $\sum_{j=1}^{J} \bar{s}_j^{cartel} = 1$.

To be able to solve the system of equations composed of (2) and (3), and by doing so recover the unknown market parameters, one would need to set two of them exogenously. One of the parameters that we initially choose to fix is the gross cartel margin $(p_j^{cartel} - c_j), \forall j = \overline{1, J}$. Note, that this is equivalent to choosing the average cartel margin $AM \equiv \sum_{j=1}^{J} \bar{s}_j^{cartel} \frac{(p_j^{cartel} - c_j)}{p_j^{cartel}}$.[7] Because the latter is a relative measure and therefore can be much easier to interpret we finally choose the average cartel margin as one of the exogenous parameters for the calibration procedure. The second parameter is the share of the outside option s_0.

Firms gross margins could be extracted from the colluding companies' annual reports, even if often only approximately. In contrast, it becomes much more complicated when it comes to the estimates of the share of the outside option. There is no standard procedure to define the potential market size, and methodology might differ significantly depending on the

[7]Recall that margin constant for all cartel participants is one of thebasic assumptions of the methodology. Keeping this in mind, when market shares and prices are known, it is easy to recover average cartel margin from the standard ones, and vice versa:

$$AM \equiv \sum_{j=1}^{J} \bar{s}_j^{cartel} \frac{(p_j^{cartel} - c_j)}{p_j^{cartel}} = (p_j^{cartel} - c_j) \underset{constant\ for\ all\ j}{} \sum_{j=1}^{J} \frac{\bar{s}_j^{cartel}}{p_j^{cartel}}$$

product and market considered. However, independently on the procedure chosen, the sum of all market shares, including the one of the outside option, must be always equal to one, i.e. $\sum_{j=1}^{J} s_j^{cartel} + s_0 = 1$.

Having set exogenously average cartel margin and share of the outside option we first recover parameter α from equation (3):

$$\alpha = \frac{1}{s_0(p_j^{cartel} - c_j)} = \frac{\sum_{j=1}^{J} \frac{\bar{s}_j^{cartel}}{p_j^{cartel}}}{AM * s_0} \quad (4)$$

In the list of the parameters set exogenously one can choose to replace cartel's margin or the share of the outside option with marginal costs if they are known. In this case equation (4) will remain valid and further steps of the methodology will not be affected.

Now we have all required information to recover the parameters of differentiation δ_j from equation (1). Marginal costs can , therefore, be recovered from the values of margins, either average for the cartel or firm-specific gross margins.

While choosing values of exogenous parameters, one needs to make sure that obtained values of marginal costs and parameter of sensitivity to the price α are non-negative. Note, that there are no sign restrictions to the values of δ_j.

At this point, one is able to calculate the set of own- and cross-price elasticities (correspondingly):

$$\varepsilon_{jj} = -\alpha p_j^{cartel}(1 - s_j^{cartel}), \quad \forall j = \overline{1, J} \quad (5)$$

$$\varepsilon_{ji} = \alpha s_i^{cartel} p_i^{cartel}, \forall j, i = \overline{1, J}, i \neq j \quad (6)$$

Obtained estimates can be compared with existing ones from the other sources. This may be seen as an additional cross-validation for the values of exogenous parameters and may result in corresponding corrections.

At the end of the calibration procedure one has all missing market parameters $(\alpha, \delta_j \text{ and } c_j, \forall j = \overline{1, J})$ recovered. They are assumed to remain the same whether the market is cartelized or not. And now we are ready to proceed with the simulation of the counterfactual (competitive) state of the market.

In the absence of collusion each firm would take a decision on its own price to maximize own profits, taking into account own marginal costs and expected pricing strategy of competitors. A standard solution for each firm's profit maximization problem would be:

$$p_j - c_j = \frac{1}{\alpha(1-s_j)}, \forall j = \overline{1,J} \tag{7}$$

while (2) remains valid.

As a solution of the system of equations (7) and (2) we obtain counterfactual (competitive) prices $p_j^c, j = \overline{1,J}$ and market shares $s_j^c, j = \overline{1,J}$. By comparing cartel's and competitive prices we can calculate price overcharge for every cartel member as well as cartel's average price overcharge:

$$\Delta P\% = \sum_{j=1}^{J} \bar{s}_j^{cartel} \frac{(p_j^{cartel} - p_j^c)}{p_j^{cartel}} \cdot 100 \tag{8}$$

Formula in (8) gives a price overcharge estimate in percentage, but it can easily be transformed into money terms by multiplying firm specific price overcharges on the corresponding cartel member sales.

Moreover, employed demand model allows explicit calculation of the consumers' welfare (surplus) losses, both in percentage and in money terms. We make use of the formula, proposed in Anderson et al. (1992)):

$$CS = \frac{1}{\alpha} \ln\left(1 + \sum_{j=1}^{J} \exp(\delta_j - \alpha p_j)\right) \tag{9}$$

Hence, relative consumers' welfare losses caused by collusive practices could be calculated as following:

$$Welfare\ losses(\%) = \frac{\left(\ln\left(1+\exp\sum_{j=1}^{J}(\delta_j - \alpha p_j^c)\right) - \ln\left(1+\sum_{j=1}^{J}\exp(\delta_j - \alpha p_j^{cartel})\right)\right)}{\ln\left(1+\exp\sum_{j=1}^{J}(\delta_j - \alpha p_j^c)\right)} \cdot 100 \tag{10}$$

On one hand, an obvious advantage of our methodology is that it requires very limited data to be implemented: it can be employed only with information on prices and observed market shares of colluding companies at least for one period of cartel existence. On the other hand, it is based on a relatively simple model and uses a few assumptions that result in certain

limitations. We discuss them below.

First, demand is designed from a simple LOGIT model, which is quite flexible but has a specific property of Independence of Irrelevant Alternatives. In a nutshell, this model generates a particular consumers' behavior pattern: motivated by a price increase consumers would switch to the product with the maximal market share, but not the one with closest quality characteristics. Indeed, it may not be a true behavioral pattern in reality.

Second, our methodology is based on assumption about the perfect collusion among cartel participants while real level of coordination among firms could be much weaker. Under these conditions, obtained estimates of price overcharge and consumers' welfare losses are the maximal ones for the assumed levels of cartel's margin and share of the outside option.

Third, when one changes assumptions about cartel margin and/or share of the outside option, then values of calibrated market parameters and, ultimately, final estimates of the interest also change. For this reason it makes sense to consider not the exact values but rather a reasonable range for each of exogenous parameters, based on the common sense and available market data. Sensitivity of estimation results with respect to the parameters that are set exogenously differs in each particular market. Considering reasonable ranges for external parameters rather than exact values shall help in assessing the robustness of obtained results. Additional market expertise, when available, could also help to narrow down the range of calibrated market parameters and, eventually, obtain more precise estimations of price overcharge and consumers' welfare losses.

In the Appendix C we illustrate application of the proposed methodology on the price-fixing cartel between civil airlines in Brazil.

It is unfortunate to acknowledge that competition authorities in developing countries often do not possess even the minimal economic data required to employ the methodology. Or, even if they do, it is often considered as confidential. Due to this reason, it was possible to perform estimations only in eleven cases. Results are provided in Table 3.

Table 3: Estimates of price overcharges and output losses obtained with the use of the developed methodology

Industry (country)	Period of existence	Min $\Delta p\%$	Max $\Delta p\%$	Min $\Delta q\%$[8]	Max $\Delta q\%$
Civil airlines (Brazil)	Jan'99-Mar'03	3.20%	33.90%	10.00%	24.2%
Crushed rock (Brazil)	Dec'99-Jun'03	3.40%	11.25%	15.69%	25.80%
Security guard services (Brazil)	1990-2003	4.80%	27.84%	14.93%	23.15%
Industrial gas (Brazil)	1998-Mar'04	4.12%	29.96%	5.00%	22.77%
Steel bars (Brazil)	1998-Nov'1999	5.49%	37.84%	10.99%	27.81%
Steel (Brazil)	1994-Dec'99	13.55%	40.13%	5.00%	29.22%
Medical gases (Chile)	2001-2004	37.50%	49.40%	2.00%	14.93%
Petroleum products (Chile)	Feb'01-Sep'02	4.57%	9.90%	10.43%	23.35%
Construction materials (Chile)	20 Oct'06	47.78%	83.48%	7.24%	22.95%
Petroleum products II (Chile)	Mar'08-Dec'08	1.78%	11.13%	9.63%	18.99%
Cement (Egypt)	Jan'03-Dec'06	28.20%	39.3%	5.00%	10.00%
Average for the category		14.04%	34.01%	8.68%	21.94%
Average		24.02%		15.41%	
Median		18.6%		16.9%	

Table 3: Price overcharge is measured with respect to the cartelized price, while losses in the output with respect to the counterfactual (competitive) state.

Obtained average and median price overcharge rate of 24.21% and 18.6% correspondingly are of the same magnitude as for the rest of the sample (23.1% and 20%, see Table 1). We acknowledge, however, that the difference between the estimated maximal and minimal bounds of price overcharges and output losses is often large. A competition authority that wants to implement the proposed methodology would certainly obtain a greater precision provided it uses the best information on the input parameters. Further analysis in Section 3 includes these additional estimations.

3. Aggregated cartels' effects

Overall, the descriptive statistics of the collected data demonstrate that the anticompetitive impact in terms of price overcharges is at least similar to that in developed countries, which calls for adequate antitrust measures. Young competition authorities, that

[8]Minimal and maximal estimated output losses can appear rounded. This is a results of some particularities of the methodology employed , particularly because some parameters need to be set exogenously.

often lack resources to efficiently fight against collusive practices are having hard times lobbing for a greater budget and, therefore, are constantly looking for strong and motivating evidence of the benefits that their existence brings. We believe that the latter could be provided by looking at the aggregate measures of cartelization harm that we provide in this section. The approach that we use consists in summing up the obtained cartel case-specific impact estimates in money terms and assessing their significance on the macro-economic level.

Precisely, in our analysis we focus on several aggregate indicators. First, inspired by Levenstein, Suslow and Oswald (2003) we find it appropriate to consider aggregated sales that were affected by collusive behavior, i.e. total revenues received by cartel members. More innovatively, we also assess the aggregate cartel damage in terms of excess profits. Both measures are summed up for all cartels in each particular country and related to the GDP. We supplement the discussion with a sort of "cost-benefit" analysis of the antitrust enforcement by relating the aggregated excess profits to the budget of the corresponding competition authority ("CA Budget").

In order to obtain more comprehensive aggregated estimates we first fill the remaining data gaps in by applying an additional treatment to the originally collected data.

For those countries where competition authority sets maximal penalty as percentage of cartel's sales (like, for instance, in Brazil, South Korea, Ukraine, South Africa, etc.), we approximate the missing cartel sales as the respective penalty in money terms divided by the maximal penalty rate.[9] Note that this approach provides an estimate of the minimal level of cartel's sales. The penalty in those cases is set based on the sales recorded in the year preceding the one where the court decision on the case was made. Therefore, the minimal approximated cartel sales need to be further multiplied by cartel duration in years. When price overcharge was unknown and it was not possible to employ the proposed methodology to estimate it, we roughly approximated the excess cartel's excess profits by multiplying the sample median overcharge rate and cartel sales. In case cartel sales were missing, we first assumed the cartel's excess profits as equal to applied penalties. Recall that, according to Table 1, applied penalties do not in average compensate for the excess profits gained by cartel

[9] For example, if a cartel was fined for 100 USD and the maximal penalty rate is 10% of cartel's sales, then minimal bound for cartel's sales can be estimated as 100/0.1=1000 USD. Because percentage penalty rule is sometimes applied to company's total sales, we have employed, where needed and where possible, a coefficient that corresponds to the share of sales on the relevant market in total company sales.

members, therefore this approximation provides a minimal level of cartel's excess profits. Knowing the minimal level of cartel's excess profits allowed, in turn, recovering back the missing cartel sales by applying the median price overcharge rate.

Finally, to make the nominal values, such as sales, excess profits, penalties and competition authorities' budgets comparable among different years, we apply relevant denominators to translate them into the currency of the last year of the considered period (specific for each country).

Aggregated harm was calculated separately for countries with sufficient data, namely Brazil, Chile, Colombia, Indonesia, South Africa, Mexico, Pakistan, Peru, Russia, South Korea, Ukraine and Zambia. The selection criterion is basically the availability of quantified impacts of cartels that represent a significant part of all detected cases in the country. Except for Zambia, whose only quantified cartel had a tremendous economic impact.

For these countries in Table 4 below we provide the breakdown of recorded cartel cases indicating the number of quantified ones. Information in brackets refers to number of cases for which corresponding missing inputs were approximated by means of the above treatment. We employ the term 'allocated' for those cartels when we were able to associate sales and excess profits with a certain year, i.e. only those when at least cartel's beginning or breakdown year was known.

Table 4: Availability of quantified impacts of detected cartels (numbers)

Country (period)	# of cartels recorded	# of cartels with data on sales	# of cartels with data on overcharges	# of 'allocated' cartels
Brazil (1995-2005)	18	17(1)	17(3)	17
Chile (2001-2009)	17	16(6)	16(7)	16
Colombia (1997-2012)	18	17(17)	17(17)	17
Indonesia (2000-2009)	12	8(0)	8(1)	7
Mexico (2002-2011)	17	17(9)	17 (11)	17
Pakistan (2003-2011)	14	14(6)	14(9)	14
Peru (1995-2009)	11	10(2)	10(2)	10
Russia (2005-2013)	15	11(10)	11(11)	11
South Africa (2000-2009)	37	23(7)	23(18)	23
South Korea (1998-2006)	26	26(0)	26(8)	26
Ukraine (2003-2012)	7	7(6)	7(7)	3
Zambia (2007-2012)	7	1(0)	1(0)	1

The two aggregated indicators of the interest we first calculate as an average for the considered period. Looking at the year-to-year dynamics would be misleading because both ends of the period have a high risk of not being representative - either because of a low activity of the competition authority in the beginning or because the end of the period is often characterized by multiple ongoing cartel investigations. Absent final decision made on the case corresponding price overcharges and other data cannot be included into the database. Because of these reasons even average for the period estimates can be biased, thus we find it important to report also the maximal value together with the year that it corresponds to. Table 5 summarizes obtained results.

Table 5: Aggregated indicators

Country	Aggregated excess profits / GDP, %		Affected sales/ GDP, %		Aggregated excess profits / CA Budget	
	Average	Max (year)	Average	Max (year)	Average	Max (year)
Brazil (1995-2005)	0.21%	0.43% (1999)	0.89%	1.86% (1999)	308	1232 (1998)
Chile (2001-2009)	0.06%	0.23% (2008)	0.92%	2.63% (2008)	23	91 (2008)
Colombia (1997-2012)	0.001%	0.002%(2011)	0.01%	0.01% (2011)	7	36 (2006)
Indonesia (2000-2009)	0.04%	0.09% (2006)	0.50%	1.14% (2006)	29	58 (2004)
Mexico (2002-2011)	0.01%	0.02% (2011)	0.05%	0.11% (2011)	7	19 (2011)
Pakistan (2003-2011)	0.22%	0.56% (2009)	1.08%	2.59% (2009)	245	518 (2008)
Peru (1995-2009)	0.002%	0.007%(2002)	0.01%	0.023% (2002)	6.44	25 (2004)
Russia (2005-2013)	0.05%	0.12% (2012)	0.24%	0.67% (2012)	0.58	1.45 (2008)
South Africa (2000-2009)	0.49%	0.81% (2002)	3.74%	6.38% (2002)	124	214 (2005)
South Korea (1998-2006)	0.53%	0.77% (2004)	3.00%	4.38% (2004)	144	214 (2004)
Ukraine (2003-2012)	0.03%	0.03% (2011)	0.15%	0.16% (2011)	0.84	0.88 (2011)
Zambia (2007-2012)	0.07%	0.09% (2007)	0.18%	0.24% (2007)	11	27 (2007)
Average	0.14%		0.9%		76	

Our results confirm that cartels` impact in developing economies can indeed be substantial. In terms of affected sales related to GDP, it varies among countries from 0.01% to 3.74% on average for the considered periods, while its maximal value reaches up to 6.38% for South Africa in 2002. Remarkably, calculations for Zambia are based on only one cartel for which data are available (market of fertilizers, 2007-2012), but even taking this into

consideration the impact is not negligible (0.24% of GDP in terms of affected sales). Actual harm in terms of aggregated cartels' excess profits is also significant, with maximal rates reaching almost 1% in terms of GDP for South Korea in 2004 and South Africa in 2002.

The cost-benefit analysis performed for selected competition authorities demonstrates that potential benefits of having an antitrust division (or alternative costs of not having it) measured as aggregated cartel excess profits exceed the competition authorities' budgets on average 76 times and can reach up to 1232 times (see the last two columns in Table 5).[10] Here we assume that a cartel would exist for at least as long as it already did before being discovered. Data on budgets that we have collected comprise expenses for all activities of the competition enforcement unit, including merger investigations that are traditionally highly demanding in terms of resources. Therefore, the cartel-specific efficiency rate can turn out significantly higher.

Our estimates can be considered as a very minimal bound for the economic harm caused by collusive behaviour because of multiple reasons. First of all, the collected data on detected cartels remain very limited. Even though some competition authorities agreed to cooperate, we have to acknowledge that the list of prosecuted 'hard – core' cartels for every country is still not complete, nor were all the required data obtained for each of the cases. Out of 249 defined cases only 83 have data on price overcharges, 175 on applied penalties and 114 on cartel's sales. As Table 4 above illustrates, many of recorded cases were excluded from calculations of the aggregate effects because of missing data. On top of this there is another reason, t hat may in fact be a principal one - some of the existing cartels remain uncovered.

[10] Here we assume that when cartel breaks down then firms come back to their competitive equilibrium strategies. As a consequence of this, firms are supposed to low down prices to a pre-cartel level. Evidence on post-cartel behavior collected by Connor (2010a) and Sproul (1993) indicates that this assumption might not be always valid. Given that for our sample very limited price data were available even for the period of cartel existence, and no data at all are available for post-cartel periods, we should admit that this is almost impossible to test whether the assumption in question holds for our sample of cartels.

Note that a high level of excess cartel profits related to the competition authority budget does not necessarily witness for the efficiency of the antitrust enforcement. Firstly, a low level of the ratio in question can result from a high efficiency of the competition authority if the latter focuses rather on cartel deterrence (education through mass media or higher penalties, etc.) than cartel detection. Low number of detections or lower excess profits can simply reflect the fact that there exist fewer cartels or that they are weaker. Second reason is that competition authorities can 'free ride' on the experience of the other ones. By 'free riding' we mean a situation when a cartel case already went through an examination in one of the competition authorities, and the others use this fact to trigger its own investigation or even use the already extracted evidence. Therefore a competition authority can win the case without investing too much. As the collected sample demonstrates, 'free riding' can indeed take in place - the same cartels are often found in a large number of (often neighboring) countries. For example, this is the case of industrial gas distribution cartels in Latin America or cement cartels in Africa. Although, 'free riding' can potentially be considered as a sort of efficiency as it is a way of 'economizing' the resources.

To assess how far (or how close) we are from understanding the real scale of the damage, in the next section we estimate the deterrence rate, i.e., the annual probability of a cartel to be detected. To our knowledge this is the first attempt to do so on a sample of cartels detected in developing countries.

4. Estimation of the deterrence rate

To estimate the deterrence rate we have adopted the approach proposed in Combe et al (2008). We did not modify their methodology, therefore only a brief description of the main idea and results of its application on our database will be provided. In a nutshell, authors consider a markovian process with two elements that are related to the cartel birth and its' death that is associated with detection. Cartels inter-arrival time and duration between their birth and detection - are both random variables distributed exponentially and independently across cartels.[11] The model allows calculating instantaneous probability of cartel detection through the maximum likelihood estimation method. Because the sample naturally contains only cartels that were detected, the estimated probability is *conditional on that the cartel will be eventually detected.* This value, in turn, represents the *maximal* bound of the global instantaneous probability of cartel detection (the sought-for deterrence rate).

For our sample the estimated maximal annual probability of detection equals to 24%. It is significantly higher than the upper bound of the same variable estimated by Combe et al. (2008) for the E.U. cartels prosecuted from 1969 to 2007 (12.9-13.3%%) that apparently witness for a more efficient antitrust enforcement in developing countries.[12] A lower rate for the E.U. can be explained by inclusion into consideration of earlier years that are characterized with a weaker antitrust enforcement. An additional explanation can be also offered. When cartel members are international corporations they often enter collusive agreements in several, often neighboring developing countries. Apart of the famous vitamins cartel, our sample includes, for instance, medical gas distribution cartels, prosecuted in Argentina, Brazil, Chile, Colombia and Mexico in late 90s-early 2000s, or cement cartels that

[11] Because the cartel duration in our database is often not precise (for example, the year only was reported) we take the maximal duration for each of the cartels that contains complete months/years, unless a more precise information is available. To see whether our data fit model assumption of independency and exponential distribution we performed the same testing as in Bryant and Eckard (1991). Corresponding estimation results and graphs are available upon request.

[12] Estimates for the E.U. are taken from Combe et al (2008) and cover cartels prosecuted from 1969 to 2007. The maximal bound for the annual deterrence rate of 13% - 17% was estimated with a similar methodology for a set of U.S. cartels. (See Bryant and Eckard (1991).) However these result should not be compared with the one from our study as situation in the antitrust enforcement has significantly changed since the period that was considered by authors (from 1961 to 1988).

took place over the last 30 years in South Africa, Argentina, Egypt, Korea, Mexico and other developing countries. Evidence provided by other countries may serve as a trigger for local investigations and can facilitate the cartel detection, increasing, therefore, the deterrence rate.

A maximal deterrence rate of 24% basically means that *at least* 3 out of 4 existing cartels remain uncovered. Therefore, we suggest that the actual economic harm caused by 'hard-core' cartels in developing countries exceeds our estimations from the previous section at least fourfold.

5. Conclusions and policy implications

The competition policy implementation and enforcement, including cartel investigations, require substantial investments. Therefore, it is important to measure to which extent those expenditures are compensated in terms of prevented consumers' damages. Especially this is relevant for developing competition authorities that often experience tough budget constraints. To provide the required evidence we have collected an original dataset that contains information on 249 major 'hard-core' cartels that were prosecuted in more than 20 developing countries from 1995 to 2013.

Descriptive statistics of our dataset of cartels do not bring any strong evidence to the widespread idea that developing countries are exposed to a higher cartel price overcharges than the developed ones. However, we do show that price overcharges are at least similar, which calls for adequate antitrust measures. We also show that the aggregated impact can be substantial. In terms of affected sales related to GDP the maximal rate reaches up to 6.38% (South Africa in 2002). The actual damage in terms of cartels' excess profits is also significant, with maximal rates reaching almost 1% of GDP (South Korea in 2004 and South Africa in 2002).

Study of Boyer and Kotchoni (2014) demonstrates on the sample from Connor (2010b) that data on price overcharges obtained from different methodologies, sources and contexts are asymmetric and heterogeneous, and therefore, are subject to a significant estimation bias. Non-biased estimates are, in fact, lower than simple medians calculated from the raw data. For example, bias correction reduces median price overcharge for the E.U. countries from 22.48% to 14.04% and from 16.67% to 13.58% for the U.S. and Canada.[13]

[13]Estimates from Boyer and Kotchoni (2014) were originally provided with respect to a 'but-for' prices, therefore they were recalculated with respect to the cartel price to be comparable with the other estimates in the paper.

Therefore, ideally, our own sample would require similar corrections to be made. We, nevertheless, insist that our aggregate damage estimates correspond to the very minimal bound of cartels' effects. This is so because of at least six reasons.

First, present study only takes into consideration cartel cases that are already closed. It, therefore, does not take into account neither cases under investigation nor those for which competition authority failed to prove its existence.

Second reason is that economic data on convicted cartels are very poor. This is so because to condemn a cartel competition authorities rely mostly on the evidence of coordination activities rather than the economic one. Coupled with confidentiality issues, this reason resulted in elimination of multiple recorded cases from calculation of aggregate effects.

Third, collusive practices harm consumers not only in terms of inflationary effects, but also because they limit consumption. Our analysis demonstrates that, on average, a cartel decreases the production level by about 15% on the concerned market (see Table 3). Taking into account these output effects would provide more accuracy for our estimations. Our methodology allows one to calculate the losses in consumers' surplus that could serve to measure both changes - in prices and in quantities. However, in our sample its' application is limited to only a few cartel cases with sufficient data.

On top of this, our estimates do not take into account neither price umbrella effects[14] nor possible degradation in quality.[15]

Fifth reason is that many of the cartelized industries produce intermediary goods, such as, for instant, cement or gas. Therefore the consequent price overcharge may proliferate further on other economic sectors, increasing the final impact manifold. By employing the country level input-output matrixes and corresponding industry pass-through rates together with estimated cartel excess profits one would be able to i) assess the potential impact of those proliferations, and ii) define a set of industries that have the highest damaging potential and therefore deserve a special attention from the competition authority. We find it as a very promising area for further development.

[14]Cartels can potentially cause a price umbrella effect as remaining firmscould have more incentives to charge higher prices facing a price increase from cartel members.

[15]Even though our model does not allow the quality characteristics to change, the degradations in quality can still appear as colluding firms may have less incentive to maintain it.

The final, but probably the most important reason for our estimates to reflect only the minimal bound, is the hidden nature of cartels. As we estimate the maximal annual probability of uncovering an existing cartel to be around 24%, we suggest that the actual economic damage resulting from collusive practices in developing countries is at least 4 times bigger that suggested by our estimations.

We have also demonstrated that even this minimal estimated economic harm for the majority of considered countries significantly exceeds the expenditures to maintain the functionality of the relevant antitrust body. This may serve as a sought-for evidence for the competition authorities who wish to justify the requirement for an additional budget to improve the cartel deterrence and detection. More than that, developing competition authorities may wish to take advantage of the proposed methodology for their own cartel investigations as it will reduce the data required to estimate the economic damages. The efficiency of the penalty rule can be then assessed by comparing the imposed fines with cartels' excess profits. Actual penalty - excess profits rates could be compared against relevant benchmarks that are considered by the competition authority as optimal.

The last, but not the least, the created cartels database may be seen as a reference list containing industries that are potentially vulnerable to collusive behavior. Cartel members often enter into collusive agreements in multiple, often neighboring, economies. Therefore, evidence from other countries can (and should) be employed by competition authorities in local investigations. This may encourage countries to create a worldwide platform that would allow sharing and maintaining the common cartel database, for instance, on the basis of the International Competition Network (ICN).

References

Aghion, P. and P. Howitt (2005), "Appropriate Growth Policy: A Unifying Framework", paper presented at the OECD Conference on Global convergence scenarios: structural and policy issues, Paris, January 2006.

Allain et al. (2011), "The Determination of Optimal Fines in Cartel Cases: The Myth of Underdeterrence", Available at SSRN: http://ssrn.com/abstract=1987107 or http://dx.doi.org/10.2139/ssrn.1987107

Anderson et al. (1992)," Discrete Choice Theory of Product Differentiation", MIT Press, 1992

Baker, J. B (2003), "The Case for Antitrust Enforcement". Journal of Economic Perspectives, Vol. 17, Number 4, Fall 2003, Pages 27-50

Berry, S.T. (1994), "Estimating Discrete-Choice Models of Product Differentiation, RAND Journal of Economics, vol. 25(2), pages 242-262

Boyer, M. and R. Kotchoni (2014), "How Much Do Cartels Overcharge?", previous (published) version of the paper can be found at http://ssrn.com/abstract=2076055

Bryant, P. and E. W. Eckard (1991), " Price Fixing: The Probability of Getting Caught", The Review of Economics and Statistics Vol. 73, No. 3 , pp. 531-536

Buccirossi, P. al. (2009), "Competition policy and productivity growth: An empirical assessment", CIG Working Papers with number SP II 2009-12.

Combe, E. et al. (2008), "Cartels: The Probability of Getting Caught in the European Union", available at SSRN: http://ssrn.com/abstract=1015061

Connor, J.M. (2005), "Price-fixing overcharges: legal and economic evidence", Staff Paper No. 04-17, Purdue University

Connor, J.M. (2010a) "Recidivism Revealed: Private International Cartels 1991-2009", available at SSRN: http://ssrn.com/abstract=1688508 or http://dx.doi.org/10.2139/ssrn.1688508

Connor, J.M. (2010b), "Price-fixing Overcharges, 2nd Edition", available at http://papers.ssrn.com/sol3/papers.cfm?abstract_id=1610262

Connor, J.M (2011a), "Price Effects of International Cartels in Markets for Primary Products", materials of the Symposium on Trade in primary Product Markets and Competition Policy" at the World Trade Organization, September 22, 2011.

Connor, J.M. (2011b), "Cartels portrayed" working papers series. The American Antitrust Institute, working papers No. 11- 06, 11-03, 11-04, 11-05, 11-06 and 11-07.

Connor, J.M. and Y. Bolotova (2006), "Cartel overcharges: Survey and meta-analysis", International Journal of Industrial Organization, 24, 1009-1137.

Crandall, R.W. and C. Winston (2004), "Does Antitrust Policy Improve Consumer Welfare? Assessing the Evidence", The Journal of Economic Perspectives, Vol. 17, No. 4 (Autumn, 2003), pp. 3-26

Griffith, R. and R. Harisson (2004), "The link between product market reform and macro-economic performance," European Economy - Economic Papers 209, Directorate General Economic and Monetary Affairs, European Commission

Hammond, S.D. (2005), "Optimal Sanctions, Optimal Deterrence", presented at ICN Annual Conference, Bonn, Germany on June 6, 2005

Jenny, F. (2006), "Cartels and Collusion in Developing Countries: Lessons from Empirical Evidence", World Competition 29(1): 109-137, 2006.

Motta, M. (2004) "Competition Policy: Theory and Practice", Cambridge University Press, 2004

Levenstein, M.C., V. Y. Suslow, and L. J. Oswald (2003), "Contemporary International Cartels And Developing Countries: Economic Effects And Implications For Competition Policy", Working Paper #03-10

Nicoletti G. and S. Scarpetta (2003), "Regulation, productivity, and growth: OECD evidence", Economic Policy, CEPR & CES & MSH, vol. 18(36), pages 9-72, 04

Sproul, M. F. (1993), "Antitrust and Prices," Journal of Political Economy, vol. 101(4), pages 741-54

Appendix A - Major 'hard core' cartels prosecuted in selected developing countries (1995-2013)

Argentina		**Chile (cont.)**	
Portland cement	1981-1999	Vehicles and spare parts	11 Aug'06 (bid rigging)
Medical gases	n/a-1997	Publishing services	Mar'08-Apr'08
Healthcare services	n/a	Pharmaceutical (distribution)	Dec'07-Apr'08
Liquid petroleum gas (S.C. Bariloche)	Jan'98-Dec'98	Public transportation	Oct'06-Nov'07
Sand (Parana city)	Jun'99-Jul'01	Radio transmission	2007
Liquid oxygen	Jan'97-Dec'01	Tourism (agent services)	2008
Cable TV (Santa Fe city)	Oct'97-Dec'01	Public transportation (maritime)	2009
Cable TV service (football transmissions)	Jan'96-Dec'98	Public transportation (bus)	Feb'07-Mar'09
Brazil		Flat Panel TV	n/a
Civil airlines	Jan'99-Mar'03	**Colombia**	
Retail fuel dealers (Goiania)	Apr'99-May'02	Cement	Feb'06-Jan'10
Retail fuel dealers (Florianopolis)	1999-2002	Mobile phone services	Apr'99-Aug'07
Retail fuel dealers (Belo Horizonte)	1999-2002	Green onions	Feb''07-Jan'09
Retail fuel dealers (Recife)	Apr'99-Feb'02	Pasteurized milk	Jan'97-n/a
Generic drugs	Jul'99-Oct'99	Green paddy rice	Jan'04-Nov'06
Maritime hose	Jun'99-May'07	Chocolate and cocoa products	Oct'06-Oct'09
Crushed rocks	Dec'99-Jun'03	Private security services	Feb'11-Sep'12
Security guard services	1990-2003	Services of grade systematization (Bogotá District schools)	Jun'08-Dec'09
Hermetic compressors	2001-2009	Milk processing	n/a-2008
Industrial gas	1998-Mar'04	Health services	Mar/09-Nov'11
Air cargo	Jul'03-Jul'05	Oxygen supply	May'05-Mar'11
Transportation	Oct'97-Jan'01	Road paving	Aug'10-Jan'12
Steel bars	1998-Nov'99	Sugar cane remuneration rates	Feb'10-Aug'11
Construction materials (sand)	1998-Apr'03	Cars' techno-mechanical and gas review	Mar'10-Oct'11
Steel	1994-Dec'99	Cars' techno-mechanical and gas review	Mar'10-Dec'11
Blood products	Jan'03-Dec'03	Feed ration service for prisons	May'11-Sept'12
Toy manufacturers (imports from China)	2006-2009	Cars' techno-mechanical and gas review	Apr'10-Mar'12
Chile		TV advertising market	Apr'10-Apr'11
Petroleum products	Feb'01-Sep'02	**Egypt**	
Medical gases (oxygen)	2001-2004	Construction (Egypt Wastewater Plant)	Jun'88-Sept'96
Medical insurance plans	2002-2004	Cement	Jan'03-Dec'06
Medical services	May'05-May'06	**El Salvador**	
Construction materials (asphalt)	20 Oct'06 (bid rigging)	Petroleum products	n/a-2007
Public transportation (bus)	2006	**Indonesia**	
Public transportation (bus)	Nov'07-May'08	Mobile phone services	Mar'03-Nov'05
Petroleum products	Mar'08-Dec'08	SMS	Jan'04-Apr'08

Indonesia (cont.)	
School books	Jan'99- Dec'00
Cement	n/a-Dec'09
Airlines	Jan'06-Dec'09
Pharmaceuticals	n/a
Poultry (day old chicken)	Jan'00-Dec'00
Sea cargo (Jakarta-Pontianak)	Jun'02-Oct'03
Sea cargo (Surabaya-Makassar)	Jan'03-Sep'03
Public transportation (city bus)	Sep'01-Oct'03
Salt Trade (North Sumatra)	Jan'05-Dec'05
Sea Cargo (Sorong Seaport)	Mar'00-Nov'08
Kazakhstan	
Petroleum products (brokers)	2002-2005
South Korea	
Batteries manufacturing (auto)	Jun'03-Sep'04
Beer	Feb'98-May'99
Cement	Jan'02-Mar'03
Construction machinery (excavators)	May'01-Nov'04
Forklifts manufacturing	Dec'99-Nov'04
Petroleum products (military, wholesale)	1998-2000
Telecom services (local, land line)	Jun'03-May'05
Telecom services (long-distance, land line)	Jun'03-May'05
Telecom services (international, landline)	Jun'03-May'05
Broadband Internet service	Jun'03-May'05
Detergent manufacturing	1998-2006
Telecommunications (mobile services) I	Jun'04-May'06
Telecommunications (mobile services) II	Jan'00-Jul'06
Gasoline and diesel (refining)	Apr'04-Jun'04
Industrial motors	1998-2006
Polyethylene (low density)	Apr'94-Apr'05
Polypropylene (high density polyethylene)	Apr'94-Apr'05
Movie tickets	Mar'07-Jul'07
Trunked radio system devices	Dec'03-Feb'06
Petrochemicals	Sep'00-Jun'05
Copy paper imports	Jan'01-Feb'04
Soft drink bottling	Feb'08-Feb'09
Gas (LPG)	Jan'03-Dec'09

South Korea (cont.)	
Elevators and escalators	Apr'96-Apr'06
Toilet roll manufacturing	Mar'97-Jan'98
Coffee	Jul'97-Jan'98
Kenya	
Coffee producers	n/a
Fertilizers I	n/a-2003
Beer (production)	n/a-2004
Soft drinks	n/a-2004
Transportation	n/a
Mechanical engineers services	n/a
Insurance (transportation sector)	n/a-2002
Petroleum (retail)	n/a-2004
Fertilizers II	n/a-2011
Tea growers	n/a-2004
Sugar	n/a-2004
Port Customs Department auctions	n/a
Malawi	
Cotton farmers	n/a
Tea growers	n/a
Tobacco growers	n/a
Bakeries	n/a
Beer	n/a
Petroleum sector	n/a
Mauritius	
Travel agency	2010
Mexico	
Gas (liquid propane)	Jan'96-Feb'96
Chemicals (film development)	Jan'98-Dec'00
Poultry	Mar'10-Mar'10
Boiled corn and corn tortillas	Mar'11-Jul'12
Corn mass and tortillas	May'10-Aug'12
Transportation (touristic sector)	Jul'09-Mar'12
Anesthesiology (services)	May'03-May'09
Auto transportation (cargo) I	Jan'10-Sep'11
Maritime public transportation	Jun'08-Jun'12
Auto transportation (cargo) II	Sept'08-Jun'10

Mexico (cont.)		**Russia (cont.)**	
Healthcare (medical drugs)	2003-2005	Laptop computer operating systems	n/a
Consulting services (real estate)	Jul'03-Apr'09	Fuel (petroleum, Krasnodarki krai)	Jan'05-Jul'05
Restricted TV signal	Oct'02-Dec'08	Fuel (petroleum, Rostov-on-Don)	n/a-2005
Food vouchers	Aug'05-Sept'05	Airlines (flights between Nizhnevartovsk and Moscow)	n/a-Dec'05
Consulting services (real estate) II	May'03-Jul'09	Railway transportation (Kemerovo)	Oct'11-Dec'12
Railway transportation (cargo)	Nov'05-Jun'09	Soda cartel	2005-2012
Cable and cable products	Feb'06-Mar'07	Polyvinylchloride cartel	2005-2009
Pakistan		Pharmaceutical cartel	2008-2009
Bank interest rates	Nov/07-Apr'08	Fish cartel (Norway)	Aug'11-Dec'12
Cement	Mar'08-Aug'09	Pollock cartel	Apr'06-Dec'12
Gas (LPG)	n/a-2009	Fish cartel (Vietnam)	Jun'08-Sept'13
Jute mills	2003-Jan'11	Salt cartel	May'10-May'13
High and low tension pre-stressed concrete poles	Aug'09-May'11	Sausage cartel	Jun'09-Dec'09
Poultry and egg industry	2007-Aug'10	Military uniform supply	2010-Jun'12
Newspapers	Apr'08-Apr'09	**South Africa**	
Vessels handling(ships)	2001-Mar'11	Fertilizers (phosphoric acid)	Jan'03-Dec'07
Port construction	May'09-Jul'10	Airlines (fuel surcharge)	May'04-Mar'05
Ghee and cooking oil	Dec'08-Jun'11	Airlines (So. Africa-Frankfurt routes)	Jan'99-Dec'02
Accounting services	Apr'07-Jan'13	Milk (farm and retail)	n/a-Jul'06
LDI operators	Sep'11-Apr'13	Bread and flour	1994-2007
GCC approved medical centers	Jan'11-Jun'12	Pharmaceuticals (wholesale distribution)	1998-2007
Banking services (1-Link Guarantee Ltd)	Sep'11-Jun'12	Tire manufacturing	1998-2007
Peru		Metal (scrap)	Jan'98-Jul'07
Urban public transportation 1	Aug'08-Oct'08	Steel (flat)	1999-Jun'08
Urban public transportation 2	Aug'08-Oct'08	Cement I	1996-2009
Public notaries	n/a	Plastic pipes	1998-2009
Dock work	Sep'08-May'09	Concrete, precast pipes, culverts, manholes, & sleepers	1973-2007
Insurance 1	Dec'01-Apr'02	Fishing	n/a-2009
Insurance 2	Oct'00-Jan'03	Cement II	Jan'04-Jun'09
Poultry	May'95-Jul'96	Construction	n/a-2009
Wheat flour	Mar'95-Jul'95	Steel distribution	n/a-2008
Heaters/boilers etc. manufacturing	Oct'95-Mar'96	Steel (re-bars, rods & sections)	n/a-2008
Oxygen distribution (healthcare)	Jan'99-Jun'04	Steel (wire, wire products)	2001-2008
Freight transport	Nov'04-May'09	Crushed rock	n/a-2008
Russia		Bricks	n/a-2008
Fuel (gasoline and jet)	Apr'08-Jul'08	Steel (tinplate)	Apr'09-Oct'09

South Africa (cont.)	
Steel (mining roof bolts)	2002-2009
Flour milling	2009-Mar'10
Bitumen	2000-2009
Poultry	2005-2009
Polypropylene plastic	1994-2009
Sugar	2000-n/a
Taxi	n/a
Auto dealers	2005-n/a
Healthcare fees	2002-2007
Pharmaceuticals	n/a-2002
Motor vehicle manufacturers/importers	n/a-2006
Freight forwarding	n/a-2007
Energy/switchgear	n/a-2008
Fertilizer (nitrogen)	2004-2006
Steel (reinforcing mesh)	2001-2008
Soda ashes (imports)	1999-2008
Tanzania	
Beer	n/a
Pipes, culverts, manholes and pre-stressed concrete sleepers	n/a-2009
Petroleum sector	n/a-2000
Turkey	
Daily newspapers	n/a
Traffic lights	n/a
Public transportation (buses)	n/a
Poultry	n/a
Bakeries	n/a
Beer	n/a
Soft drink	n/a
Maritime transport service	n/a-2004
Mechanical engineers	n/a
Insurance	n/a-2003
Telecommunications	n/a-2002
Architects' and Engineers' services	n/a-2002
Yeast	n/a
Cement	n/a
Cement (Aegean region)	2002-2004

Turkey (cont.)	
Accumulators	n/a
Ukraine	
Acquisition of raw timber auctions (furniture)	2011
Sale of poultry meat	n/a
Sale of sugar	n/a
Sale of alcohol	n/a
Sale of buckwheat	n/a
Individual insurance markets	2003
Market of services on sale of arrested property state	2004
Zambia	
Pipes, culverts, manholes and pre-stressed concrete sleepers.	n/a
Oil marketing	2001-2002
Fertilizer	2007-2013
Grain procurement and marketing (maize-meal)	Mar'04-Jun'04
Public transport	n/a
Poultry	1998-1999
Panel Beating Services	Sep'11-Dec'11
Zimbabwe	
Bakeries	n/a

Appendix B - Questionnaire

FIRST PART. General questions

1) Annual budget of the competition policy enforcement unit during the period 1995-2013[16] (in local currency);

SECOND PART. Identification of cartels.

2) Please, provide a list of major "hard core" cartels for the period 1995-2013;
3) For each identified cartel, provide information on:
    a. Relevant market (product, geography, etc);
    b. Names of cartel members;
    c. Period of existence of the cartel (beginning/termination);
    d. Date of discovery of the cartel;
    e. Date of entry of each company in the cartel coalition, if available;
    f. Fines applied, if any (in local currency);
    g. Price overcharge by cartel members, if available (percentage with respect to the cartel price or money terms in local currency)

THIRD PART. Economic data on each cartel identified in the second section of the questionnaire.

1) At least for one period (month/year) of cartel existence indicate the **market share/volume sold** and **price** (in local currency) of the product/ products for each colluding company;
2) If possible, give an estimation of the average margin for the cartel = (price-marginal costs)/price;
3) Please, provide, whether available, the estimate of the volume of the relevant market (in local currency), if not:
4) According to the good that is analyzed, please provide an estimation of the total market share of the non-cartel members on the relative market;

[16] Time period is subject to change depending on the date when the competition authority started to be functioning.

Appendix C - Example of the calibration and estimation procedure

Four national airlines, namely Varig, TAM, Transbrasil and VASP, were convicted in collusive price-fixing behavior on the civil air transportation market between Rio de Janeiro (airport Santos Dumont) and San Paolo (airport Congonhas) during the year of 1999. We do not go into details concerning the evidence that the Brazilian competition authority employed to convict a cartel but will rather focus on the estimation of the economic harm to consumers caused by this anticompetitive practice.

Table C-1 below provides the collected data regarding the observed one-way ticket prices charged by cartel members, as well as their observed market shares (based on number of tickets sold). These are the minimal data that are sufficient to implement our methodology and recover the price overcharges.

Table C-1: Input data (as of July 1999)

Airline	Observed market share	Average price of a one way ticket, in Reals[17]
VARIG	46.6%	129.32
TAM	41.5%	124.90
Transbrasil	6.5%	106.85
VASP	5.4%	108.03

Source: Conselho Administrativo de Defesa Econômica (the competiton authority of Brazil)

We recognize that it would be more correct to separate leisure and business segments of the demand, which would obviously have different sensitivities to price (parameter α), however available data did not permit us to do so. Given that the share of business segment on the relevant market reaches up to 70%, we believe that recovered market parameters will correspond mostly to this demand category.

As the developed methodology implies, to perform calibration of supply and demand parameters we need to set the share of the outside alternative (s_0) and average cartel margin exogenously. We use additional data on the case to set the admissible ranges for these parameters.

[17] Real – Brazilian national currency

Considered airports are the only ones situated close to the city centers of Rio de Janeiro and Sao Paulo, which makes them especially relevant for business passengers. In addition, there are no convenient substitutes, such as sufficiently fast trains or buses. Airlines that formed the cartel perform nearly 100% of the flights between the mentioned airports. Therefore, one can assume that share of the outside alternative for the business segment cannot be too big. However, presence of the leisure segment and other airports serving the same origin and destination markets suggests that s_0 cannot be too low either. We arbitrary choose the admissible range for the share of the outside option as $s_0 \in [10\%,50\%]$.

As for the second exogenous parameter – average cartel margin, we first make use of the results of Betancor and Nombela (2001), who demonstrate that marginal costs of American and European airlines are at least equal and at most twice higher than their average costs. We assume further that Brazilian airlines' cost structure is not much different from that in Europe and the U.S. Having extracted average costs from the annual reports of the colluding companies, we get 40% as a maximal value for the average margin (when marginal costs are equal to average costs). Given that airlines' activities include also those non-cartelized, we assume that possible margin on the cartelized market could potentially have an upper bound above 40%. After a final check with sign constraints for marginal costs and price sensitivity parameter α, we define a permitted range for the average cartel margin as [10%, 45%].

When one changes level of external parameters, then calibrated market parameters also change. Along with the minimal and maximal bounds, considering some intermediary values might be also reasonable if an analyst has an idea about the most probable values of exogenous parameters inside the chosen interval. Therefore, in Table C-2 we provide calibrated price sensitivity α depending on the average cartel margin and share of the outside option: for minimal, maximal and some intermediary values of external parameters. These dependencies are monotonic. We also report corresponding calibrated values of $\delta_j,\ j = \overline{1,J}$ in Table C-3.

Table C-2: Calibrated price sensitivity parameter (α)

		Average cartel margin			
		10%	**20%**	**35%**	**45%**
Share of the outside option (S_0)	**10%**	0.80	0.40	0.23	0.18
	20%	0.40	0.20	0.11	0.09
	35%	0.23	0.11	0.07	0.05
	50%	0.16	0.08	0.05	0.04

Source: Simulations

Table C-3: Calibrated parameters of differentiation (δ_j)

	Average cartel margin/ s_0			
Airline	**10%/10%**	**45%/10%**	**10%/50%**	**45%/50%**
VARIG	105.22	24.42	20.02	3.86
TAM	101.66	23.62	19.19	3.58
Transbrasil	85.30	18.54	14.43	1.08
VASP	86.06	18.56	14.44	0.94

Source: Simulations

We observe that calibrated parameter α and $\delta_{j,}\ j=\overline{1,J}$ decrease when the share of the outside option increases, margins being fixed. This dependence follows directly from equations C-1 and C-4 and can be explained as following. Lower α indicates that preferences of consumers are mostly driven by the quality rather than prices. Lower δ_j, therefore, results in a higher number of consumers who preferred the outside option as its' utility is normalized and remains fixed. α also decreases with higher cartel's margin - when consumers are less sensitive to the price, cartel members have more incentives to charge a higher price.

For the set of calibrated market parameters we further perform the simulation of the counterfactual (competitive) state.[18] Tables C-4 and C-5 below report the average for the cartel price overcharge rates (formula (8)), and consumers' welfare losses (formula (10)) estimated for a given combination of values of exogenous parameters.

[18]We solve the system of non-linear equations implied by proposed methodology with the use of SAS routines and procedures.

Table C-4: Estimated price overcharge rate (average for the cartel)

		Average cartel margin			
		10%	**20%**	**35%**	**45%**
Share of the outside option (S0)	**10%**	7.3%	14.7%	26.2%	33.9%
	20%	4.5%	9.2%	13.6%	21.8%
	35%	4.8%	8.7%	18.2%	20.8%
	50%	3.2%	6.5%	14.2%	18.9%

Source: Simulations

Table C-5: Estimated consumers' welfare losses, %

		Average cartel margin			
		10%	**20%**	**35%**	**45%**
Share of the outside option (S0)	**10%**	78.6%	78.6%	78.6%	78.6%
	20%	66.1%	66.1%	65.8%	66.2%
	35%	50.4%	48.0%	52.8%	49.5%
	50%	35.0%	35.2%	41.2%	42.2%

Source: Simulations

Variations of the obtained estimations of price overcharges and welfare losses according to the level of external parameters are intuitive. On one hand, when cartel margin is being fixed, a high share of the outside option informs the analyst about a high elasticity of demand. In these conditions, the ability of colluding firms' to increase their prices is very limited. Accordingly, welfare losses are also les significant. On another hand, keeping the share of the outside option fixed, higher desired cartel margin naturally transforms into a higher price increase. Though, no definite conclusion can be made concerning the relative change in consumers' welfare.[19]

We acknowledge that variations of the estimates in Table C-4 and C-5 are quite large. Price overcharge varies from 3.2% to 33.9%, while the welfare losses estimates range from 42.2% to 78.6%. A greater precision can be gained provided that more precise inputs are at hands.

[19] Increase in cartel's margin decreases calibrated values of marginal costs (cartel prices are given), and also decreases calibrated price sensitivity α (see equation (3)). Left-hand side of equation (1) remains constant, therefore, to compensate the decrease in α, δ_j should decrease too. In competitive state we cannot predict whether $(\delta_j - \alpha p_j^c)$ will increase or decrease for every product, because all three parameters have lower values. Equation (1) indicates that if market shares in competitive state will be relatively higher with respect to the share of the outside option, then welfare level will be also higher, and vice versa.