

# Help from Above: Hub-and-Spoke Collusion in a Brazilian Gasoline Market

Daniel Chaves  
Western University

Marco Duarte  
University of Wisconsin-Madison

Preliminary and Incomplete. Please do not cite.

## **Abstract**

A number of cartel litigation cases worldwide describe situations in which one level of the supply chain helped another level to horizontally coordinate, i.e. hub-and-spoke cartel (Harrington, 2018). We empirically investigate a hub-and-spoke cartel in the Brazilian automotive fuel industry. In our case, upstream firms helped the downstream cartel to punish defectors by offering wholesale price discounts for the defector's close competitors. We build a simple model based on the industry characteristics to show how the upstream firms can benefit from a cartelized downstream. We propose for a future version of the article to quantify the importance of the upstream actions for the stability of the downstream cartel.

# 1 Introduction

The study of competitive conduct in vertical markets has restricted its attention to the practice of vertical restraints, e.g. resale price maintenance (Jullien and Rey, 2007) and foreclosures (Ordover and Salop., 1990; Asker, 2016). However, as pointed out in Harrington (2018), competition authorities around the world have been dealing with collusive settings in which one level of the supply chain facilitated a collusive agreement in another level of the supply chain, named hub-and-spoke collusion.<sup>1</sup> The existence of this type of arrangement is at odds with the implications from standard upstream/downstream models, especially regarding the double-marginalization problem. This paper is a theoretical and empirical study of a hub-and-spoke cartel.

Our setting is the automotive fuel industry in Brasilia, Brazil. In November 2015, after a long investigation, the police and the Brazilian competition authority arrested gas station owners under the charges of price fixing. As the prosecution documents and leniency agreements point out, the key feature of this cartel was that firms in one level of the supply chain (fuel distributors) facilitated a horizontal agreement in another level of the chain (gas stations). Using the original prosecution documents and detailed data on prices and quantities along the supply chain, we address the following questions: (i) how can upstream firms earn higher profits when downstream firms collude? (ii) how can upstream firms help downstream firms in colluding?

Our strategy has three steps. First, we provide documentary analysis describing the cartel's internal organization and the mechanisms used by upstream firms to help downstream firms sustain collusion. Second, we develop an economic model of the supply chain that rationalizes the information contained in the prosecution documents and data. Lastly, to understand the importance of the upstream actions for the cartel, we propose to quantify the incentive compatibility constraint faced by gas stations under counterfactual scenarios of the upstream behavior. To do so, we first estimate a flexible demand model of automotive fuel that accounts for spatial differentiation among stations.<sup>2</sup> Then, we follow Igami and Sugaya (2019) and compute the respective incentive compatibility constraint for each cartel member.

---

<sup>1</sup>Asker and Hemphill (2019) discuss an historical example of a hub-and-spoke cartel situation similar to ours in the American sugar industry during the 1880s.

<sup>2</sup>As in Houde (2012), the demand model also allows for income and commuting patterns heterogeneity across consumers.

By studying the hub-and-spoke cartel in the automotive fuel market in Brasilia, Brazil, we add to different streams of the Industrial Organization and Antitrust literature. First, we add to an incipient literature concerned with explaining the formation of hub-and-spoke cartels. To the best of our knowledge, Sahuguet and Walckiers (2017) is the only article to propose a theoretical model of hub-and-spoke collusion. In a setting with one supplier and two retailers, the authors show how the downstream can sustain collusion by sharing information with each other about demand shocks through the upstream. Furthermore, the supplier benefits from the information sharing by being able to charge higher wholesale prices when demand is high. We, in turn, contribute to this literature with a description of a market structure where information sharing is not a constituent component of a hub-and-spoke collusion.

Second, this paper adds to the empirical literature studying the internal organization of cartels. Despite the vast theoretical knowledge on the market features that facilitate cartel stability, the secretive nature of cartels and the confidentiality involved in the prosecuted cases impose limitations on what researchers know in practice (Levenstein and Suslow, 2015). A few exceptions are Genesove and Mullin (2001); Asker (2010); Clark and Houde (2013); Igami and Sugaya (2019). We contribute to this literature by providing a detailed documentary analysis of a cartel and by quantifying the importance of the upstream actions to the stability of the downstream collusion.

## **2 Institutional background and data**

### **2.1 Overview of the Brazilian automotive fuel industry**

Three features of the Brazilian automotive fuel industry are markedly different from the automotive fuel industry worldwide: (i) gasoline and ethanol are the main fuel alternatives; (ii) the presence of a state-owned monopolist in the production of gasoline; and (iii) the prohibition of vertical integration between distribution and retail.

In most countries, consumers have the option to buy automobiles that run on gasoline or diesel. In Brazil, the only vehicles that run on diesel and have access to the retail network are pick-up trucks. Since these vehicles account for a small fraction of consumers, we choose not to address the retail sales of

diesel in this work.<sup>3</sup> Instead, most automobiles in Brazil run on gasoline or are bifuel (run with gasoline, ethanol or any combination of both).<sup>4</sup> Hence our focus on gasoline and ethanol.

As depicted in figure 1, the automotive fuel supply chain in Brazil is divided in three tiers: production; distribution; and retail. In the production stage, the state-owned monopolist, Petrobras, refines domestic and imported oil to produce more than 90% of the gasoline sold in Brazil.<sup>5</sup> Petrobras sells its production to distributors through 36 different supply points located across the Brazilian territory. Officially, Petrobras has been free to set prices since the early 2000's. However, until October 2016, the price Petrobras' charged distributors was being set by the federal government. In particular, the government used Petrobras to absorb shocks coming from the international oil price and smooth domestic fuel price changes. In contrast, small private distilleries produce ethanol from sugar cane and are dispersed across the country. All the tax charged from the supply chain is collected in the production stage.

Distributors buy gasoline at the supply points and ethanol from the private distilleries, and stock them in private tanks. Although distributors can import refined gasoline abroad, imports never accounted for more than 10% of the gasoline sold in the country. Before selling the gasoline to retailers, regulation mandates distributors to mix it with ethanol on a fixed proportion of one liter of ethanol for three liters of gasoline. Distributors then sell and deliver the mixed gasoline and ethanol to geographically dispersed gas stations based on buying orders initiated by the stations. Hereafter, we will refer to the mixed gasoline that retailers buy from distributors and sell to consumers simply as gasoline.

Almost every station in Brazil sells both ethanol and gasoline. The stations are only allowed to buy gasoline and ethanol from distributors. Regulation prohibits distributors to operate gas stations but allow them to sign

---

<sup>3</sup>The share of diesel vehicles sold in 2015 was 1.3% (Anfavea, 2019).

<sup>4</sup>Ethanol became an option to Brazilian consumers in the late 1970's as a result of a government program called *Proalcool*. *Proalcool* was a response from the Brazilian government to the first oil shock in the mid 1970's and was designed to reduce the countries' dependence of imported oil. Ethanol consumption surged in the 1980's as most of the cars sold during that decade ran on ethanol but declined during the 1990's as the price of oil declined and the price of sugar increased.

<sup>5</sup>The stated-owned monopoly in the refinement is a remnant of dictatorship movements and industrialization policy during the 20th century.

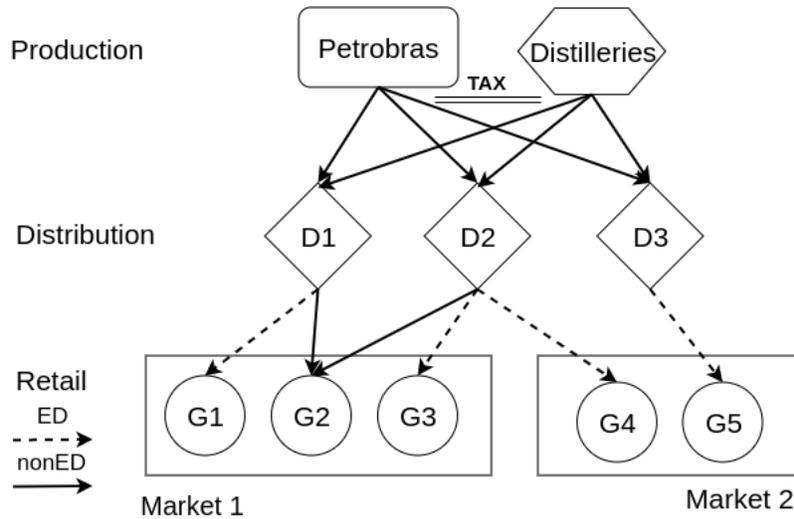


Figure 1: Automotive fuel industry supply chain.

exclusive dealing contracts with each station.<sup>6</sup> A standard contract mandates the gas station to buy only from the distributor it has a contract with and determines a minimum quantity that must be bought during the contract period.<sup>7</sup> While the exclusive dealing is in place, the gas station benefits from the use of the distributor’s brand and advertisement campaigns. Stations that do not have exclusive dealing contracts are free to buy gasoline from any distributor, and therefore are called *independent* station. The independent stations must, by law, display the name of the distributor from whom they bought the fuel in tags at the nozzles. However, they cannot use the distributor brand to promote sales or somehow characterize the station.<sup>8</sup>

## 2.2 Data

The main source of data used in this paper is the Brazilian Regulatory Agency of Petroleum, Natural gas and Biofuel, *ANP* hereafter. Since July 2001, ANP

<sup>6</sup>The law against vertical integration was created during the liberalization of the sector at the end of the 90s, with the intention to sustain competition along the supply chain.

<sup>7</sup>The length of the contract usually varies depending on how much the distributor helped financing the construction of the gas station.

<sup>8</sup>Throughout this work we are going to use stations with exclusive dealing contracts and branded stations as equivalent.

conducts a weekly survey in 455 Brazilian municipalities that are representative of the country. In each municipality, ANP collects detailed price information from a random sample of stations. The coverage of the sample varies according to the size of the municipality. For the large capitols, coverage is between 10% and 25%. For small municipalities, coverage is between 40% and 50%. The information collected includes the retail and wholesale prices of gasoline and ethanol, the name of the distributor that sold the respective fuel to the station, the brand affiliation and the address of the station.

Also from ANP, we obtained for every station the size of the fuel tanks, the number of nozzles assigned to each fuel and the monthly volume of each fuel that stations purchased from distributors. We also obtained the list of distributors that operates in each state of the country as well as the monthly volume bought by each distributor in each supply point. Moreover, the data on prices that distributor pay at the supply points is published monthly by Petrobras. The information on the monthly average ethanol price in distilleries comes from ESALQ, an energy sector think-tank.

### **3 Cartel**

Our knowledge on the gasoline cartel’s internal organization comes from litigation documents provided by the prosecutor’s investigation. In what follow, we first describe the market that was targeted by the investigation, and then we provide detailed information on how the cartel operated. We complement the description of the legal documents with data from the industry to draw a detailed picture of the collusive agreement.

#### **3.1 Brasilia fuel market**

Similar to other countries, Brazil’s federal government body is situated inside a federal district that is composed by only the federal capital city. The federal capital, Brasilia, was planned and constructed by the state during the 1950’s in the midwest region of the country. One of the main reasons for creating a new federal capital was to promote the occupation of the midwest part of the country, largely underpopulated. As a consequence, Brasilia is a large and isolated urban space. In 2010 it had a population of 4.2 million people and the closest large urban area is 110 miles apart.

Almost the totality of gasoline sold in Brasilia is bought through Petrobra’s supply point located inside the federal district. Table 1 displays the market share of BR, Ipiranga and Raizen, the three distributors involved in the cartel.<sup>9</sup> The shares were computed using data from November 2015, the month the police started the wave of arrests related to the operation of the cartel. BR, Ipiranga and Raizen account for 93% of the total sales of gasoline and 88% of the sales of ethanol. Furthermore, 41% of the 308 stations operating during that period had an exclusive dealing agreement with BR, 17% with Ipiranga and 18% with Raizen.

Table 1: Market share of distributors - November 2015

	Share of sales (%)		Share of stations with ED agreement (%)
	Gasoline	Ethanol	
BR	47	41	41
Ipiranga	28	28	17
Raizen	18	19	18
Total	93	88	76

The retail market in Brasilia is characterized by one large player and a number of smaller station owners. The Cascol group, a family-owned and long established company, own 90 stations (approximately 30% of all stations). A large amount of the group’s stations are located in the downtown area. Some of their stations operate with exclusive dealing contracts and some are independent. In particular, 50% of their stations have exclusive dealing contracts with BR, 16% have exclusive dealing with Ipiranga and 34% are independent. Excluding Cascol, the average group has around 3 stations. Moreover, if we do not take into account the ones owned by Cascol, in 2015 Brasilia had only 40 stations that did not have exclusive dealing contracts.<sup>10</sup>

From table 2 we can see that Brasilia is marked by a large potential demand for fuel and geographically sparse gas stations, compared to other state capitals. This translate into gas stations with a large number of pumps and a high number of buying orders to distributors. However, the percent

<sup>9</sup>These distributors are also the largest national players, with all three present on the 26 Brazilian states.

<sup>10</sup>The number of exclusive dealing contracts and total number of stations is stable through time.

Table 2: Gas Stations Summary Statistics - 2015

	Brasilia	Other Capitals
Number of stations	308	246
Percent of branded	76.95	72.39
Approx number of orders in a month	7.46	4.70
Median tank size	30	30
Median number of pumps	6	4.50
Median number of stations in a 2km range	14.50	24
Car fleet/Population	0.40	0.27
Ethanol sale/Gasoline sale	0.10	0.32

of stations with exclusive dealing contracts is not significantly different from other capitals. Moreover, the ratio of ethanol sale over gasoline sale is relatively small. As will be pointed in the next section, the cartel operations can explain part of this low ethanol sale.

Total quantity sold in Brasilia kept increasing through all the relevant period, with a small decrease in 2015. Since the 2015 decrease is also present in the average sale of the state capitals, we assume that large part of it is a reflection of the severe recession faced by the economy during this year.

### 3.2 Cartel Operation

In 2011, ANP informed the public prosecution office about an uncommon price co-movement between gas stations in Brasilia. With this information, the prosecution office, together with the police, started to investigate the practice collusive conduct by the gas stations. The investigators wiretapped station owners and distributors during the year of 2015. Subsequently, they seized documents and collected testimonies at the end of the same year. The conversations and documents presented by the prosecution to the court showed Cascol as the leader in the retail price fixing group. In February of 2016, with the objective of terminating the illicit behavior, the court determined that a state intervention should be executed. As such, Cascol's management board was replaced by a government appointee.

According to the prosecution documents, the determination of retail prices proceeded as follow: (i) the director of operations from the Cascol group was

informed by distributors' sales representatives on the new wholesale price; (ii) using this information, Cascol decided on a new price to charge for fuel on its stations; (iii) before changing the price, it informed other members of the cartel on the decision; (iv) the other members were responsible for transmitting the information to other stations in their vicinity. Unbranded stations were allowed to charge a 2 cents difference with respect to the accorded price. Stations in peripheral regions were allowed to charge a 3 cents difference.

Figure 2 makes it clear that the cartel was successful in eliminating the gasoline price dispersion across Brasilia. There a significant drop in price dispersion during 2011, the same year stated by the court documents for when the cartel started to be fully operational. We can also see a significant increase in dispersion after 2016, coinciding with the market intervention by the competition regulator during January of the same year.

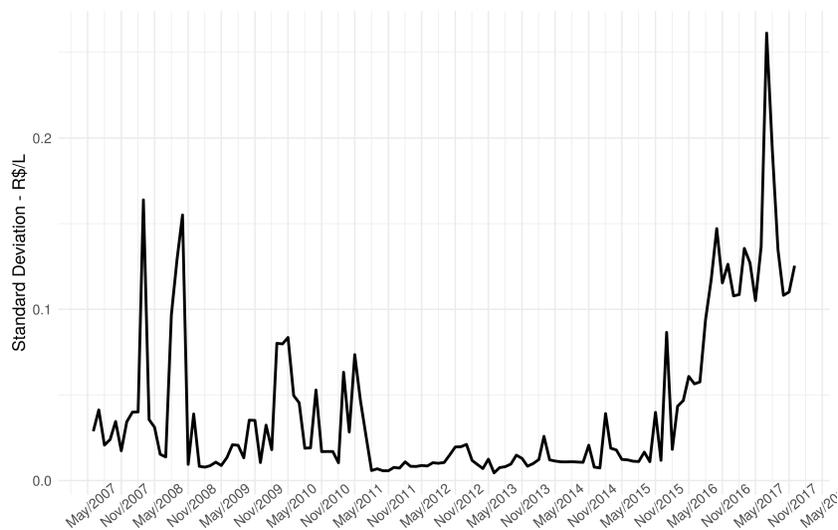


Figure 2: Retail price dispersion

Made it clear by the wiretapping conversations, members of the cartel dealt with deviations from the agreed price in two steps. First they reach the station that deviated and try to persuade it to come back to the agreement. If the first approach was not successful, then the members start the punishment by lowering prices in stations close to the one that first departed. Although it is not clear how frequent the occurrence of price wars were, the prosecu-

tion documents mention two occasions during the year of 2015. Something unusual during the punishment phase and also documented by the police is that distributors offered wholesale price discount for gas stations involved in the price war, except for the station that triggers it.<sup>11</sup> According to conversations between distributor’s employees, the discount should be at most 10 cents on the liter and it should be seized as soon as the prices came back to “normal”.

Figure 3 show evidence that the cartel succeeded in generating above normal profits from gasoline sale.<sup>12</sup> Although mark-ups from the whole supply chain in Brasilia are higher than the average even before 2011,<sup>13</sup> the cartel was able to increase this difference during the period that it was fully active. If we discriminate the mark-up for each level of the supply chain, we observe a different timing between retail and distribution in the price setting. In the first three years of the cartel the retail succeeded in setting a mark-up above the national average. In the last two years, distributors were able to increase wholesale margins while the retail margin went back to the national average.

The next section provides a simple theoretical framework that illustrates what we believe is the relevant channel for which upstream firms benefit from downstream collusion in our setting.

## 4 Distributor profits under minimum-retail-margin constraint

The evidence from the prosecution documents indicate the existence of an informal contract between distributors and stations that guarantee a minimum margin for retailers if they signed an exclusive dealing agreement. Documents seized in BR’s headquarter make it explicit that a minimum-retail-margin for the exclusive retailers is key for a “good relationship” in the long-term, i.e. to maintain the exclusive contracts. If the minimum-margin is perceived as a transfer from distributors to gas stations, then together with an exclusive dealing agreement, it can work as an exclusionary practice by distributors, similar to the predictions from Asker and Bar-Isaac (2014). In this first ver-

---

<sup>11</sup>In the sugar cartel described by Asker and Hemphill (2019) punishing defections was also made easier with the help from the hub.

<sup>12</sup>Aggregate quantity follow a positive trend through all the period.

<sup>13</sup>It can be the case that some price coordination exist before 2011, but evidences from a fully operational cartel just come out in 2011.

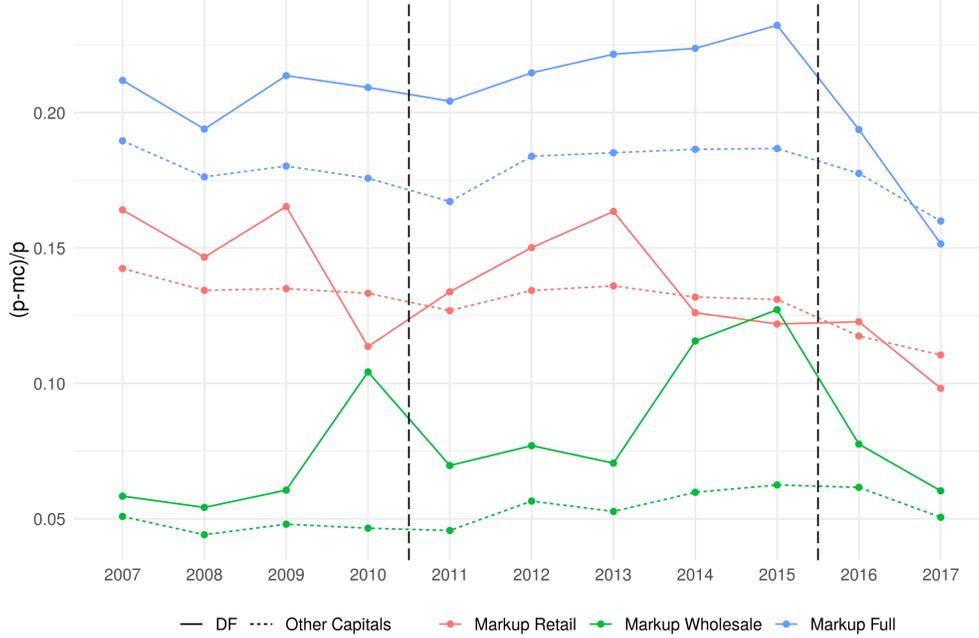


Figure 3: Mark-up evolution

sion of the model we take the minimum-retail-margin as given and work on the effects of the downstream collusive behavior on the upstream profits.

In this simple model we have two gas stations,  $i$  and  $j$ , that deals exclusively with one distributor  $D$ . Distributor play first setting the wholesale prices  $(w_i, w_j)$ , and gas stations play next competing in retail prices  $(p_i, p_j)$ . Gas stations are horizontally differentiated. The vertical contract is of linear prices, but with a clause that distributor must guarantee a minimum margin  $\eta \in \mathbb{R}_+$  for the gas stations. Let the profit for gas station  $i$  be:

$$\pi_i = q_i(p_i - w_i) + \theta q_j(p_j - w_j)$$

where  $q_k$  is quantity for gas station  $k$  and  $\theta \in [0, 1]$  is the conduct parameter. The solution for gas station  $i$  maximization problem is:

$$p_i - w_i = -\frac{q_i}{\frac{\partial q_i}{\partial p_i} + \theta \frac{\partial q_j}{\partial p_i}}$$

Hence, distributor's problem takes the form:

$$\max\{q_i(w_i - mc) + q_j(w_j - mc)\} \quad s.t. \quad p_k - w_k \geq \eta, \forall k \in \{i, j\}$$

where  $mc$  is the marginal cost. Lets assume a symmetric demand for the gas stations and evaluate distributor's profit under the symmetric equilibrium for a given  $\theta$ :  $\pi^D(\theta) = 2q(p(\theta, w(\theta))[w(\theta) - mc]$ .

We are interested on the difference  $\pi^D(1) - \pi^D(0)$ . Taking the derivative of the profit with respect to  $\theta$ :

$$\begin{aligned} \frac{\partial \pi^D}{\partial \theta} &= \frac{\partial q}{\partial \theta}(w - mc) + q \frac{\partial w}{\partial \theta} \\ &= \frac{\partial q}{\partial p} \left( \frac{\partial p}{\partial w} \frac{\partial w}{\partial \theta} + \frac{\partial p}{\partial \theta} \right) (w - mc) + q \frac{\partial w}{\partial \theta} \\ &= \frac{\partial w}{\partial \theta} \left[ \frac{\partial q}{\partial p} \frac{\partial p}{\partial w} (w - mc) + q \right] + \frac{\partial q}{\partial p} \frac{\partial p}{\partial \theta} (w - mc) \equiv f(\theta) \quad (1) \end{aligned}$$

Note that the last element in the right hand side of (1) is the double-marginalization problem, that intensifies with the retail collusive conduct. The first element is the increase in profits that comes from a more relaxed minimum-retail-margin constraint after gas stations collude.

Using the implicit function theorem in the minimum-retail-margin constraint we can write:

$$\frac{\partial w}{\partial \theta} = \begin{cases} -\frac{\partial p / \partial \theta}{\partial p / \partial w - 1} & \text{if } w(\theta) \leq w^* \\ 0 & \text{otherwise} \end{cases}$$

where  $w^*$  is the wholesale price solution for the unconstrained problem. Assuming  $\eta$  is high enough such that  $w(1) \leq w^*$ , we have:

$$\pi^D(1) - \pi^D(0) > 0 \iff \int_0^1 f(\theta) d\theta > 0 \quad (2)$$

A sufficient condition for  $\pi^D(1) - \pi^D(0) > 0$  is:

$$\frac{-q}{\partial q / \partial p}(\theta) \geq w(\theta) - mc, \quad \forall \theta \in [0, 1].$$

But  $\frac{-q}{\partial q / \partial p}$  is the perfect collusion retail margin evaluated at  $w(\theta)$ . Hence, if we have a demand curvature lower than one (which implies retail pass-through lower than 1), a sufficient condition for the distributor to profit from a cartelized retail is:

$$p(w(1), 1) - w(1) \geq w(1) - mc,$$

i.e., the retail margin must be bigger than the wholesale margin at the cartel condition while the minimum-retail-margin constraint is binding.<sup>14</sup>

## References

- Asker, J. (2010, June). A study of the internal organization of a bidding cartel. *American Economic Review* 100(3), 724–62.
- Asker, J. (2016). Diagnosing foreclosure due to exclusive dealing. *Journal of Industrial Economics* 64(3), 375–410.
- Asker, J. and H. Bar-Isaac (2014). Raising retailers’ profits: On vertical practices and the exclusion of rivals. *The American Economic Review* 104(2), 672–686.
- Asker, J. and C. S. Hemphill (2019). A Study of Exclusionary Coalitions: The Canadian Sugar Coalition, 1888-1889.
- Clark, R. and J.-F. Houde (2013). Collusion with asymmetric retailers: Evidence from a gasoline price-fixing case. *American Economic Journal: Microeconomics* 5(3), 97–123.
- Genesove, D. and W. P. Mullin (2001, June). Rules, communication, and collusion: Narrative evidence from the sugar institute case. *American Economic Review* 91(3), 379–398.
- Harrington, J. (2018). How do hub-and-spoke cartels operate? lessons from nine case studies. *Mimeo - The Wharton School, University of Pennsylvania*.
- Houde, J.-F. (2012). Spatial differentiation and vertical mergers in retail markets for gasoline. *The American Economic Review* 102(5), 2147–2182.
- Igami, M. and T. Sugaya (2019). Measuring the incentive to collude: The vitamin cartels, 1990–1999. *Mimeo Yale University*.
- Jullien, B. and P. Rey (2007). Resale price maintenance and collusion. *The RAND Journal of Economics* 38(4), 983–1001.

---

<sup>14</sup>An analogous result holds for  $E > 1$  and  $p(w(0), 0) - w(0) \geq w(0) - mc$

- Levenstein, M. C. and V. Y. Suslow (2015). Cartels and collusion – empirical evidence. *The Oxford Handbook of International Antitrust Economics 2*.
- Ordover, Janusz A., G. S. and S. C. Salop. (1990). Equilibrium vertical foreclosure. *The American Economic Review 80*(1), 127–142.
- Sahuguet, N. and A. Walckiers (2017). A theory of hub-and-spoke collusion. *International Journal of Industrial Organization 53*, 353 – 370.