The Mechanics of Collusion

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The construction industry is according to the bribe payers index from Transparency International the most corrupt industry, well ahead of the defense sector. Corruption and collusion are closely interrelated in the public sector, they nurture each other. However, collusion does not depend on corruption, it can thrive by itself. A basic question is whether collusion is mostly a moral or an institutional issue. Using the title "mechanics of collusion" and proving the implied automatic reactions clearly strengthens the argument for an institutional view. There is no freedom of choice in mechanics and accordingly there are no moral issues. The predominant antecedents of the construction industry (sealed-bid auctions, competitive environment, large contract volumes) are setting incentives for collusive cooperation. Such a behavior can even be morally defended. Since it is illegal (while extant) in most countries, it cannot be encouraged. However, it is worthwhile to discuss changes to the procurement process that will set incentives to discourage collusion.

Keywords
collusion, game theory, institutions, monopsony

INTRODUCTION

The practice of collusion is illegal. Most capitalist countries have laws safeguarding competition. In the USA, anti-trust legislation prohibits monopolization, restraints of trade, and collusion among firms. The base of this legislation was laid 120 years ago with the Sherman Antitrust Act (1890), the Clayton Antitrust Act, and the Federal Trade Commission Act (both 1914). The fundamental idea behind this legislation is that free competition serves the general welfare best by limiting the power of any one party when determining price and quantity through the interaction of supply and demand (Samuelson / Nordhaus 1989). The idea is to protect the weaker market side (the buyer in general or the client in construction) and therefore to enable a competitive market to develop that is sustainable.

Competitive markets are perceived as maximizing the welfare of society (composed of all buyers and all suppliers) since in them long-run economic profit is zero. Economic profit is the difference between total revenue and total cost. The economic concept of total cost takes into consideration the opportunity cost of any activity, i.e. the value of the best forgone alternative. In other words, total cost includes all self-supplied services priced at the value of the best forgone alternative (Hirshleifer / Hirshleifer 1998). In construction, this is especially the income of the owner and interest on equity. Accounting profit does not consider opportunity cost.

Collusion in duopolies

Collusion in duopolies is the typical case used in textbooks to introduce this practice. While duopolies are practically non-existent in the construction industry, a duopoly allows to understand the basic mechanics of the process. The following example is from Taylor (1995) and uses game theory for analysis.

Two companies called Bageldum and Bageldee produce rather homogenous products, bagels. They have a choice of charging the competitive price where they will earn no economic profit as marginal cost equals price or they could collude, charge the monopoly price and make a profit of 2 mill. dollars each. There is also an incentive to defect from the collusion by undercutting the monopoly price just slightly (thus becoming competitive with a price above marginal cost) and by selling a large volume of bagels with a comfortable profit (4 mill. dollars in the example). The other company then will make a loss equal to fixed cost (-1 mill. dollars). The payoff matrix shown in table 1 resembles that of the well known prisoner's dilemma.

In the prisoner's dilemma, communication is physically impossible while in the case of a duopoly price communication is illegal but possible. The incentive to defect is large and an innocent Bageldum might choose this option. Bageldee has no other choice but to follow in reducing the price, otherwise it will be wiped out. Thus, both arrive at the competitive price. Bagels are sold continuously and the game is repeated over and over again contrary to the prisoner's dilemma which is played just once. Bageldum and Bageldee will get the idea sooner or later and collude again to charge the monopoly price. If the game is played often enough, there is not even need for explicit collusion. Understanding the mechanics, both companies will converge towards the monopoly price by tacit collusion which is not illegal. It is well established that the results of monopoly pricing are quantities supplied below equilibrium quantity Q_0 and prices charged above equilibrium price P_0, definitely a sub-optimal outcome with regard to overall welfare (Varian 2001).

The difference between the prisoner's dilemma and duopolistic collusion is due to two facts: communication is possible and the game is repeated in the case of duopolies. As a duopoly is highly unlikely to be found in the construction industry, we need a model of market structures for the construction industry to advance the argument.

Market structure of the construction industry

Three different levels of market structure can be discerned in the construction industry (Brockmann 2009):

- Macro-level or national construction market: In all capitalist countries the number of construction companies competing for jobs is very large. Construction investment is high and the average job size is small relative to the overall investment (while still being a large sum per se). Both facts mean that there are many suppliers and buyers: The market is in perfect competition.
- Mezzo-level or regional construction market: In most cases and dependant on the business cycle both, supply and demand, are characterized by a large number of players. The market is in perfect competition, except for a few abnormalities.
- Micro-level or construction project market: The structure depends on the choice of the client (demand-side). In the most common case of sealed-bid auctions, the structure can be characterized as a monopsony where the client has complete price information and companies are ignorant except with regard to their own offer. The client has considerable market power on this level. After signing of contract this structure will shift into a two-sided monopoly, but this is irrelevant for collusive behavior because this ends latest with the signature.

Competitive markets on the macro- and mezzo-level deny each single construction company to have an influence on quantity or price, they act as quantity and price takers. Anything close to a duopoly with its influence on pricing might be found in specific and few niches, otherwise it is of no importance.

Course of the argument

This introduction is followed by a short description of the research methodology. We accept the idea of competitive

Choices		Bageldee (A)			
		Competitive Price		Monopoly Price	
Bageldum (B)	Competitive Price	A: $0	B: $0	A: -$1 mill.	B: $4 mill.
	Monopoly Price	A: $4 mill.	B: -$1 mill.	A: $2 mill.	B: $2 mill.

Table 1. **Payoff matrix for the bagel duopoly**

Number of contractors	1	2	3	4	5	6	7	8	9	10
Expectancy value E(b)	±0,00	-0,564	-0,846	-1,029	-1,162	-1,266	-1,351	-1,423	-1,484	-1,537

Table 2. **Expectancy values for bids in sealed-bid auctions**

markets maximizing welfare for the following discussions. However, there remains the question whether construction markets are organized in a way to produce the equilibrium quantity Q_o at the equilibrium price P_o. This question will be researched in the chapter on pricing in the construction industry. The results of the discussion on pricing are then introduced as incentives for playing and organizing strategic games in the chapter on collusion in construction. A summary of the results and an overall interpretation are given in the conclusions.

Research Methodology

Economic theory, game theory, and archival data are used to develop the argument by logical deduction. Three research questions are driving the argument:

1. Why does collusion exist in construction?
2. How are collusive games played?
3. How can collusion be prevented?

These research questions can also be formulated as two hypotheses: (1) There are strong economic incentives for contractors in the construction industry to engage in collusion. (2) Collusive games in construction do not necessarily decrease social welfare.

Pricing in the construction industry

Pricing in construction depends on the procurement method chosen by the client as buyer. There is a large number of different procurement methods. To simplify the discussion, we will concentrate on the most common one, the conventional method (Masterman 2002) in the form of a sealed-bid auction and award to the low bidder. In many counties this is the prescribed procurement method for public clients. Sealed-bid auctions with award to the low bidder are characterized by a price bias, an information bias, and an uncertainty bias. The first two are a result of the monopsonistic power of the client, the last one is an estimating bias for complex contract goods.

Price bias in sealed-bid auctions

In general, pricing in construction could follow the laws of supply and demand, if procurement would not make use of sealed-bid auctions. The result of sealed-bid auctions is the monopsony market structure for any given project. The expectancy value of a bid E(b) from a number of contractors (n) depends on this number and is in all cases except for n = 1 below the price resulting from the equilibrium price P_o in competitive markets (Leitzinger 1988). The larger the number of bidders, the smaller are the chances to win an auction by submitting the equilibrium price. Winners are faced with a price below equilibrium in competitive markets assuming a normal distribution of the bids (see table 2). Price bias can be explained by estimating errors or by technology advance.

Estimating bias for complex contract goods in sealed-bid auctions

Contract goods are very different from exchange goods, they are fabricated after signing a contract, they are most often single units and of considerable complexity. Milgrom (1989) discusses two premises in conjunction with pricing in sealed-bid auctions of contract goods: the private and the common values assumption. The private values assumption states that contractors can determine their cost (labor, materials, equipment, subcontractors, indirect cost) and Milgrom does not accept this assumption to hold. He assumes estimating errors by all bidders (ε_i) with a normal distribution about the mean (i.e. no bias). All detailed analyses of single estimates and the bid-spread of submissions support the statement. The estimating approach takes this into consideration and deals with the problem by detailing a structure into a comprehensive work breakdown schedule. Judgment mistakes occur for most items, however, they are not systematic. Over a large amount of items these cancel each other out and there is a tendency towards a mean value. In an example of a post-construction analysis of a structure, the differences in single items reached almost 100% while the overall difference between planned and actual cost was only 3%. The contractor was lucky, he had overestimated the total cost (Birol 2009).

The second assumption is accepted by Milgrom: all companies face approximately the same cost (C), the common values assumption holds. In different segments of the market companies of equal size tend to compete against each other, therefore the purchasing power of the companies is the same. Short-term advantages of one competitor (i.e. use of cheap foreign labor) must be imitated by the others due to the competitiveness of the market.

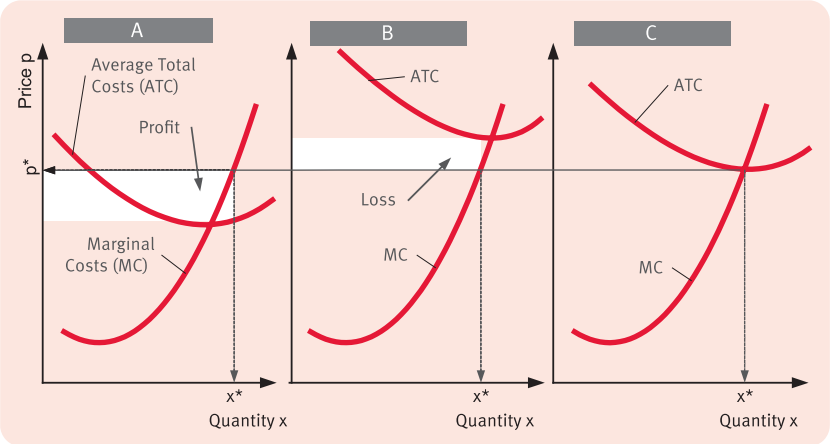

Figure 1: Average total cost, marginal cost, profits and losses

With these considerations Milgrom can formulate $X_i = C + \varepsilon_i$. While the estimating error is unbiased, this does not hold true for the successful bid. The lowest bid lies below the mean value and therefore below equilibrium price P_o.

Technology advance in sealed-bid auctions

It is not necessary to make use of Milgrom's equation to explain the values of table 2. The same argument can be made for companies with different degrees of competitiveness. Assume some companies to be technologically advanced and others to be lagging behind.

According to economic theory companies stop producing once marginal cost (MC) equals market price. Average total cost (ATC) for each company now depends on technology and these differ between contractors. The ATC of contractor A of fig. 1 with an advanced technology are below market price resulting in a profit. For contractor B who is lagging behind on technology, the inverse is true and the contractor will lose money. Case C shows the average contractor who does neither achieve an economic profit nor suffer a loss.

It can be assumed that the cost are normally distributed around a mean determined by the intersection of marginal and average total cost. There are some companies with high, some with low cost and most are found close to the mean (Heuß 1965). This allows us to draw a theoretical curve of the planned cost. All companies want to cover at least the average variable cost, this sets the lower boundary of the normal distribution (see fig. 2).

Whether we assume estimating errors or technology differences, the result is the same: There is a normal distribution around a mean value. When the low bidder is being awarded the contract, then the auction results are biased. In one case we have the winner's curse, in the other case wins the technologically most advanced company. However, this company cannot reap profits from its advance but must hand over most of it to the client. This does not only decrease the incentives to innovate it also takes away the necessary means.

Information bias in sealed-bid auctions

In many cases, private clients use their complete information of all unit prices of all the different bidders to negotiate the price further. The asymmetric information allows the client to play one bidder against the next. False information about the price of one bidder given to another one cannot be detected by either bidder during a simultaneous negotiation round. Only at the end of the negotiation the bidders can exchange and check the client's information. This strategy by the client is legal, yet the consequences of the monopsony are as detrimental to the overall welfare as it is perceived to be true for monopolies.

In general fashion results of information asymmetry are shown in fig. 3 (Prognos 1977). Depending on which side is in possession of privy information, there will be a shift of the mean

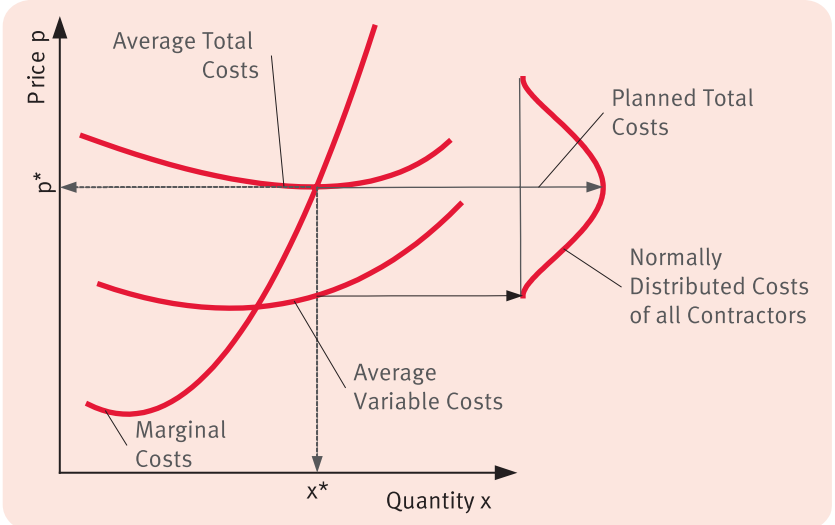

Figure 2: Normally distributed cost of all contractors in a bid

price in that direction. It is for this reason that in many countries public clients are not allowed to negotiate the price after opening the sealed bids.

Effects of sealed-bid auctions

Perfect competition in construction markets combined with sealed-bid auctions and followed by a monopsony situation assures the market power of the client. The contractor is confronted with four factors:

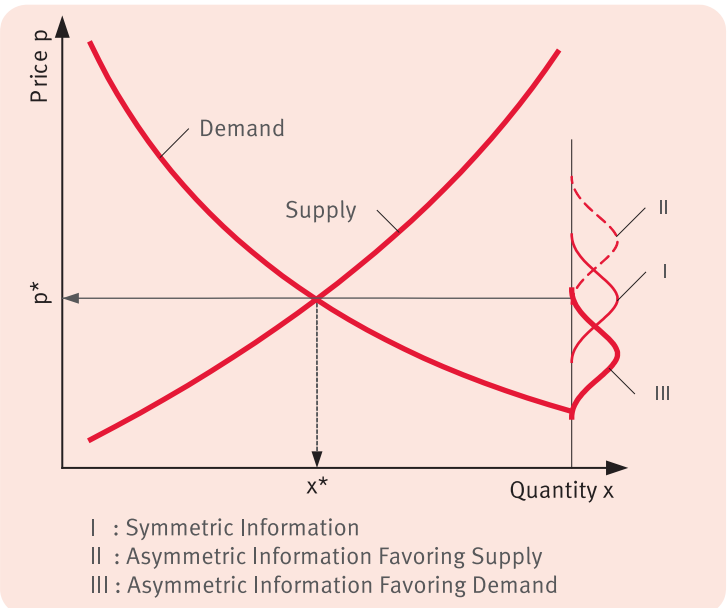

Figure 3: Influence of asymmetric information on price

- Sealed-bid auctions as institutions are biased with regard to estimating errors, driving the low-bid award price below equilibrium price.
- Sealed-bid auctions as institutions are biased with regard to technology, driving the low-bid award price below equilibrium price.
- Both effects will overlap and aggregate, driving the award price further below equilibrium price. In the worst case, the technologically most advanced contractor commits the biggest estimating error.
- Sealed-bid auctions as institutions are biased with regard to information, driving the low-bid award price below equilibrium price. This holds especially true in a two-phase award process, when the auction is followed by price negotiations.

Accordingly, contractors feel to be continuously pressed into an unfair pricing system in comparison to competitive market structures. Their only chance to counter the asymmetric information advantage of the client is through collusive cooperation. In terms of game theory it can be stated that the payoffs for a non-collusive outcome of a sealed-bid auction are negative in comparison with the often as fair perceived equilibrium price.
The incentives in the auction game are not set in a way to keep the contractors interested in keeping the rules. Anti-trust laws are required to keep them in line. However they are not always successful.

The Game of Collusion

The game of collusion being played by contractors wrests the information edge away from the client and transfers it to the contractors. There are two possible environments where collusion can thrive. On the one hand (naturally caused collusion) there are natural niches where the players are limited setting up an oligopoly or even a duopoly as in the introductory example. On the other hand (artificially caused collusion) information from the client is required and bribery is used to get the information.

Bribery is rather widespread in construction. The construction industry is according to Transparency International (Bribe Payers Index 2008) the most corrupt industry, easily outpacing notorious sectors like defense (see table 3). The lower the index number, the more corrupt is a sector.

Corruption is also a cultural problem, there are significant differences between countries. A cluster analysis of some industrialized and some newly developed countries by Transparency International yields the results of table 4. In this case, cluster 1 contains the least and cluster 4 the most corrupt countries.

Benchmarks of the data can be found by interpreting additional survey results. Belgium belongs to the cleanest cluster and still 16 percent of the respondents believe that Belgian companies use familiar or personal relationships “often” or “ almost always” to win public contracts.
Bribery as a basic ingredient that can be employed towards collusion is more or less common in the construction sector. Having won this pennant is a doubtful honor for any sector.

Naturally caused collusion

Oligopolies exist because there are some factors limiting competition. One possibility is a limited regional oligopoly, another is a long-term monopoly in a niche of the construction sector. Deep-water dredging is one

Sector	Index
Public works contracts & construction	5,6
Oil & gas	5,7
Mining	5,8
Real estate & property development	5,9
Heavy manufacturing	6,1
Pharmaceutical & medical care	6,2
Civilian aerospace	6,3
Arms & defense	6,4

Table 3: **Bribery in industry sectors**

example for the latter. Dredgers are undoubtedly required resources, they are visible and the whole interested world knows who owns them. Competitors for large deep-water dredging contracts are thus known and they form a naturally caused oligopoly. Market entry is limited by the high investment for dredgers.

Tacit collusion is not possible because there is not a large quantity of goods being supplied to the market as it is the case for bagels or refinery products etc. Instead, the goods traded are defined by large single-unit contracts that are often awarded by sealed-bid auctions. These games are not repeated often enough to establish a market equilibrium at monopoly prices. In addition the size of a single contract offers considerable incentives to defect from collusion and this is facilitated because the contract prices are always publicized. Except for abstaining from collusion altogether and accepting the biased sealed-bid auction price, the competitors can only engage in explicit collusion.

The mechanics of the ensuing process are driven by two mechanisms. Firstly the colluding contractors must agree on a selection mechanism and secondly they must decide on a price setting mechanism. Thirdly – but not necessarily – a profit distribution mechanism needs to be established. Bribery is not required to gain information, the competitors are known by possession of the limiting factor (in the case above, by the dredgers).

The selection mechanism must allow to determine whose term it is. This can either be based on statistical data, such as market share at the beginning of collusion, or on argumentation where a bundle of criteria might be considered.

The price setting mechanism again depends on two options: Companies can either generate their own profits once they have been chosen or the profit of each company can be distributed to all colluding contractors. The first case sets the stage for a two-phase game that is cooperative in the first phase and competitive in the second. Here, the chosen contractor wants to establish the highest reasonable price possible while all the others want to limit his profits since he will still be a competitor in other areas or at other times. The price will shift from below equilibrium price upward. How much upward depends on the price effect of the collusion. In an older study (Prognos 1977), the price effect was found to amount to 2,5% as part of return on turnover for all projects (competitively and collusively bid). Since the total return on turnover during the same period was smaller than 2,5%, there would have been prices below equilibrium without collusion.

The second case brings also a two-phase game about, but both phases are cooperative. Since all companies are interested in the profit from the focal transaction they have a tendency to charge the highest price possible which is the monopoly price. The monopoly price decreases welfare due to

Cluster 1	Australia, Belgium, Canada, Germany, Japan, Netherlands, Switzerland, UK
Cluster 2	France, Singapore, Spain, United States
Cluster 3	Brazil, Hong Kong, Italy, South Africa, South Korea and Taiwan.
Cluster 4	China, India, Mexico and Russia

Table 4: **Cluster analysis of corruption in selected countries**

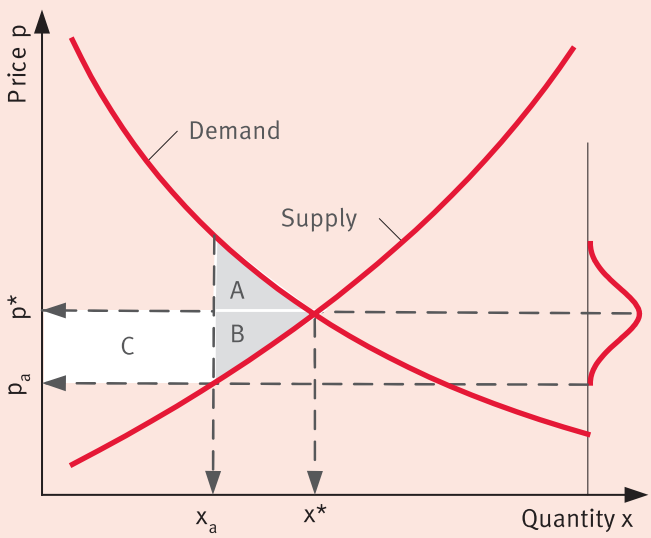

Figure 4: **Deadweight loss due to sealed-bid auctions**

the overall deadweight loss, it is not a desirable result (Varian 1999).

For considerations about the collusive outcome on social welfare, this distinction is of utmost importance. The argument on pricing was that sealed-bid auctions force the contractors to except prices below equilibrium and this lowers overall welfare. The effect is shown in fig. 4. The auction price is below the equilibrium price and this has two results: (1) It augments the clients' surplus (C) by the same amount that it reduces the contractors' surplus. (2) In addition there is a decrease in both surpluses (A +B), a deadweight loss. This deadweight loss measures the reduction of social welfare. Since only the quantity x_a is produced, there still remains a willingness to pay from the clients' side that will not be served by the contractors since they will not provide the additional quantity at price p_a.

Artificially caused collusion

Clients basically have three options in arranging a market through procurement:

- A perfect competition / monopsony by letting all interested contractors submit a bid. The number (and names) of players in the game is large and unknown to everybody.
- A perfect competition / limited monopsony by preparing a bidders list. The client knows the number and names of the bidders.
- A perfect competition / two-sided monopoly by negotiating with just one contractor. In this case knowledge is symmetric.

Case 1 does not provide enough information for collusion. In order to enter the game, there must not only be an incentive but also the knowledge of all participants.

Case 2 is the classical set-up for collusion in a market that is generally in perfect competition. In order to get the information contained in the bidders list, contractors must bribe someone in the organization of the client. A principal-agent relationship is an absolute prerequisite for bribery. The agent in such relationships can profit at the expense of the principal. In a private company, the owners are the principals and all employees are agents. Accordingly all employees with knowledge of the bidders list are possible targets for bribery. The taxpayer is the principal in public companies, all employees are agents and therefore all of them are possible addressees of bribes.

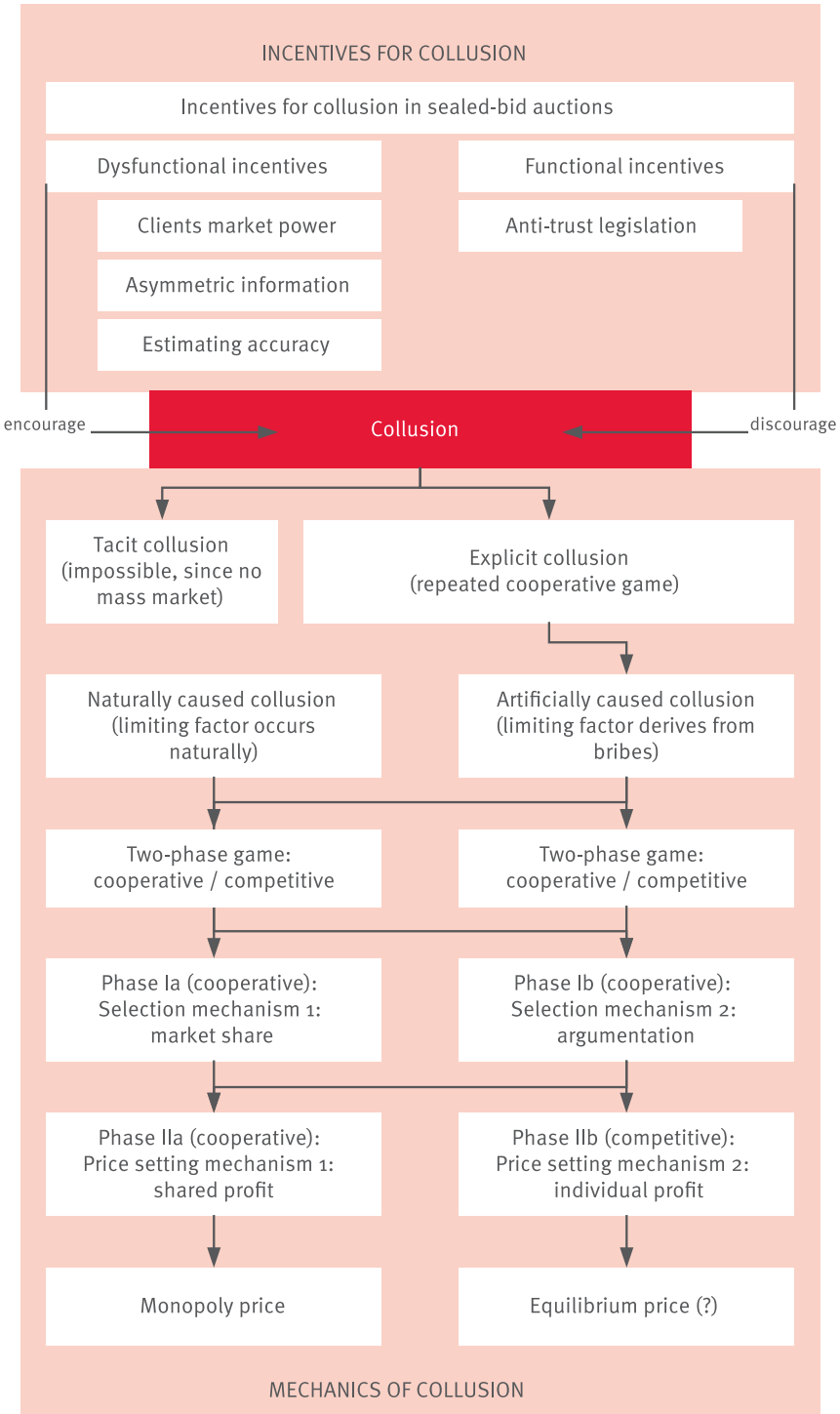

Figure 5: Incentives for and mechanics of collusion

Case 3 does not lend itself to collusion because of lack of players. Bribery is still a possibility to get access to information for the negotiation process and to create an asymmetric information situation.

Bribery in construction is facilitated by the large contract sums and the imprecise knowledge of prices. One million dollars more for a contract of 10 million dollars cannot be easily detected as being excessive. A bribe of 100.000 dollars out of the extra million is in most cases enough to convince a morally weak agent.

For a collusion scheme to work, there must be repeated tenders, preferably an infinity. Then and only then the contractors can play repeated collusive games among themselves. It is not necessary that all contractors are always invited. The group playing the repeated games can be larger than the bidders for one contract. The collusive arrangement must, however, include all contractors that have been or will be invited.

CONCLUSION

The line of the complete argument can be found in a condensed form in fig. 5. There are strong incentives in the construction sector to engage in collusion. The main argument is that widely used sealed-bid auctions with award to the low bidder produce outcomes below equilibrium price. This is unacceptable to the bidders and economically undesirable since it produces an overall deadweight loss to society.

Depending on the mechanisms chosen in collusive games, the result will be monopoly pricing (economically undesirable) or a price not far away from the equilibrium price (economically desirable). The first will be produced by structures that include repeated games by a group, cooperative behavior when predetermining the winner of the bid, and cooperative behavior when setting the price because all players participate in the profit. The latter depends on repeated games and cooperation predetermining the winner. The price is restrained by a competitive phase when agreeing on the profit that accrues only to the winner.

A change of the institutional arrangements of procurement processes is required if collusion is to be avoided, legislation is not sufficient. Both hypotheses can be answered positively: (1) There are indeed strong incentives to enter into collusive games. In the long run economical survival is at stake. (2) The outcomes of collusive games need not be detrimental to social welfare of an economy.

A word of warning is warranted at the end. Putting aside all arguments, collusion is an illegal practice. Prison sentences are not uncommon when collusion is uncovered.

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