

RENT SHARING TO CONTROL NON-CARTEL SUPPLY IN THE GERMAN CEMENT MARKET¹

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Abstract

A challenge for many cartels is avoiding a destabilizing increase in non-cartel supply in response to having raised price. In the case of the German cement cartel that operated over 1991-2002, the primary source of non-cartel supply was imports from Eastern European cement manufacturers. Testimonies in a private enforcement case have claimed that the cartel sought to control imports by sharing rents with intermediaries in order to discourage them from sourcing foreign supply. Specifically, cartel members would allow an intermediary to issue the invoice for a transaction and charge a fee even though the output went directly from the cartel member's plant to the customer. We investigate this claim by first developing a theory of collusive pricing that takes account of the option of bribing intermediaries. The theory predicts that the cement cartel members are more likely to share rents with an intermediary when the nearest Eastern European plant is closer and there is more Eastern European capacity outside of the control of the cartel. Estimating a logit model that predicts when a cartel member sells through an intermediary, the empirical analysis supports both predictions.

Keywords: Collusion, cartel, non-cartel supply, cement, distribution channels, intermediary

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1. Introduction

Collusion is not easy. The prospect of reaping large profits from raising the market price can be jeopardized by several sources of instability. First, there is internal instability coming from a member violating the collusive agreement. This act of non-compliance is typically for the purpose of gaining a larger share of the market than had been allocated to it. Second, there is external instability in the form of alternative sources of supply. When the cartel raises price and the cartel is not all-inclusive, those firms outside of the cartel will often seek to increase their sales by undercutting the collusive price. And, even when all existing suppliers are members of the cartel, a higher market price can attract entry. Third, a cartel must avoid detection by customers and the competition authority which would bring an end to collusion. In sum, effective collusion requires that cartel members are sufficiently compliant with the collusive agreement, non-cartel members do not significantly expand supply, and the cartel avoids detection.²

Let us consider the second source of cartel instability: increased supply by firms that reside outside of the cartel. There are numerous episodes for which an expansion in non-cartel supply either greatly impacted the profitability of collusion or even resulted in the demise of the cartel. A notable example is the vitamin C cartel of the early 1990s.³ Formed in 1991, it comprised the four largest producers who in aggregate had 87 percent of global sales. Of particular relevance, the cartel excluded Chinese manufacturers who had a market share of 8 percent at the time. The cartel implemented a 30 percent increase in prices from 1990 to late 1993, in response to which it lost 29 percent of global sales to Chinese suppliers, who tripled their sales, and other fringe producers. With the erosion of the cartel's share of the global market, prices subsequently fell by 33 percent from the end of 1993 to 1995. The cartel's last formal meeting occurred in August 1995. The failure to control the growth of non-cartel supply resulted in cartel death.

Cartels are well aware of the threat of non-cartel supply and they have deployed four general methods for handling it, which we refer to as takeover, starvation, coercion, and bribery. The *takeover* approach is the most straightforward and probably the most effective (though not necessarily the most profitable). Here, the cartel takes control of the sources of non-cartel supply by acquiring non-cartel suppliers or the assets necessary to produce. A *starvation*

² For some cases and empirical analyses concerning these various sources of instability, the reader is referred to Harrington (2006), Levenstein and Suslow (2006, 2011), Connor (2008), and Marshall and Marx (2012).

³ The details are from Connor (2008).

strategy curtails non-cartel supply by taking control of an essential input or technology. *Coercion* refers to aggressive practices - such as a targeted price war - that harms non-cartel suppliers with the intent of either inducing them to constrain their supply or join the cartel or exit the market. Rather than use the stick, a *bribery* strategy uses the carrot by sharing collusive rents with non-cartel suppliers if they agree to limit their expansion of supply. As the identification of these four strategies is, to our knowledge, new to the literature, Section 2 illustrates them with a collection of cartel cases.⁴

The focus of this paper is exploring how non-cartel supply was handled in the case of the German cement cartel which lasted from 1991 to 2002. The primary threat was imports from cement manufacturers in Eastern Europe, specifically, plants located in the Czech Republic, Poland, and Slovakia. For legal and logistical reasons, importation from those countries into Germany required the use of German companies acting as intermediaries. The claim was made in the context of a private litigation case⁵ that, in order to avoid intermediaries bringing the cement of Eastern European suppliers into the German market, the German cement cartel shared some of the collusive rents with those intermediaries. In light of the four methods for handling non-cartel supply, this conjectured strategy could be cast as either starvation - by controlling a key input to foreign cement manufacturers - or bribery - in that intermediaries were bought off.

For the purpose of examining the validity of the claim that the German cement cartel bribed intermediaries in order to limit non-cartel supply, this paper develops a theory of collusive behavior that encompasses the option of sharing rents with intermediaries. The theory is then taken to data and we find evidence in support of the theory's predictions. Hence, we find empirical support for the claim that the German cement cartel bought off intermediaries for the purpose of limiting imports and thereby constraining sources of non-cartel supply.

The paper is organized as follows. Section 2 reviews how various cartels have controlled non-cartel supply. Section 3 provides a general description of the German cement cartel including an overview of primary threats to its stability with a focus on the role of

⁴ Generally related to exclusionary practices (though not necessarily part of collusion), there is an extensive literature on foreclosure ("starvation" in our terminology), see, e.g., Hortacsu and Syverson (2007). Similarly, there are literatures related to coercion (see, e.g., Saloner (1987)) and acquisitions of smaller rivals (see, e.g., Granstrand and Sjölander (1990)).

⁵ Regional Court of Düsseldorf, Case 34 O (Kart) 147/05 of August 2005. Further general information on civil proceedings concerning the German cement cartel is provided on the following webpage: <http://www.carteldamageclaims.com/portfolios/cement-cartels/> (last accessed on 26 July 2017).

intermediaries. In Section 4, a theory of collusive pricing in the presence of intermediaries and non-cartel suppliers is developed which allows for the option of sharing rents with an intermediary in exchange for them not sourcing non-cartel supply. That theory generates a set of hypotheses that are then tested in Section 5. Section 6 concludes.

2. Cartel Strategies for Controlling Non-Cartel Supply

Suppose a cartel increases price in the presence of some suppliers who are not part of the cartel. The likely response of those non-cartel suppliers is to undercut the cartel's price and expand supply which has the potential for substantively undermining the profitability of collusion. In responding to the expansion of non-cartel supply, cartels have pursued four strategies: takeover, starvation, coercion, and bribery. Examples of each of these are provided below.

Takeover: A cartel curtails non-cartel supply by acquiring the non-cartel suppliers or the assets used to provide that supply.

The five global producers of aluminum formed a cartel in 1900-01 which lasted until 1908 when a recession and entry caused the cartel's collapse. The established firms then went about acquiring nine recent entrants after which they re-established the cartel in 1912.⁶

Members of the international steel cartel in the 1930s acquired fringe firms at prices based on "their nuisance value to the cartel" which apparently exceeded a valuation based on their projected earnings.⁷

The electrical and mechanical carbon and graphite products cartel operated over 1988-99 and struggled with non-cartel suppliers known as "cutters" which would purchase carbon blocks from the cartel members and then produce final products that would compete with the cartel's supply. One cutter in particular, EKL, was aggressively supplying the German market to the point that the cartel discussed a coordinated response and entertained two options. First, none of the members of the cartel would supply any graphite to EKL (a strategy defined below to be "starvation"). Second, EKL would be denied any market share by cartel members systematically undercutting EKL's price with respect to those customers entertaining doing

⁶ See Storli (2014).

⁷ Stocking and Watkins (1946), p. 177.

business with EKL (a strategy defined below to be “coercion”). Ultimately, the takeover approach was pursued as cartel member SGL Carbon acquired EKL in 1997.⁸

Starvation: A cartel curtails non-cartel supply by limiting non-cartel suppliers’ access to an essential input or technology.

The Austria-Hungary sugar cartel was formed in 1891 to coordinate the supply of refined sugar. By the time of its demise in 1894, the cartel had learned the importance of controlling raw sugar to constrain the non-cartel supply of refined sugar. Reformed in 1897, the 58 sugar refiners in the cartel put together an exclusive arrangement whereby the 178 raw sugar suppliers would only supply the 58 cartel members and the latter would only buy raw sugar from those suppliers.⁹

From the late 1980s into the 1990s, the international sorbates cartel struggled with entry by Russian and Chinese suppliers. When several potential competitors from China requested licensing the sorbates technology from existing producers, the five cartel members agreed not to provide their technology to other sorbates producers.¹⁰

Coercion: A cartel curtails non-cartel supply through aggressive practices, such as selective price cuts with respect to a non-cartel supplier’s customers, with either the intent of continuing these practices until the non-cartel supplier constrains its supply or joins the cartel or exits the market.

The Swedish beer brewing industry formed a national cartel in 1906 that lasted for fifty years. The cartel’s primary initial task was recruiting members and, by late 1908, only a few minor breweries had not joined. The methods of recruitment were initially persuasion but, if that failed, then coercion. In a particularly difficult case in the city of Eskilstuna, the cartel leased a small brewery and used it to engage in intense price competition against a recalcitrant firm which eventually chose to join the cartel.¹¹

⁸ *Official Journal of the European Union*, L 125/45, 28.4.2004, Case No. C.38.359 - Electrical and mechanical carbon and graphite products, Decision of December 3, 2003; cited in Harrington (2006).

⁹ See Fink (2016).

¹⁰ Commission of the European Communities, Commission Decision of 1.10.2003 (Case COMP/E-1/37.370 - Sorbates); cited in Harrington (2006).

¹¹ See Lundqvist (1998).

In the early 20th century, shipping cartels (referred to as “conferences”) were found to have “successfully conspired to drive competitors from the market or coerce them to join the conferences, through the use of ‘fighting ships’ that systematically undercut competitors’ rates for however long it took to drive them out of the business.”¹²

The international electrical equipment cartel of the 1930s created a “deposit fund” which “could be used to support cut-throat competition against a non-member competitor in any of the territory [sic] coming within the scope of operation of the agreement” or “to support competitive warfare against [a] former cartel member.”¹³

Formed in 1929, the international steel rail cartel sought to constrain supply from non-cartel members “by allowing the London Committee to fix, when apprised of such threatened competition, a sufficiently lower price ... to make sure the nonassociated producer would not obtain the order and to compensate the [cartel member] for the differential between this lower price and the standard price by payment out of a reserve fund provided by contributions on a tonnage-delivered basis by [cartel members].”¹⁴

In the district heating pipes cartel of the 1990s, the Swedish firm Powerpipe declined an invitation to join the cartel and later filed a complaint with the European Commission on the grounds that the colluding firms had acted anti-competitively against it. Cartel members had recruited key employees of Powerpipe and led Powerpipe to understand that it should withdraw from the German market. After Powerpipe was awarded a sizable German contract, the cartel decided to organize a collective boycott of Powerpipe's customers and suppliers.¹⁵

With the vitamin B1 cartel, increased non-cartel supply by Chinese manufacturers led cartel members to price aggressively in a selective manner to reclaim lost customers.¹⁶

Bribery: A cartel curtails non-cartel supply by sharing collusive rents with non-cartel suppliers.

¹² Marshall and Marx (2012), p. 148, f. 7.

¹³ FTC “Report on International Electrical Equipment Cartels” (1948), p. 33.

¹⁴ FTC “Report on International Steel Cartels” (1948), p. 4.

¹⁵ Judgment of the Court of First Instance (Fourth Chamber) of 20 March 2002. - ABB Asea Brown Boveri Ltd v Commission of the European Communities; cited in Harrington (2006).

¹⁶ *Official Journal of the European Union*, L 6/1, 10.1.2003, Case COMP/E-1/37.512 - Vitamins, Decision of November 21, 2001; cited in Harrington (2006).

From 1885 to 1902, competition in the bromine industry was controlled by a pool comprising twelve producers. The pool was a legal entity with exclusive contracts to buy the output of a bromine producer at a guaranteed price. Deutsche Bromkonvention represented the only source of foreign non-cartel supply and the pool controlled it by entering an agreement whereby the pool would not export in exchange for Deutsche Bromkonvention not supplying the U.S. market.¹⁷

In the global alkali cartel of the 1920s, cartel members ICI and Alkasso were concerned with the entry of a Brazilian company, Matarazzo. To forestall such entry, they agreed to sell alkali at preferential prices to Matarazzo.¹⁸

The vitamin B2 cartel managed non-cartel supply by having cartel members purchase it. In order to control Coors, which was a producer of B2 but not a member of the cartel, cartel members Roche and BASF agreed that Roche would purchase 115 tons of B2 (which represented half of Coors's capacity) and BASF in turn would purchase 43 tons from Roche. In this manner, they shared the burden of controlling Coors' supply.¹⁹

3. The German Cement Cartel and the Threat of Imports

3.1 Primary Threats to Cartel Stability

Since 1991, a cement cartel existed in Germany among the six largest cement companies: Dyckerhoff AG, HeidelbergCement AG, Lafarge Zement GmbH, Readymix AG, Schwenk Zement KG, and Holcim (Deutschland) AG. These companies divided up the German cement market by setting up regional cartels in the north, south, east, and west. For those companies with plants located in different parts of the country, they were members of multiple regional cartels. Collusion was implemented through a market-sharing agreement that set sales quotas for members of each regional cartel. In addition, the cartel sought to include or acquire small and medium-sized domestic firms.²⁰

¹⁷ See Levenstein (1997).

¹⁸ See Stocking and Watkins (1946).

¹⁹ *Official Journal of the European Union*, L 6/1, 10.1.2003, Case COMP/E-1/37.512 - Vitamins, Decision of November 21, 2001; cited in Harrington (2006).

²⁰ For further details on the German cement cartel, the reader is referred to Friederiszick and Röller (2010), Hüschelrath and Veith (2016), and Harrington, Hüschelrath, Laitenberger, and Smuda (2015).

The cartel lasted from 1991 to 2002 and during that time there were two major developments that challenged the stability of the cartel. First, as analyzed in Harrington Hüschelrath, Laitenberger, and Smuda (2015), demand for cement from construction activities in East Germany fell significantly below expectations. The resulting underutilization of production capacities induced one of the cartel members to deviate from the collusive agreement which ultimately led to the breakdown of the cartel in February 2002. A second source of instability arose in the early days of the cement cartel. The political liberalization processes in most Eastern European countries – including their transition to market economies – opened up the possibility of low-priced imports into Germany from cement manufacturers in countries such as the Czech Republic, Poland, and Slovakia.²¹ These alternative sources of cement supply for German customers presented a possibly serious challenge to the cement cartel.²²

The significance of the import threat from Eastern Europe as well as some indication of how the cartel responded to that threat is documented in Figure 1. Reading off of the right vertical axis, the dashed line is the share of German cement consumption (in volume) supplied by plants not located in Germany, while the solid line is the share of consumption supplied by plants located in Eastern Europe. The black bars report the fraction of capacity in the Czech Republic, Poland, and Slovakia owned by members of the German cement cartel (reading off of the left vertical axis). As the Czech Republic, Poland, and Slovakia were the overwhelming suppliers to Germany from Eastern Europe (with no less than 93 percent of annual Eastern European imports to Germany during our observation period), we will refer to capacity and imports from those three countries as Eastern European capacity and imports. Finally, let us note that the import shares are based on sales from all plants in the Czech Republic, Poland, and Slovakia including those owned by members of the German cement cartel.²³ However, we will argue that the evidence is consistent with the cartel not exporting much cement from their Eastern

²¹ According to Fiederer et al. (1994, pp. 61 ff.), the average domestic price for a ton of cement in 1993 was about EUR 75 (including transportation costs) compared to an import price which, before adding transportation costs, was around EUR 40 per ton for Czech cement. As discussed by Fiederer et al. (1994), the main sources of the lower prices were the lower labor and energy costs of Eastern European firms.

²² Fiederer et al. (1994) offers a detailed assessment of the German cement market. For a theoretical investigation of the threat of imports for cartel stability, see Feinberg (1989). In the Brazilian cement market, Salvo (2010) shows that the threat of imports significantly disciplined incumbent behavior.

²³ The available import-export statistics do not allow disaggregating it into sales from plants owned by German companies and by non-German companies.

European plants to Germany so that the import shares reported in Figure 1 can be viewed as largely coming from non-cartel suppliers.

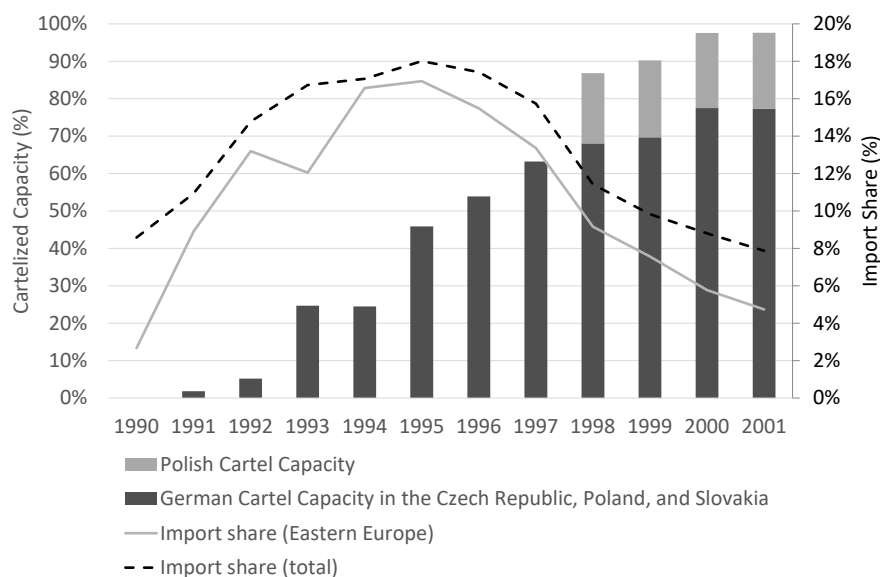


Figure 1: Import Shares for Eastern Europe and Cartelized Capacity in the Czech Republic, Poland, and Slovakia, 1991-2001

Data Sources: Verein Deutscher Zementwerke e.V.; German Statistical Office; World Cement Directory; Polish cartel decision document; own ownership database²⁴

As seen in Figure 1, the early years of the cartel experienced a substantial increase in the amount of cement imported from Eastern Europe. While only 3 percent of German cement consumption was supplied by those foreign plants in 1990, it had climbed to 13 percent by 1992. (Note that the German cement cartel controlled only 20 percent of Eastern European capacity in 1992 so it is unlikely that the rise can be attributed to imports produced by capacity controlled by the cartel.) The import share peaked in 1995 at almost 17 percent of German demand and then began a steady decline throughout the remaining period. By 2001, the import share was back to its 1990 level of around 4 percent.²⁵ (Note that this declining import share

²⁴ The cartelized capacity share is calculated by using the kiln capacities as reported in the World Cement Directories 1991, 1996 and 2002. All values for 1998 were missing and were interpolated. Additionally, for Slovakia, data for plant Stupava and for the year 1997 were missing. For the Czech Republic, data for plant Hranice in the years 1995-1997 and for plant Prachovice in the year 2002 were missing. For Poland, data for plant Gorka and for plant Strzelce in the years 1999 to 2002 were missing. The respective missing values were interpolated with either the respective last year available or the average between the respective years. Capacity values for the years after 2002 were taken from 2001 and set to zero in case of plant closures.

²⁵ While there were imports from plants in Western European countries, their import share (relative to German consumption) fluctuated in a fairly tight range of 4 to 7 percent in our observation period. Imports from those countries as well as other Eastern European countries were small in size and were mostly observed if the respective customer was close to the German border. As discussed by Friederiszick and Röller (2001, p. 66ff.),

was occurring while the share of Eastern European capacity controlled by the German cement cartel was rising. Again, this is evidence that they were choosing not to import cement from those plants to the German market and, therefore, the import share largely represents supply from Eastern European plants not controlled by the cartel.)

It is reasonable to attribute the sizable increase in the import share over 1990-95 to the higher prices for cement in Germany as a result of the cartel. The high domestic prices provided an opening for Eastern European cement manufacturers to sell their product at prices which would more than cover their production and transportation costs. However, the German cement cartel was not idly standing by while non-cartel suppliers captured an increasing share of the market. Beginning in 1991, members of the German cement cartel acquired plants in the Czech Republic, Poland and Slovakia and either closed the plant or curtailed exports to Germany. From 1991 to 2001, the six largest German cement companies bought 20 cement plants in Poland, seven in the Czech Republic, and five in Slovakia.²⁶ These acquisitions led to a substantial rise in the share of Eastern European production capacity controlled by the German cement cartel as seen in Figure 1 (black bars). In addition, starting in 1998, there was a cartel in the Polish cement market among Polish cement manufacturers, and there is evidence of a mutual understanding between them and the German cement cartel to stay out of each other's market.²⁷ For this reason, Figure 1 also reports the fraction of Eastern European capacity controlled by the German *and* Polish cement cartels (black and gray bars) on the grounds that all of that capacity may have been excluded as a source of non-cartel supply into the German cement market.²⁸

From 1990 to 1999, the German cement cartel went from having no production capacity in Eastern Europe to controlling 77 percent of capacity and perhaps as much as 98 percent (if one includes the Polish cement cartel's capacity). Thus, in response to the rising flow of imports from non-cartel suppliers over 1991-95, the cartel managed to cut off that supply - as reflected

such imports have always existed in the German cement market and are typically aimed at reducing transport costs. The absolute level of these imports is moderate in size and prices are typically similar to the German level. They add that these imports tend to decrease with a rise in demand in the respective foreign country.

²⁶ A list of these acquisitions is available from the authors upon request.

²⁷ In the Polish Cartel, there is evidence that the quota of Miebach was increased as compensation for their decreased export activities to Germany (paragraph 171 and 479, Polish cartel decision).

²⁸ For details on the Polish cement cartel, the reader is referred to Bejger (2011).

in a decline in the import share from 17 percent in 1995 to 4 percent in 2001 - by taking control of many of the plants in the Czech Republic, Poland and Slovakia.

3.2 The Role of Intermediaries in the Supply of Imports

In the German cement market, a customer could purchase cement directly from a cement manufacturer or through an intermediary. The former is referred to as “direct selling” and involves a direct negotiation between the buyer and the cement producer. After a purchase agreement is reached, the product is delivered by the seller or picked up by either the buyer or a commissioned third party (typically, a shipper). The invoice is directly issued by the seller who is the cement producer. When instead an intermediary is used, a customer places an order through that intermediary. The role of the intermediary is issuing the invoice and covering the delcredere risk (that is, the possible loss from a party not fulfilling its obligations). The intermediary may also handle price negotiations with the cement manufacturer on behalf of the buyer and could be involved in the transportation of cement from the plant to the customer.

There is potentially substantive value in the use of an intermediary when the customer is small or the cement manufacturer’s plant is outside of Germany. With a small customer, an intermediary can be better at sourcing supply and negotiating with a supplier. For legal and logistical reasons, it was difficult for German cement customers to buy directly from Eastern European cement manufacturers and thus they heavily used German intermediaries. For the 36 German customers in our data set over 1993-2005 (details of which are provided in Section 5), Figure 2 breaks down the number of transactions according to whether the transaction was direct or involved an intermediary. Consistent with the essential role of intermediaries when dealing with foreign plants, 91 percent of all transactions between a German customer and a non-German plant (for the entire period) used an intermediary. In contrast, only 66 percent of transactions involved an intermediary when the plant was located in Germany.

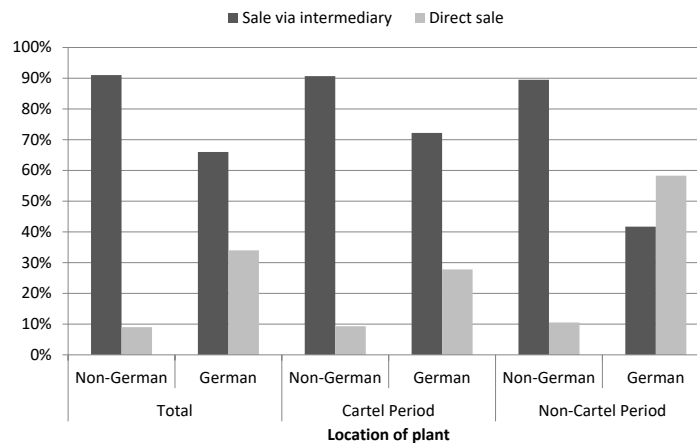


Figure 2: Use of Direct Selling and Intermediaries Depending on Plant Location

Data Source: own analysis based on CDC data

By comparison, the value in using an intermediary is not at all clear when the cement customer is large and the plant is located in Germany:²⁹

In the sale of larger amounts of cement, the functions [of the intermediaries] are very limited. The acquisition of customers including the agreement on a certain price typically does not rest with the intermediary but with the cement producer. The transport from the producer to the customer may, but need not, be carried out by the intermediary.

It is then curious that, during the cartel period, many large customers who were purchasing from German cement manufacturers did so through intermediaries. For the 36 customers in our data set, Figure 3 reports how the annual volume is allocated between direct selling and through intermediaries, and partitions the latter into price-setting intermediaries (PSIs) and non-price-setting intermediaries (NPSIs). In the early years of the cartel, around 75 percent of volume went through intermediaries and it was more than 50 percent in every year during the cartel period. Whether or not an intermediary was used, these customers used the same transportation services as with direct selling in that the cement went directly from the German plant to the customer. The value provided by an intermediary would then seem to have been minimal, especially for transactions through NPSIs, which apparently did little more than process an invoice. It is worth noting that the intermediary channel declined in importance prior to the cartel breakdown in 2002, and this was especially true for transactions using NPSIs.

²⁹ Translated from Spenner (1996, p. 48).

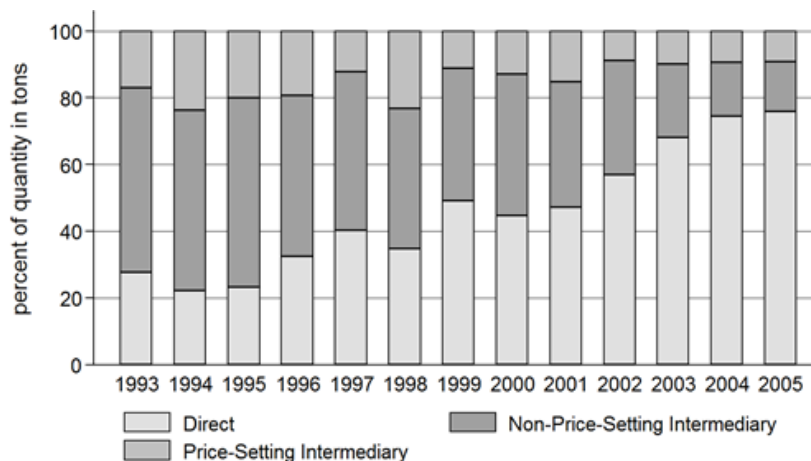


Figure 3: Shares of Different Distribution Channels, 1993-2005

Data Source: own analysis based on CDC data

As a possible explanation of this puzzle, individuals testifying in a private litigation case³⁰ claimed that the members of the German cement cartel funneled transactions through intermediaries – particularly the low-value NPSIs – as a way to share collusive rents in exchange for intermediaries not importing Eastern European cement. As already documented, intermediaries had an essential role in importing supply from Eastern European cement manufacturers. As the argument goes, intermediaries were allowed to invoice transactions between German cement customers and German cartel members for which they charged a fee in exchange for not bringing in imports. In bribing the intermediaries, one can either think of the intermediary as an essential input (for non-cartel cement companies in Eastern Europe) or as a non-cartel supplier. With either interpretation, the practice amounts to sharing rents with non-members of the cartel in order to avoid competition with the cartel.

Figure 2 provides some preliminary evidence in support of this claim. While the use of intermediaries with a non-German plant was basically the same between the cartel and post-cartel periods (around 90 percent of transactions in both cases), intermediaries were significantly less used with German plants after cartel breakdown. During the cartel phase, 72 percent of transactions with German plants used an intermediary. But, after the cartel's breakdown, an intermediary was used in only 42 percent of transactions.

³⁰ Regional Court of Düsseldorf, Case 34 O (Kart) 147/05 of August 2005. Further general information on civil proceedings concerning the German cement cartel is provided on the following webpage: <http://www.carteldamageclaims.com/portfolios/cement-cartels/> (last accessed on 26 July 2017).

An alternative strategy to bribing intermediaries would have been to acquire them. Along those lines, the 2009 Judgment of the Higher Regional Court provides documentary evidence that members of the German cement cartel acquired some intermediaries who were acting as importers as well as the import activities of certain intermediaries and buyers.³¹ However, it might have required considerable financial capital to have purchased all of the intermediaries that were able to engage in import activities. This observation leads to the complementary strategy of sharing rents with intermediaries in exchange for them not importing non-cartel supply into the German cement market.

Still, the feasibility of sharing rents with all intermediaries who could have sourced Eastern European cement is not immediate given there were often over 200 intermediaries active in any year during the cartel period. However, there are two reasons to believe that the actual number of intermediaries that would need to be bribed is far smaller. First, some intermediaries lacked the necessary business contacts and logistical options to organize cement imports (mostly by train) from Eastern Europe. Only those intermediaries with such a capability would require bribes. Notably, there were 394 distinct intermediaries during the cartel period of 1993-2002, out of which only 33 sourced any foreign supply. Second, there might be a small number of intermediaries who could supply a particular customer, either for logistical reasons or because of relationship-specific capital. Relevant to this claim is that in any customer-intermediary transaction, there was a 73.5% chance that the customer used the same intermediary for the same loading point in the previous year. This reasonably high level of persistence could be due to a limited set of relevant intermediary options for a customer. The evidence is then broadly consistent with the need to bribe relatively few intermediaries in order to shut off imports to a customer. Nevertheless, in the absence of better data to address the matter, it remains an open question how many intermediaries would have had to take part in a rent-sharing scheme in order for it to be effective.

Although the claim that the German cement cartel shared rents with intermediaries in order to deter them from sourcing Eastern European cement is intriguing, the preliminary evidence we have reviewed is at best suggestive. It is quite possible that intermediaries provided certain functions for large customers that were not easily apparent, and that the reduced use of intermediaries in the post-cartel period is due to a variety of factors associated with a change in

³¹ Examples explicitly mentioned were the incidents referred to as “Berger”, “Consulta”, “Meier”, and “Lueg & Duda” (paragraphs 41ff.).

the competitive landscape. The objective of this paper is to systematically test the claim that the cartel shared collusive profits with intermediaries in order to limit imports. For this purpose, a collusive theory that endogenizes rent-sharing with an intermediary is developed in Section 4. That theory provides some testable hypotheses for behavior during the cartel period which are then taken to the data in Section 5.

4. A Theory of Collusive Pricing with Intermediaries

Consider a market with a cartel that acts as a joint profit-maximizer and suppose there is a single intermediary and a single non-cartel supplier.³² We will later discuss allowing for multiple intermediaries.³³ The cartel and the non-cartel supplier offer homogeneous products and the market demand curve is $D(p)$. The cartel produces at constant marginal cost c' . For the non-cartel firm to supply this market, it must operate through the intermediary. The non-cartel firm produces at constant marginal cost c'' , while the intermediary's services are provided at constant marginal cost g . Assume $c'' + g > c'$ so the cartel is the more efficient supplier.

To simplify the analysis, let us suppose $D(p)$ is perfectly inelastic at $\bar{Q} > 0$ when $p \leq \bar{p}$ and is zero when $p > \bar{p}$. Assume $\bar{p} > c'' + g (> c')$, from which it follows that the monopoly price is \bar{p} . In the Online Appendix, it is shown that the main results of this section extend to the more standard case that $D(p)$ is decreasing in price and $(p - c)D(p)$ is strictly quasi-concave (when positive).

A standard approach to analyzing this setting is to suppose that the cartel chooses a price to maximize its joint profit while taking into account how the non-cartel supplier will respond; that is, the extensive form is sequential move with the cartel acting as a price leader. In this case, if the cartel's price exceeds the cost of non-cartel supply then the partnership of the non-cartel firm and intermediary will price below it and leave the cartel with zero demand and zero

³² For simplicity, we will specify a one-shot setting and assume a joint profit-maximizing cartel. However, all results can be derived as an equilibrium in an infinitely repeated game in which each firm maximizes the present value of its profit stream as long as firms' discount factors are sufficiently close to one. The absence of antitrust enforcement in the model should not impact our qualitative results regarding the decision to sell directly or through an intermediary.

³³ Extending the model to have multiple intermediaries and non-cartel suppliers would be a major complication as it would require modelling multi-lateral bargaining. As argued later, we believe the intuition for the case of one intermediary and one non-cartel supplier is likely to be robust.

profit. To avoid that outcome, the cartel will price just below $c'' + g$ in response to which the non-cartel firm prices at (or above) $c'' + g$. The cartel earns profit of approximately $(c'' + g - c')\bar{Q}$. As long as the cost advantage of the cartel is not too great – so that $\bar{p} > c'' + g$ – the cartel is constrained to pricing no higher than the cost of alternative supply.³⁴

Let us now enrich this setting by giving the cartel the opportunity to share rents with the intermediary for the purpose of preventing non-cartel supply from entering the market. As an initial cut at the problem, suppose the cartel could offer a per unit payment s to the intermediary to prevent it from sourcing non-cartel supply. The cartel would then set the monopoly price of \bar{p} , given that non-cartel supply would be blocked, and earn profit of $(\bar{p} - c' - s)\bar{Q}$. Alternatively, its profit is $(c'' + g - c')\bar{Q}$ by undercutting the non-cartel supplier's price and not providing a payment to the intermediary. The cartel then prefers to share rents with the intermediary when:

$$(\bar{p} - c' - s)\bar{Q} \geq (c'' + g - c')\bar{Q} \leftrightarrow s \leq \bar{p} - c'' - g. \quad (1)$$

Not surprisingly, the cartel will pursue rent-sharing when the required payment to the intermediary is sufficiently small. Of course, the level of the payment required could well depend on how costly is the provision of non-cartel supply by the intermediary; that is, s could depend on c'' (which, for example, depends on the distance between the non-cartel supplier and the customer). To determine when it is optimal to share rents with the intermediary, we then turn to deriving the payment required to gain the intermediary's cooperation.

In modelling the interaction between the cartel, the non-cartel supplier, and the intermediary, there are a variety of possible extensive forms though we will argue for a particular one. As assumed above, the cartel commits to price and then those firms that are not part of the cartel select a price; thus, the cartel acts as a price leader. Having set its price, the cartel is presumed to approach the intermediary about a possible sharing of profit in exchange for the intermediary not offering its services to the non-cartel supplier. The per unit payment from the cartel to the intermediary is specified to be described by the generalized Nash Bargaining Solution (NBS).

³⁴ The sequential-move extensive form is used, for example, in Bos and Harrington (2010). If instead the two suppliers make simultaneous price decisions then there are many other Nash equilibria including the just described subgame perfect equilibrium for this sequential-move game. The latter outcome is generally thought to be the most reasonable Nash equilibrium for the simultaneous-move game.

If the two parties succeed in coming to an agreement then the game ends with no non-cartel supply. If the cartel and intermediary fail to come to an agreement, the non-cartel firm and the intermediary bargain over both the price to the consumer and how revenues are shared between the two parties. Again, the outcome of that negotiation is represented as a generalized NBS. If they fail to come to an agreement then there is no non-cartel supply and the cartel sells to the market at the price it set in the first stage. This sequence of moves is depicted in Figure 4.³⁵

In sum, the game has three stages: 1) the cartel sets a price p^c at which it is willing to sell to customers; 2) the cartel and the intermediary negotiate over a per unit payment to the intermediary which represents a splitting of profit associated with the cartel selling at a price p^c ; and 3) if the cartel and the intermediary fail to reach an agreement then the intermediary and the non-cartel supplier bargain over the product price and how that revenue is allocated between the two parties. The presumption is that if the cartel fails to come to an agreement with the intermediary in stage 2 then the intermediary will cut a deal with the non-cartel supplier.

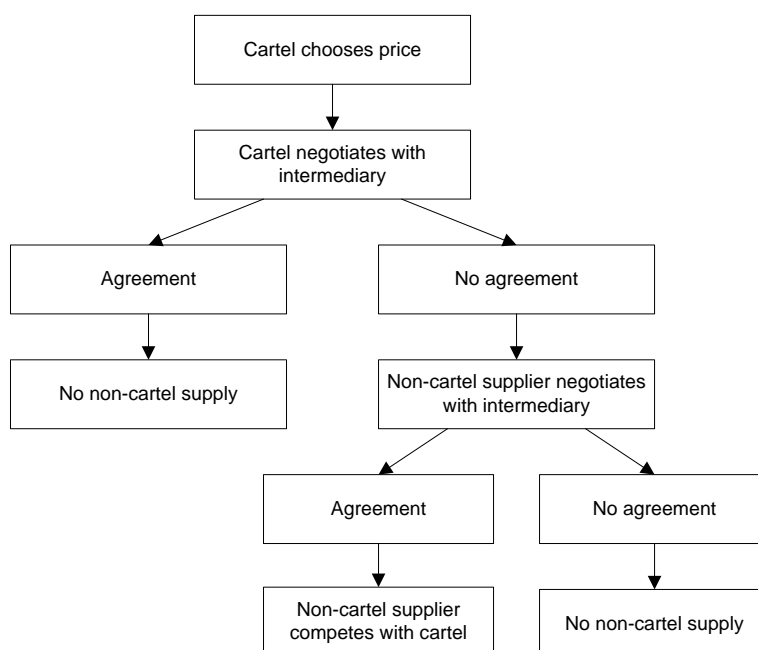


Figure 4: Sequence of Moves in Cartel-Intermediary-Non-Cartel Supplier Game

³⁵ Note that we are assuming that the intermediary and the non-cartel firm bargain over both the product price and a sharing of revenues with the intermediary, while the intermediary and the cartel only bargain over the sharing of revenues as the cartel has already chosen its price. This asymmetric treatment is justified because the cartel can sell without the assistance of the intermediary, while the non-cartel firm cannot. Thus, the cartel can commit to a price and then approach the intermediary about making a deal. In contrast, the non-cartel firm and intermediary are both necessary for supplying the market so it is not meaningful for the non-cartel firm to have set the product price without having come to an agreement with the intermediary.

This three-stage game is solved using backward induction. Suppose bargaining between the cartel and the intermediary broke down so stage 3 is reached. With regards to the bargaining between the intermediary and the non-cartel firm, their threat points have them each earn zero profit because they do not supply the market. The intermediary and non-cartel supplier are assumed to choose the price p (charged to customers) and the payment received per unit by the intermediary. Denoting that per unit payment by r , the non-cartel supplier then receives $p - r$ per unit. Note that the NBS will have $p \in (c'' + g, p^c)$ for that yields positive total profit while any other price yields non-positive profit. It is presumed $p^c \leq \bar{p}$ so demand is \bar{Q} .

Letting β denote the bargaining power of the non-cartel supplier, p and r are chosen to solve the NBS objective:

$$\max_{p,r} [(p - c'' - r)\bar{Q}]^\beta [(r - g)\bar{Q}]^{1-\beta} = \max_{p,r} (p - c'' - r)^\beta (r - g)^{1-\beta} \bar{Q}. \quad (2)$$

Let us first solve for r and then for p . Solving the first-order condition with respect to the payment to the intermediary yields $r^*(p) = (1 - \beta)(p - c'') + \beta g$. Given customers pay a price p for non-cartel supply, the intermediary earns profit of

$$(r^*(p) - g)\bar{Q} = (1 - \beta)(p - c'' - g)\bar{Q}, \quad (3)$$

and the non-cartel supplier receives:

$$(p - c'' - r^*(p))\bar{Q} = \beta(p - c'' - g)\bar{Q}. \quad (4)$$

As both payoffs are increasing in p , they will set the product price just below the cartel price p^c in which case the stage 3 payoffs to the intermediary and non-cartel supplier are, respectively,

$$(1 - \beta)(p^c - c'' - g)\bar{Q} \text{ and } \beta(p^c - c'' - g)\bar{Q}. \quad (5)$$

Let us now move to stage 2 where the cartel and the intermediary bargain given the cartel has set a product price of p^c . s denotes the per unit payment received by the intermediary in which case the cartel receives $p^c - s$ per unit. Given that the cartel does not need the services of the intermediary, the cost g is not incurred and the payment to the intermediary is only to prevent it from offering its services to the non-cartel supplier.

Letting α denote the bargaining power of the cartel, s is chosen to solve the NBS objective:

$$\max_s [(p^c - c' - s)\bar{Q}]^\alpha [s\bar{Q} - (1 - \beta)(p^c - c'' - g)\bar{Q}]^{1-\alpha}$$

or

$$\max_s (p^c - c' - s)^\alpha [s - (1 - \beta)(p^c - c'' - g)]^{1-\alpha} \bar{Q}. \quad (6)$$

Note that the threat point for the cartel is zero because failure to agree results in the non-cartel firm (with the assistance of the intermediary) selling at a price just below the cartel's price. This results in the intermediary's threat point of $(1 - \beta)(p^c - c'' - g)\bar{Q}$.

Solving the first-order condition associated with (6) for the NBS per unit payment to the intermediary yields

$$s^*(p^c) = (1 - \alpha\beta)p^c - (1 - \alpha)c' - \alpha(1 - \beta)(c'' + g). \quad (7)$$

The intermediary's payment is decreasing in the bargaining power of the cartel and the bargaining power of the non-cartel supplier:

$$\frac{\partial s^*(p^c)}{\partial \alpha} = -(p^c - c') + (1 - \beta)(p^c - c'' - g) < 0 \quad (8)$$

$$\frac{\partial s^*(p^c)}{\partial \beta} = -\alpha(p^c - c'' - g) < 0. \quad (9)$$

Because less bargaining power with respect to the non-cartel supplier lowers the stage 3 payoff for the intermediary, its threat point in bargaining with the cartel is smaller which results in a lower payment; hence, $s^*(p^c)$ is decreasing in β . The payoffs to the intermediary and the cartel, respectively, are

$$\begin{aligned} s^*(p^c)\bar{Q} &= [(1 - \alpha\beta)p^c - (1 - \alpha)c' - \alpha(1 - \beta)(c'' + g)]\bar{Q} \\ [p^c - c' - s^*(p^c)]\bar{Q} &= \alpha[\beta p^c - c' + (1 - \beta)(c'' + g)]\bar{Q}. \end{aligned}$$

Given the cartel's payoff is increasing in its product price, it follows that the optimal cartel price is \bar{p} in which case the payoffs to the intermediary and the cartel, respectively, are

$$[(1 - \alpha\beta)\bar{p} - (1 - \alpha)c' - \alpha(1 - \beta)(c'' + g)]\bar{Q} \quad (10)$$

$$\alpha[\beta\bar{p} - c' + (1 - \beta)(c'' + g)]\bar{Q}. \quad (11)$$

The cartel optimally shares rents with the intermediary when (11) exceeds the profit from pricing just below the cost of non-cartel supply:

$$\alpha[\beta\bar{p} - c' + (1 - \beta)(c'' + g)]\bar{Q} \geq (c'' + g - c')\bar{Q} \leftrightarrow$$

$$c'' + g \leq \frac{\alpha\beta\bar{p} + (1 - \alpha)c'}{1 - \alpha(1 - \beta)}. \quad (12)$$

When the cost of non-cartel supply, $c'' + g$, is sufficiently low, the cartel will choose to share rents with the intermediary in order to prevent it from sourcing non-cartel supply. When the cost of non-cartel supply is sufficiently high, the cartel will instead sell directly to the buyer by pricing below the cost of delivering non-cartel supply.

The model has made the simplifying assumption that there is one intermediary and one cartel supplier. As a non-cartel supplier must go through an intermediary, the problematic assumption for the empirical analysis is that of a single intermediary given that there were, in fact, many intermediaries. In order to prevent a customer having access to non-cartel supply, the cartel would need to share rents with all those intermediaries that could source Eastern European cement. As argued in Section 3, there is evidence to suggest that the number of intermediaries that had the capability to source foreign cement was limited, but still a customer always had access to several. Having shown that it can be profitable for the cartel to bribe a single intermediary, could it be profitable to bribe several intermediaries?

Though that question cannot be fully addressed without extending our model to allow for multiple intermediaries, the current model suggests that it could have been viable. Multiple intermediaries means competition among those intermediaries to obtain foreign supply for a buyer. This competition-enhancing effect is captured in our model by increasing β , which is the parameter that controls the bargaining power of the non-cartel supplier when negotiating with the intermediary. A higher value for β translates into a lower profit for the intermediary when it buys from the non-cartel supplier, which then lowers its threat point when dealing with the cartel. As shown in (9), the latter results in a smaller payment by the cartel to the intermediary. As the required bribe per intermediary would then be smaller with more intermediaries, it is not clear whether the total amount of rents to be shared would be higher with more intermediaries; by the logic of standard models of competition, one would expect it to be lower.³⁶ It is then

³⁶ In most oligopoly and rent-seeking models, total industry profit is decreasing in the number of firms or agents.

quite possible that rent-sharing could be a profitable strategy for the cartel even when there are multiple intermediaries.

This section concludes by deriving testable hypotheses from the theory. As the distance between the nearest Eastern European plant and a customer shrinks, the lower is c'' and, by (14), the more likely is the cartel to sell through an intermediary (in order to share rents with it) rather than sell directly. Hence, conditional on buying from a German cartel member, the more likely is a buyer to purchase through an intermediary when the nearest Eastern European plant is closer to the buyer.

Hypothesis 1: As a buyer's distance to the nearest Eastern European cement supplier declines, it is less (more) likely that the German cement cartel sells directly (through an intermediary).

Let us argue, in general terms, that Hypothesis 1 does not hold if the decision to use an intermediary is driven by cost, as is the case under competition, rather than rent sharing. Let I denote the event of a transaction through an intermediary (either with a German or non-German supplier), DR denote the event of buying direct from a supplier, and G denote the event of buying from a German supplier. $\Pr(I|G)$ is then the probability a buyer uses an intermediary conditional on purchasing from a German supplier. By Bayes Rule,

$$\Pr(I|G) = \frac{\Pr(I)\Pr(G|I)}{\Pr(I)\Pr(G|I) + (1 - \Pr(I))\Pr(G|DR)} = \frac{\Pr(I)\Pr(G|I)}{\Pr(I)\Pr(I|G) + (1 - \Pr(I))} \quad (13)$$

where the second equality follows from the presumption that a buyer can only buy direct from a German supplier, so $\Pr(G|DR) = 1$. Assume that a buyer's decision to approach an intermediary, which determines $\Pr(I)$, is driven by the buyer's traits, such as size, and is independent of the distance from the nearest Eastern European supplier. Given it has decided to use an intermediary, a buyer is less likely to buy from a German supplier when the distance from the nearest Eastern European supplier is shorter because the cost of that Eastern European supplier is then lower relative to German suppliers; in other words, $\Pr(G|I)$ is smaller. Finally, note that

$$\frac{\partial \Pr(I|G)}{\partial \Pr(G|I)} = \frac{\Pr(I)(1 - \Pr(I))}{[\Pr(I)\Pr(I|G) + (1 - \Pr(I))]^2} > 0. \quad (14)$$

If the decision to use an intermediary is driven by cost then a reduction in the distance from the nearest Eastern European supplier decreases $\Pr(G|I)$ and it follows from (16) that the likelihood of using an intermediary conditional on buying from a German supplier, $\Pr(I|G)$, is decreased. Note that this property runs contrary to Hypothesis 1.³⁷ In sum, Hypothesis 1 holds when the cartel engages in rent sharing with intermediaries but does not hold when the use of intermediaries is driven by cost factors.

The above argument for selling through an intermediary is more likely to be operative, the more Eastern European capacity that could possibly be a source of non-cartel supply. Hence, the larger the share of Eastern European capacity controlled by the German cement cartel, the less of a need to bribe intermediaries which then makes it less likely to sell through an intermediary.

Hypothesis 2: As the share of Eastern European capacity controlled by the German cement cartel rises, it is more (less) likely that the German cement cartel sells directly (through an intermediary).

In the next section, these hypotheses are tested for the German cement cartel.

5. Empirical Analysis

In this section, we test these two hypotheses by estimating the likelihood that a customer, when buying from a German cement manufacturer, does so directly (“direct selling”) or through an intermediary. As the predictions pertain to when cement suppliers are cartelized and there are likely to be many behavioral and structural changes associated with a shift from collusion to competition, the empirical analysis will focus on the time period during which firms were colluding. We will then show that our main findings are robust to including the post-cartel

³⁷ An assumption in drawing this conclusion is that a buyer’s decision to use an intermediary, $\Pr(I)$, is independent of its distance from the nearest Eastern European supplier. However, it is possible that a buyer closer to the border could be more inclined to use an intermediary if it anticipated that buying foreign supply is likely to be the most attractive option. In that case, $\Pr(I)$ would depend on a buyer’s distance to the nearest Eastern European supplier. If that effect is present, it would be a countervailing force. While a buyer closer to the border is less likely to buy from a German supplier conditional on using an intermediary, it is more likely to use an intermediary; the former (latter) effect makes it less (more) likely to use an intermediary conditional on buying from a German supplier. Our argument that cost factors could not cause Hypothesis 1 is robust if the former effect dominates the latter effect.

period in the analysis.

The remainder of the section is structured as follows. Section 5.1 describes the data set and offers some summary statistics on the use of intermediaries. Section 5.2 presents our econometric approach and estimation results.

5.1 Data Set and Descriptive Analysis

The raw data was collected by Cartel Damage Claims (CDC) of Brussels and consists of approximately 500,000 market transactions from 36 mostly large customers supplied by the German cement cartel from January 1993 to December 2005.³⁸ Market transactions include information on product types, dates of purchases, delivered quantities, involved intermediaries, cancellations, rebates, early payment discounts, and free-of-charge deliveries as well as locations of the cement plants and unloading points. We have supplemented this raw data set with information on all cement plants located in Germany as well as those near the German border. Using Google Maps, all coordinates were retrieved for each unloading point in our sample and the number of independent cement suppliers located within a radius of 150 kilometers (road distance) of those coordinates serves as a measure of the set of available suppliers to a customer. Additionally, we calculated the road distance to the nearest East European plant and added data about regional construction activity from the German Statistical Office to capture demand fluctuations.

The empirical analysis uses data on sales from plants located in Germany and for one specific cement type called ‘CEM I’ (Standard Portland Cement) which accounts for almost 80 percent of all available transactions.³⁹ For reasons of consistency and interpretation, the transaction data is aggregated on a monthly basis at the level of the cement plant-cement seller-unloading point-cement consistency (32.5, 42.5 and 52.5 N/R). Table 1 presents the (quantity weighted) descriptive statistics of the data set.

³⁸ The data set used in this paper covers deliveries that account for about 4 percent of total sales in Germany. However, because the large cement producers are vertically integrated downstream (e.g., in the ready-mix concrete industry), the share of the data set from the non-integrated segment of the market is substantially larger than 4%. Given that Hortaçsu and Syverson (2007) find little evidence that vertical foreclosure effects are quantitatively important in the U.S. cement and concrete industries, it is reasonable to assume that the observed prices in our dataset are similar to prices overall.

³⁹ The share of pure CEM I cement is decreasing towards the end of the data set as cement companies began to partially substitute raw cement (“clinker”) with other materials such as sand or ash in order to reduce carbon dioxide emissions.

As the theoretical predictions pertain to when firms are colluding, the empirical analysis will first be based on the 23,659 observations during the cartel period, which runs from the start of the data set in January 1993 to the collapse of the cartel in February 2002.⁴⁰ In a second step, we run additional specifications using both cartel and post-cartel data (accounting for 6,008 additional observations) and explore robustness.

Customers in our data set are, on the whole, large. *Customer size* is defined to be the quantity of cement purchased per year from all suppliers. When weighing each customer by its share of the number of transactions, average customer size is about 110,000 tons per year which is reported in Table 1. If instead each customer is counted only once, average customer size is 30,080 tons per year with a standard deviation of 53,580 tons.

Table 1: Descriptive Statistics (quantity weighted)

	Cartel period		Post Cartel Period		Overall	
	Mea	S.D.	Mea	S.D.	Mea	S.D.
	n		n		n	
Direct selling	0.43	(0.50)	0.74	(0.44)	0.50	(0.50)
Selling through intermediary	0.57	(0.50)	0.26	(0.44)	0.50	(0.50)
Customer size (million tons /year)	0.09	(0.10)	0.16	(0.18)	0.11	(0.12)
Next East European Plant (in 1000km)	0.40	(0.16)	0.39	(0.17)	0.40	(0.16)
GCCEP (in %)	0.70	(0.27)	0.98	(0.00)	0.76	(0.26)
GCCE (in %)	0.59	(0.18)	0.77	(0.01)	0.63	(0.17)
No. of firms within 150km, yearly count	5.17	(2.73)	4.69	(2.28)	5.06	(2.64)
Unload region: East	0.26	(0.44)	0.29	(0.45)	0.26	(0.44)
Unload region: West	0.32	(0.47)	0.27	(0.45)	0.31	(0.46)
Unload region: North	0.10	(0.29)	0.06	(0.24)	0.09	(0.28)
Unload region: South	0.33	(0.47)	0.37	(0.48)	0.34	(0.47)
Construction employment	0.86	(0.23)	0.72	(0.19)	0.83	(0.23)
Construction permits	0.15	(0.06)	0.09	(0.04)	0.13	(0.06)
Consistency 32.5	0.31	(0.46)	0.40	(0.49)	0.33	(0.47)
Consistency 42.5	0.65	(0.48)	0.52	(0.50)	0.62	(0.49)
Consistency 52.5	0.04	(0.20)	0.08	(0.27)	0.05	(0.22)
Post Cartel period	0.00	(0.00)	1.00	(0.00)	0.23	(0.42)
Observations	23659		6008		29667	

Notes: GCCE and GCCEP are the (yearly) shares of capacity controlled by cartel firms. GCCE is the German Cartel Capacity in Eastern Europe while GCCEP is the German Cartel Capacity in Eastern Europe plus Polish Cartel Capacity. Construction employment is the yearly number of construction workers (in millions) per cartel region; Construction permits is the yearly number of permits (in millions) for residential and non-residential apartments in houses per cartel region.

The average road distance from a buyer's unloading point to the nearest Eastern European plant is around 400 km. By the theory, the variable of interest is a buyer's best alternative supplier in Eastern Europe which may not be the nearest Eastern Europe plant because that

⁴⁰ For an analysis of the cartel collapse, see Harrington et al (2015).

plant may not have the lowest total cost (due to higher production cost), may not have available capacity, or may be controlled by the German cement cartel. While not perfect, *nearest Eastern European plant* would seem to be a good proxy for a buyer's best source of supply outside of the cartel.

German cartelized capacity in Eastern European (GCCE) is the share of all capacities in the Czech Republic, Poland, and Slovakia owned by the German cement cartel. Over the entire cartel period, this share averaged 59 percent though, we know from Figure 1, it steadily rose until it reached 77 percent by the end of the cartel and remained there. Thus, eventually, at most 23 percent of capacity was a source of non-cartel supply. It was previously mentioned that the Polish cement cartel may have agreed not to import cement into Germany. This would have started as early as 1998 when the Polish cement cartel was formed. For that reason, Table 2 also reports *German cartelized capacity in Eastern European plus Polish cartelized capacity (GCCEP)* which is the share of all capacities in the Czech Republic, Poland, and Slovakia owned by members of the German and Polish cement cartels. It averaged 70 percent and reached a peak of 98 percent by the cartel's end. Results will be presented using *GCCE* though are very similar when using *GCCEP*.

Turning to the remaining independent variables, the *number of firms within 150km* of a buyer measures potential competition if firms were competing. Though there are fewer transactions in the north for the customers in our data set, transactions are almost equally distributed across the other three regions. The two demand-side variables are *construction employment* and *construction permits*.

The dependent variable is an indicator variable that takes the value 1 when the transaction occurred through direct selling and 0 when it involved an intermediary. Under *direct selling*, prices are directly negotiated between the buyer and the cement producer and the latter files the invoice. Whenever the party which filed the invoice was not a cement producer, we categorized the distribution channel as *intermediary*. The fraction of transactions with direct selling was 43 percent when the cartel was operating which is significantly less than the 74 percent after the cartel breakdown.

5.2 Estimation and Results

We now turn to providing an econometric model to test the hypotheses put forth at the end of Section 3. Using a logit model, the dependent value in our model takes the value 1 if the transaction was done through direct selling and 0 otherwise.

$$y^* = \beta'X + \varepsilon \text{ with } y = 1 \text{ if } y^* > 0, \text{ otherwise } y = 0$$

The dependent variable y is specific to the identity of the customer's unloading point, the seller (which is either a cement manufacturer or an intermediary), the delivering plant, the product and time. To account for potential autocorrelation over time, we cluster at this level (and refer to it as "local business relationship level"). Vector X includes several variables that were also used in Harrington et al. (2015). A customer's size is measured by the total annual ordered quantity. A customer's market environment is measured by the number of cement firms within 150 km road distance. Properties of the delivered products are two indicator variables for the consistency of the cement. As there may be unobserved heterogeneity between regions, region-fixed effects are included. Demand proxies include the number of construction workers and the number of new construction permits, both of which are measured for the region of a customers' unloading point. In light of our hypotheses, the key variables are the distance to the nearest Eastern European plant and the share of Eastern European capacity controlled by the members of the German cement cartel. By "Eastern Europe," we mean the Czech Republic, Poland, and Slovakia which, as argued earlier, were the overwhelming sources of non-cartel supply.

Using maximum likelihood, Table 2 reports the estimated coefficients for four specifications. Specification (1) uses data only from the cartel period and is our preferred specification. Specifications (2) and (3) include data from the post-cartel period. In specification (2), we add the variable *PostCartel* to control for transactions after the cartel breakdown, while specification (3) allows for an interaction between *PostCartel* and *Distance*. Specification (4) differs from specification (3) by excluding observations from the year in which the cartel broke down (2002), on the grounds that the transitional phase between collusion and competition may introduce unusual patterns.

Table 2: Logit estimation – Coefficients

	(1) Coef.	t-stat	(2) Coef.	t-stat	(3) Coef.	t-stat	(4) Coef.	t-stat
Distance next EE plant	7.713***	(4.01)	8.196***	(4.44)	8.444***	(4.53)	8.583***	(4.52)
GCCE	3.985***	(4.27)	3.373***	(3.74)	3.588***	(3.99)	3.982***	(4.34)
GCCE*Dist. next EE plant	-7.002***	(-2.93)	-5.606**	(-2.47)	-6.232***	(-2.74)	-7.261***	(-3.13)
Post Cartel (PC)			0.714***	(4.29)	0.246	(0.57)	0.500	(0.95)
PC* Dist. next EE plant					1.029	(1.03)	0.979	(0.83)
Customer size	-0.050	(-0.04)	1.840*	(1.88)	1.891*	(1.91)	1.367	(1.37)
No. of firms within 150km	-0.149**	(-2.45)	-0.129**	(-2.47)	-0.128**	(-2.47)	-0.127**	(-2.36)
East	3.714***	(6.64)	3.707***	(7.35)	3.785***	(7.22)	3.566***	(6.80)
South	2.826***	(6.30)	2.592***	(6.81)	2.683***	(6.72)	2.542***	(6.18)
North	-2.863***	(-3.08)	-0.714	(-0.95)	-0.794	(-1.06)	-0.674	(-0.91)
Consistency 32.5	-0.174	(-0.74)	-0.069	(-0.34)	-0.083	(-0.41)	-0.143	(-0.68)
Consistency 52.5	1.480***	(3.15)	1.329***	(3.63)	1.321***	(3.61)	1.369***	(3.58)
Construction employment	-1.203	(-1.29)	-0.330	(-0.41)	-0.585	(-0.73)	-0.007	(-0.01)
Construction permits	-5.309***	(-2.62)	-4.471**	(-2.26)	-4.440**	(-2.25)	-4.882**	(-2.47)
Constant	-3.985***	(-3.06)	-5.315***	(-4.22)	-5.225***	(-4.19)	-5.576***	(-4.37)
Sample	Cartel Period		Full data set		Full data set		Full data set without year 2002	
N	23659		29667		29667		27694	
Pseudo R ²	0.23		0.27		0.27		0.26	

t statistics in parentheses, * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$, Standard errors were clustered at the local relationship-product-level.

Our hypotheses are that the estimated coefficients on *Distance* and *GCCE* are positive so that direct selling is more likely (or, equivalently, using an intermediary is less likely) when the distance between the buyer and the nearest Eastern European plant is greater and the German cement cartel owns more Eastern European capacity. Of particular interest is the coefficient of the interaction between *Distance* and *GCCE*, which is predicted to be negative because *Distance* should matter less if there is less non-cartel capacity. Our discussion will focus on the corresponding average marginal effects which are reported in Table 3.⁴¹

⁴¹ For each observation, we calculate the effect of an arbitrarily small change in distance on direct selling and take the average of these effects over the whole sample.

Table 3: Logit estimation results - Average marginal effects

	(1)	(2)	(3)	(4)
<i>Average marginal effects of single covariates</i>				
GCCE	0.194*** (2.78)	0.176** (2.39)	0.171** (2.33)	0.173** (2.41)
Distance next EE plant	0.518** (2.54)	0.701*** (3.60)	0.711*** (3.62)	0.631*** (3.17)
Post Cartel (PC)		0.116*** (4.24)	0.107*** (4.00)	0.148*** (4.27)
Customer size	-0.007 (-0.04)	0.279* (1.93)	0.287** (1.96)	0.206 (1.39)
No. of firms within 150km	-0.022** (-2.40)	-0.020** (-2.44)	-0.019** (-2.44)	-0.019** (-2.32)
East	0.621*** (12.28)	0.612*** (14.20)	0.619*** (14.42)	0.598*** (12.24)
South	0.395*** (8.31)	0.384*** (8.75)	0.394*** (9.03)	0.372*** (7.97)
North	-0.250*** (-6.69)	-0.101 (-1.02)	-0.111 (-1.15)	-0.095 (-0.98)
Consistency 32.5	-0.026 (-0.75)	-0.010 (-0.34)	-0.013 (-0.41)	-0.021 (-0.69)
Consistency 52.5	0.255*** (2.94)	0.224*** (3.50)	0.222*** (3.48)	0.230*** (3.43)
Constr. employment	-0.178 (-1.29)	-0.050 (-0.41)	-0.089 (-0.73)	-0.001 (-0.01)
Constr. permits	-0.787** (-2.57)	-0.679** (-2.20)	-0.674** (-2.20)	-0.737** (-2.42)
<i>Average marginal effect at combinations of covariates</i>				
Dist. GCCE=0	0.924*** (3.18)	1.121*** (3.62)	1.206*** (3.82)	1.187*** (3.84)
Dist. GCCE=0.5	0.638*** (3.07)	0.846*** (4.21)	0.876*** (4.26)	0.803*** (3.87)
Dist. GCCE=1	0.114 (0.39)	0.417 (1.52)	0.383 (1.43)	0.229 (0.86)
Dist. GCCE=0 & PC =0		1.093*** (3.51)	1.135*** (3.62)	1.126*** (3.62)
Dist. GCCE=0.5 & PC =0		0.849*** (4.19)	0.834*** (4.13)	0.776*** (3.78)
Dist. GCCE=1 & PC =0		0.418 (1.52)	0.350 (1.30)	0.208 (0.77)
Dist. GCCE=1 & PC =1		0.438 (1.52)	0.558* (1.68)	0.394 (1.11)
Sample	Cartel Period		Cartel and Post Cartel Period	
			without year 2002	
N	23659	29667	29667	27694
Pseudo R ²	0.23	0.27	0.27	0.26

Average marginal effects. Standard Errors were clustered at the local relationship-product-level. *t* statistics in parentheses; * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.

As shown in Table 3, the distance to the nearest Eastern European plant is positively related to the likelihood of a customer buying directly. This finding is consistent with Hypothesis 1. As the variable is measured in 1000 kilometers, an increase in distance of 250 kilometers between a customer and the nearest plant in Eastern Europe raises the probability of direct selling by 13-18 percent, depending on the specification. It is then less likely that a transaction is conducted through an intermediary if the cost advantage of the cartel supplier vis-à-vis the non-cartel-supplier is enhanced, which is in line with a prediction of the theoretical model.

Our estimates also support Hypothesis 2. The probability of direct selling is higher when the share of Eastern European production capacity controlled by the German cement cartel rises. The probability of direct selling is increased by 17-20 percent when German control over Eastern European capacity is increased from zero to 100 percent. This finding is consistent with the argument that the cartel's need to share rents with intermediaries is diminished when the cartel controls more of the capacity that could produce imports.

The most compelling evidence in support of rent sharing with intermediaries comes from

the interaction term. In all specifications, the marginal impact of distance on the probability of direct selling is weaker when the cartel controls more Eastern European capacity. Thus, the predicted negative relationship between distance and direct selling due to the need to bribe intermediaries is reduced in magnitude when there is less non-cartel supply. When the German cement cartel does not control any of the Eastern European capacity ($GCCE = 0$), the average marginal effect of distance ranges from 0.924 to 1.212 depending on the specification, so that a rise in distance of 250 kilometers raises the probability of direct selling by 23-30 percent. However, if the German cement cartel controls all of the Eastern European capacity ($GCCE = 1$), the average marginal effect of distance is far smaller at 0.114-0.417 and is no longer statistically significant.⁴² Absent the need to bribe intermediaries, the distance between a customer and the nearest Eastern European plant should not influence whether a customer that buys its cement from a German plant uses an intermediary.⁴³

Finally, let us comment on some findings associated with comparing the cartel and post-cartel periods. Examining the average marginal effect for *PostCartel* in specifications (2)-(4), the probability of direct selling increases by 11-15 percent after the cartel's shutdown. The rise in direct selling is likely to reflect a general restructuring of buyer-seller relationships associated with a move to competition. More pertinent to the theory is the average marginal effect of distance conditional on the fraction of Eastern European capacity controlled by German suppliers. For the cartel period ($PC = 0$), there is a highly significant average marginal effect of distance when the German cartel does not control any Eastern European capacity ($GCCE=0$),

⁴² The weaker effect of distance when $GCCE$ is higher is also found for the intermediate case when the German cement cartel controls 50% of Eastern European capacity. Note that the average marginal effect of *Distance* at $GCCE=0.5$ is lower than for $GCCE=0$ and higher than that for $GCCE=1$.

⁴³ An alternative explanation for our empirical results has been suggested by a referee. Suppose some customers developed relationships with some intermediaries which lowered the transaction costs between the customer and certain suppliers. Further suppose that these customer-intermediary relationships were more common for customers near the border because of proximity to foreign suppliers. If the information costs of buying direct exogenously fell over time, buyers might increasingly choose not to use intermediaries and, furthermore, this effect would be strongest for those buyers near the border. There are, however, two facts that run contrary to this alternative theory. First, the rationale offered for the initially higher use of intermediaries by buyers near the border is their access to foreign supply. However, there was very little cement sourced from Eastern Europe as of 1990, for the fall of communism had only recently happened. Second, this theory predicts that intermediaries would be used less for purchases from both German and foreign suppliers. As reported in Figure 2, the fraction of foreign purchases through an intermediary held steady at around 90 percent throughout the period. In sum, while this alternative explanation is plausible, the evidence does not tend to support it.

which ceases to be significant when it has full control ($GCCE=1$). That finding is consistent with our results for specification (1). Further supportive evidence comes from specification (2) which finds no statistically significant effect of distance in the post-cartel period ($PC = 1$) when the German cartel controls all Eastern European capacity ($GCCE=1$).⁴⁴ However, specification (3), which adds an interaction between *PostCartel* and *Distance*, does find an effect of distance after the cartel's shutdown. While that estimate does not conform with the theory, it is weak and not robust. It is only marginally significant ($p=0.094$) and the estimated coefficient on the interaction between *PostCartel* and *Distance* is not significantly different from zero (see Table 2). Furthermore, when the transition year of 2002 from collusion to competition is excluded in specification (4), the result disappears as the average marginal effect of distance becomes insignificant ($p=0.268$). In sum, the robust findings from the empirical analysis support the theory that the German cement cartel diverted transactions to intermediaries in order to share rents in exchange for them not sourcing supply from Eastern European cement manufacturers.

6. Conclusion

It is fair to say that the German cement manufacturers ran an effective cartel as reflected in an average overcharge exceeding 25 percent (Hüschelrath, Müller, and Veith, 2016) and a duration exceeding a decade. Though the cartel eventually collapsed due to the lack of compliance of one of its members, it *was* able to constrain external sources of instability. The cartel's members purchased numerous cement plants in Eastern Europe that were a potential source of low-priced imports. But even before those acquisitions, our analysis provided evidence that the cartel limited imports by sharing rents with German intermediaries so that they would not source foreign supply. This bribery scheme was executed by allowing an intermediary to issue an invoice and charge a fee on a transaction between a German cement cartel member and a German cement customer even though the cement was transported directly from the seller to the buyer. The sharing of rents with intermediaries was predicted to be more likely when the threat of non-cartel supply was more serious. Consistent with that prediction, we showed that the closer was the distance between a German cement buyer and the nearest Eastern European cement plant, the more likely that a German cement cartel member was to involve an intermediary in selling to that buyer. Furthermore, this effect was found to be weaker when the German cement cartel controlled more Eastern European capacity in which case there

⁴⁴ The German cartel controlled about 80 percent of Eastern European capacity at the end of the cartel period.

was less of a need to bribe intermediaries. This episode is yet more evidence of the creativity and audacity of cartels to control sources of instability in order to be able to maintain supracompetitive prices.

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