Obfuscation in vertical markets*

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Abstract

In the wake of increasing transparency requirements enforced by regulatory agencies worldwide, Italian law obliged gas stations to publish their fuel price changes on an online platform, but, differently from other countries, it allowed price cuts to be veiled under some circumstances. We show that this transparency rule makes it profitable for strategic retailers to obfuscate price reductions. Consistent with the theory, we find that obfuscators and their neighboring competitors tend to report higher fuel prices.

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Keywords: obfuscation; vertically integrated markets; online platforms; transparency rule; fuel prices.

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1 Introduction

From the 2000s, regulatory agencies worldwide started requiring retailers to post their prices on online price comparison platforms, with the intended aim of increasing transparency to consumers. While the previous literature has focused on how these price communication rules affect competition and eventually lead to collusion (Ater and Rigbi, 2017; Cabral et al., 2018; Byrne and de Roos, 2019; Luco, 2019), we study how a transparency rule may lead to obfuscation.

Since 2015, Italian law has established a transparency requirement rule, which mandates gas stations to publish retail fuel prices on a public online platform: firms are required to notify to the Ministry for Economic Development (MED) the current price of the day at least once a week and all price hikes within the day, otherwise they might incur a fine.[1] No additional requirements are set for price drops: there is therefore an opportunity to veil drops without being subject to a fine. Data coming from the MED platform show that most gas stations usually report all price changes, but about 17 per cent of them communicate only when it is strictly necessary. We argue that hiding price drops is a deliberate behavior of some strategic retailers, intended to induce the rival wholesalers to raise prices in order to gain customers at the expenses of their local market competitors. We are the first, to the best of our knowledge, to illustrate the consequences of obfuscation targeted at other vertically related competitors rather than directly at consumers.

This strategy is profit-enhancing since the Italian gasoline market has the following characteristics. First, it is vertically integrated: large oil companies (wholesalers) control the drilling, extraction, oil refining and the distribution of oil products; they have long-term exclusive contracts with gasoline stations (retailers) to supply fuel to be sold to final consumers. Second, retailers are, in principle, free to choose final prices, but in practice, they charge the price suggested by the oil companies, and receive a fixed retail margin (Borenstein

[1]Australia pioneered such a transparency rule in 2001, more recently followed by Chile in 2012, Germany in 2013, and, eventually, Italy in 2015.

and Shepard, 1996; Alderighi and Baudino, 2015; FIGISC et al., 2017). Finally, although the retail fuel market is characterized by high search costs for consumers, the evidence suggests that, in spite of their purpose, these platforms are hardly used by consumers, while they are employed by wholesalers to monitor the competitors' retail prices and to choose the suggested price to communicate to their retailers (AGCM, 2013; Byrne and de Roos, 2017).

Our theoretical framework rationalizes this behavior by considering a vertically-related market with two wholesalers, each one patronized by one retailer. Competition in the retail market is played as in a standard Hotelling game. Only the first retailer can misreport when the wholesaler's costs are low (i.e., he can hide that there was a price drop due to the low costs of his wholesaler), while the second retailer always reports the true costs (i.e., he always communicates his prices). The second wholesaler, when she observes high costs, is not able to distinguish whether they correspond to high costs reported by the strategic/non-strategic retailer or to low costs misreported by the strategic one. She, therefore, sets a price, which is based on her costs and on the beliefs on those of the opponent. In this setup, the strategic retailer has a dominant strategy to misreport low costs (i.e., to obfuscate price drops). In this way, when the first wholesaler has low costs and sets low prices, the strategic retailer can gain a larger base of customers and, therefore, higher profits, since retail margins are fixed.

In the empirical analysis, daily data on reported prices from the official Ministerial platform during year 2015 confirm the theoretical prediction. Prices communicated by an obfuscator are, on average, higher than those reported by other retailers. This result provides a first support that this type of strategic behaviour is present. In addition to this, we find that prices communicated by nearby retailers of an obfuscator are higher than those reported by retailers who do not face strategic players. This second piece of evidence suggests that obfuscators can cheat the rival wholesalers and induce them to choose higher prices. Finally, we find that higher prices are more pronounced when prices are falling, as well as when price dispersion is higher. Indeed, these conditions give more opportunities for strategic retailers to obfuscate price cuts.

Our results add to the literature on obfuscation, which focuses on those practices intended to hamper direct comparison of some specific attribute of the product, market conditions, or prices to obtain higher profits. Such a broad definition encompasses different strategies, such as the use of 'add-ons' at high unadvertised prices (Ellison, 2005), the shrouding of product attributes (Gabaix and Laibson, 2006), multidimensional pricing (Spiegler, 2006), listing multiple prices (Ireland, 2007), the choice of price formats that are difficult to compare (Piccione and Spiegler, 2012; Chioveanu and Zhou, 2013; Edwards, 2019), intertemporal price variations (de Roos and Smirnov, 2018); and any attempt to increase the cost or the time required for consumer search (Wilson, 2010; Ellison and Wolitzky, 2012). Ellison and Ellison (2009) provide evidence of the benefits of such practices using data from an Internet retailer. Ellison (2016) reviews the empirical papers that have documented obfuscation strategies. While this literature has so far focused on obfuscation targeted at customers, we contribute to it by showing that obfuscation can also be targeted at competitors in a vertically-related market, with the aim of gaining customers at their expenses.

This paper is also related to the above-mentioned literature on price transparency platforms and competition. Byrne and de Roos (2019) find that such platforms eventually favored implicit collusion among wholesalers in Australia, but also show that some time is needed for firms to learn how to collude (three years, in their case). Looking at German gas stations, Cabral et al. (2018) report that the process is much faster in the presence of price matching guarantees. Luco (2019) shows that price disclosure in Chile increased margins on average and may have important distributional effects. To the best of our knowledge, this is the first contribution to consider the market effects of an imperfect transparency rule, i.e., when compulsory communication only concerns a subset of prices. More specifically, we show how an asymmetric communication rule leads to prices that are higher in markets with strategic retailers than in those without them. Such unequal customers' conditions across markets can be brought to an end by modifying the transparency rule and requiring the communication of all prices.

Finally, we also contribute to the consolidated literature on retail pricing in gasoline markets that investigates the relationship between prices and local competition or station amenities. In this respect, we add evidence that prices decrease with seller density (Barron et al., 2004; Hosken et al., 2008; Pennerstorfer and Weiss, 2013; Lach and Moraga-González, 2017), and we show that the presence of amenities is negatively related to the retail fuel price charged to consumers (Barron et al., 2004; Eckert and West, 2005; Hosken et al., 2008; Eckert, 2013).

The rest of the paper is organized as follows. Section 2 provides a description of the Italian fuel market. The theoretical model is presented in Section 3. Data and methodology are introduced, respectively, in Sections 4 and 5. Section 6 illustrates the main empirical results and robustness checks, and Section 7 concludes.

2 The Italian fuel market

The Italian fuel market is characterized by an extensive network of around 18,000 retailers, which were present in about 63% of the municipalities in 2015.[2] Gas stations sell fuels in two different ways: self-service, and full-service; for the latter the presence of an attendant is needed. Full-service, due to its higher costs, is less popular, and not all retailers offer it. The bulk of the demand is represented by diesel and gasoline fuels: the passenger car fleet in Italy is almost equally split between gasoline- (51.80%) and diesel-fueled (42.80%) vehicles.[3]

The wholesale market is dominated by six large brands (Agip, Api-Ip, Esso, Q8, Tamoil, and Total Erg): data from the MED show that branded retailers, with long-term exclusive contracts with one of these six brands, are 78.40% of the total. Wholesalers choose both the wholesale and the retail price, as well as a firm-specific retail margin, given by the

[2] As our empirical analysis is based on daily price data for 2015, we report figures for that period throughout the following discussion.

[3] Statistics on passanger car fleet by fuel type are available on the European Automobile Manufacturers Association (ACEA) website.

difference between these two prices (Borenstein and Shepard, 1996; Alderighi and Baudino, 2015; AGCM, 2013; FIGISC et al., 2017). They also take into account local factors such as logistics and the degree of competition (AGCM, 2013). Unbranded retailers constitute 21.60% of the population. They are independently managed firms and set prices more freely as they are not tied by long-term exclusive contracts to a wholesaler. This residual category also includes those retailers patronized by smaller wholesalers, who depend on third parties to supply the Italian market, because, for example, they do not own refineries in Italy, e.g., Repsol.

In 2009, Italian law 99/09 made it mandatory for each gas station to report prices regularly to the MED with the declared purpose "to favor the widest circulation of information on prices set by any gas station on the whole national territory" (law 99/09, item 51, paragraph 1). The Ministerial Decree of October, 15 2010 sets the communication rule. Price communications should take place: 1) within the day whenever there is a price increase; and 2) in any case, even if prices are unchanged, at least within the eighth day from the last communication date.[4] Although it is likely that the legislator was not fully aware of the implications of this legal rule, the rationale can be that, being sympathetic to consumer welfare and aiming at keeping prices down, it wanted to monitor price hikes more than price drops. This is also suggested by the punishment scheme: retailers who do not comply with the communication rule are fined from 516 to 3,098 euros.

The share of Italian consumers using the platform seems very limited. Byrne and de Roos (2017) estimate that only 6%-13% of shoppers actively use the Australian price comparison website each day, which is much more user-friendly than the Italian one.[5] Even worse results

[4]The other countries adopting price transparency programs choose different rules for the frequency of communication. In Australia, for instance, retailers are required by law to notify their next day's prices to the government (Byrne and de Roos, 2019). In Chile, retailers have to communicate any price change within 15 minutes (Luco, 2019). In Germany, retailers are required to notify all price changes in real time (Haucap et al., 2017; Cabral et al., 2018).

[5]Byrne and de Roos (2017) study the Australian platform in Perth. In their data, Fuelwatch receives between 10,000 and 20,000 visits per day, from a market with 157,000 estimated daily shoppers and 1.7

have been reached with the App linked to the MED website, called “Osservatorio prezzi”, which has received only around 10,000 downloads as of October, 2019 on Google Play Store and is rated 1.9 out of 5. In a country with more than 37 million passenger cars in circulation in 2015 according to Eurostat, the share of consumers using the official Ministerial platform is therefore very limited. In general, we can safely assume that in the Italian fuel market most consumers usually retrieve retail prices from the gas stations' price boards.[6]

The platform is instead an useful information tool for wholesalers. Indeed, most wholesalers, when interviewed by the Italian Antitrust Authority, declared that to set their reference price at national level they took into account the behavior of their competitors "through autonomous ad hoc investigations with a dedicated office or with the help of retailers" (AGCM, 2013, p. 171). The introduction of the price comparison platform has decreased the cost of collecting such information on competitors' pricing behavior for wholesalers: web scraping tools, for example, are able to retrieve the whole set of prices posted on a platform in a few minutes, in fully automated way, without errors or inaccuracies, and with very limited costs.

As mentioned in the Introduction, these price transparency platforms may favour implicit collusion among wholesalers, who nonetheless need time to learn to coordinate (Byrne and de Roos, 2019; Cabral et al., 2018). In order to minimize the risk that our data also include this confounding effect, we limit our data coverage to 2015, the first year in which the platform becomes fully operational.[7]

While prices are set by the wholesaler, retailers are in charge of the communication of prices. Indeed, the regulation is enforced through a restricted area in the MED platform,

million people. To compare the user-friendliness of the two platforms visit the Australian and the Italian ones.

[6]Rossi and Chintagunta (2016, 2018) focus on the introduction of price comparison signs by the side of the highway in Italy and show that consumers rely on them for their purchasing decisions.

[7]Additionally, in the period under consideration AGCM does not detect any breach of competition in the retail fuel market. See: www.agcm.it

where retailers must log in to communicate prices. Once the price is communicated, it is published on the MED platform, and it therefore becomes therefore publicly available. On those days in which a firm does not communicate its price, the website reports the price, which was most recently communicated. Thus, although retail prices are chosen by wholesalers, some retailers, i.e., the strategic ones, have the possibility to veil their price drops.

Other retailers may not seize the opportunity to veil price drops offered by the law. First, they may overestimate the importance of publishing price cuts on the online price comparison platform in order to attract more consumers. Second, retailers may instruct workers in charge of uploading information on the platform to report all prices: this simplifies their administrative tasks and limits the risk of being fined for missing communication. Indeed, each station must manage the communications of different prices, i.e., gasoline, diesel, methane gas and liquid propane gas, full- and self-service, standard and premium. Station-specific fuel prices exhibit different patterns of variation including differences in the sign of price variation (e.g., diesel up and gasoline down, or vice versa). Thus, the burden of selecting which prices to communicate can drive gas stations to simplify the procedure and notify all prices. Finally, also the instructions on the platform indicate that all the price changes should be communicated. To conclude, the choice not to communicate is the result of a deliberate choice of some strategic players. Indeed, in Section 4 we show that most of the retailers (around 84%) have followed the conventional road to communicate all prices.

To provide additional evidence to support our modeling strategy, we surveyed around 200 retailers randomly extracted from the population of Italian retailers. Our sample is representative of the population of retailers with respect to the geographical location and the patronized wholesaler, as reported in Table A.1 in the Appendix. Panel A of Table 1 shows that around 90% of branded retailers accept the price that has been set by the wholesaler without any intervention. The remaining retailers do some tinkering with prices. Even among unbranded retailers, which are not tied through a long-term exclusive contract to a wholesaler, more than 40% adopt the price imposed by the fuel provider. Panel B indicates that around 92% of the branded retailers are in charge of communications on the MED platform. Of the remaining 7% of the branded retailers, the wholesaler is directly in charge of the communication, while the remaining 1% (2 retailers) claimed to be unaware of the communication rule. Unbranded retailers yield comparable findings: the vast majority (84%) is in charge of the communication, in a few cases (around 9%) the wholesaler is in charge, while only two unbranded retailers claim not to be aware of the transparency rule. These findings further support our modeling assumptions, that retail prices are set by the wholesalers, and the retailer may only affect the stream of communications, i.e., the choice whether to report price decreases or not is solely in charge of the retailers.

[INSERT TABLE 1 ABOUT HERE]

To sum up, the retail fuel market can be described as follows: 1) wholesalers basically set final prices; 2) fuel prices are retail-specific and depend on wholesale costs and the price charged by nearby competing retailers, which are reported on the online platform; 3) retailers receive a markup set by the wholesaler; 4) when they are strategic, they can choose not to communicate price drops to the platform.

3 The model

In this section, we analyze price communication and determination in the retail fuel market by using a dynamic Bayesian game. Our modeling approach is based on the idea that wholesalers use prices posted on the platform to obtain information about their opponents' costs. Therefore, when a retailer chooses not to report a price drop, we interpret this action as the choice to represent a high price and therefore to communicate a high cost. The following setup considers the case in which retailers decide whether to communicate their prices or not, and in this way they can either report or misrepresent the real cost to opponent wholesalers. Here a retailer is defined an obfuscator when he does not reveal low costs.

A vertically-related market is composed by two wholesalers, W_0 and W_1, and two Retailers, R_0 and R_1. Retailer R_i is affiliated to Wholesaler W_i, with $i = 0, 1$. Price competition in the retail market is modeled by a Hotelling game. Consumers are uniformly distributed on the segment $[0, 1]$ with unitary mass. They have zero-one demand, and the market is in equilibrium. Reservation prices are sufficiently high that the market is fully covered. Transport costs are linear and per unit transport costs are normalized to $1/2$ to simplify the presentation of the model.

To reflect the structure of the fuel market, we assume that final prices p_0 and p_1 are chosen by, respectively, Wholesalers W_0 and W_1, rather than by retailers. As discussed in Section 2, each retailer receives a margin, $\mu > 0$, for any unit sold. Retail margins are included in the wholesale costs, c_i; while retailer costs are normalized to zero. The retailers' behavior is reflected by their possibility to misreport the cost of their wholesaler to the other wholesaler, i.e., to act as an obfuscator. In order to simplify the model, we assume that only Retailer R_0 can be strategic, while Retailer R_1 is never strategic. Thus, retailer R_0 may have two different moves ('report' and 'misreport'), while retailer R_1 has only one move ('report') in any node of the game, which is why we exclude him from the game.

Figure 1 provides an illustration of the Retail fuel price game we are considering. The timing of the game is as follows. Nature, N, chooses whether Retailer R_0 is strategic with probability s or not strategic with probability $1 - s$. Afterwards, Nature chooses whether the costs of Wholesaler W_0 are high ($c_0 = \bar{c}$) with probability $q \in (0, 1)$ or low ($c_0 = \underline{c}$) with probability $1 - q$. Retailer R_0 and Wholesaler W_0 receive this information. If Retailer R_0 is not strategic, then also Wholesaler W_1 receives the information about the true costs; if instead Retailer R_0 is strategic, he can choose to misreport low costs to Wholesaler W_1, who receives the information that costs are high even when they are low. The model does not allow Retailer R_0 to misreport high costs since the transparency rule obliges retailers to communicate price hikes, i.e., the cases in which the costs of Wholesaler W_0 have increased.

Finally, Wholesalers W_0 and W_1 play a simultaneous (Bayesian) Hotelling game, where the two players have different information sets. Wholesaler W_0 knows exactly in which node she is playing, while Wholesaler W_1 has two information sets. In the first one, she has received the information that costs are high: it happens when Nature has chosen high costs or when it has chosen low costs but the strategic Retailer R_0 has reported high costs. In the second information set, Wholesaler W_1 receives the information that costs are low: it happens when Nature has chosen low costs and Retailer R_0 is not strategic or Retailer R_0 is strategic and has reported low costs. At each information set, Wholesaler W_1 has a belief on which node she is visiting. For our analysis, it is sufficient to state the beliefs of Wholesaler W_1 on $\theta \in \{0, 1\}$, the decision of the strategic Retailer R_0 to report ($\theta = 0$) or misreport ($\theta = 1$) when there are low costs.

[INSERT FIGURE 1 ABOUT HERE]

We solve the model using the concept of Perfect Bayesian Equilibrium, which requires that two conditions hold (Fudenberg and Tirole, 1991): sequential rationality (i.e., players' strategies specify optimal actions, given their beliefs and the strategies of other players) and the consistency of their beliefs (i.e., each player's belief is consistent with the strategy profile, in other words it follows the Bayesian rule when possible).

We initially consider the continuation games starting from each of the two information sets, where the two wholesalers play a simultaneous Hotelling game. Note that the market share of Wholesaler W_1 is given by:

$$x = \frac{1}{2} + p_1 - p_0. \tag{1}$$

Simple computations imply that the response functions of the two firms are:

$$p_0 = \frac{1}{4} + \frac{c_0 + p_1}{2}, \tag{2}$$

$$p_1 = \frac{1}{4} + \frac{c_1 + p_0}{2}. \tag{3}$$

With the information set 1 (Retailer R_0 reports $\bar{c}$), Wholesaler W_1 has no exact information on whether the costs of the opponent are high or low. Let $\hat{\theta} \in [0,1]$ be her belief on θ, the probability that the strategic Retailer R_0 misreports when there are low costs. Thus, using the Bayesian rule, the conditional probability that the true costs are $\bar{c}$ when Wholesaler W_1 receives $\bar{c}$ given her belief $\hat{\theta}$ is:

$$\phi(\hat{\theta}) = Prob(\bar{c}|\bar{c}, \hat{\theta}) = \frac{q}{q + s\hat{\theta}(1-q)}. \tag{4}$$

From (2), the optimal price chosen by Wholesaler W_0 is affected by her costs. Since in this information set, Wholesaler W_0 may have both high and low costs, she will choose two different prices. Let $\bar{p}$ be her price when Wholesaler W_0 has high costs $c_0 = \bar{c}$, and let $\underline{p}^O$ be the price when she has low costs $c_0 = \underline{c}$ and Retailer R_0 has obfuscated the true costs, communicating that costs are high. In this continuation game, Wholesaler W_1 will choose the price $\bar{p}_1$, which is the optimal reply to the expected price of the opponent, $p^e(\hat{\theta}) = \phi(\hat{\theta})\bar{p} + (1-\phi(\hat{\theta}))\underline{p}^O$.

We solve the continuation game using the Bayesian Nash equilibrium concept, obtaining the following equilibrium prices:

$$\underline{p}^O(\hat{\theta}) = \frac{1}{2} + \frac{1}{6}c^e(\hat{\theta}) + \frac{1}{2}\underline{c} + \frac{1}{3}c_1, \tag{5}$$

$$\bar{p}(\hat{\theta}) = \frac{1}{2} + \frac{1}{6}c^e(\hat{\theta}) + \frac{1}{2}\bar{c} + \frac{1}{3}c_1, \tag{6}$$

$$\bar{p}_1(\hat{\theta}) = \frac{1}{2} + \frac{2}{3}c_1 + \frac{1}{3}c^e(\hat{\theta}), \tag{7}$$

where $c^e(\hat{\theta}) = \phi(\hat{\theta})\bar{c} + (1-\phi(\hat{\theta}))\underline{c}$.

At information set 2, both wholesalers know that $c_0 = \underline{c}$, therefore equilibrium prices are not affected by the beliefs θ of Wholesaler W_1. Using (1) - (3), we obtain the following solutions:

$$\underline{p} = \frac{1}{2} + \frac{2}{3}\underline{c} + \frac{1}{3}c_1, \tag{8}$$

$$\underline{p}_1 = \frac{1}{2} + \frac{2}{3}c_1 + \frac{1}{3}\underline{c}. \tag{9}$$

We now consider whether Retailer R_0 has an incentive to misreport when costs are low. Remember that when costs are high, the retailer cannot cheat: this reflects the transparency rule requiring compulsory communication of any price hike. For any belief θ, from (1) and noting that per unit margins are μ, when Retailer R_0 misreports ($\theta = 1$), expected payoff $\pi(1, \hat{\theta})$ is:

$$\pi(1, \hat{\theta}) = \mu \left[\frac{1}{2} + \bar{p}_1(\hat{\theta}) - \underline{p}^O(\hat{\theta}) \right], \tag{10}$$

and, similarly, when he reports truthfully ($\theta = 0$), his expected payoff $\pi(0, \hat{\theta})$ is:

$$\pi(0, \hat{\theta}) = \mu \left[\frac{1}{2} + \underline{p}_1 - \underline{p} \right]. \tag{11}$$

Using (10) and (11), we find that:

$$\pi(1, \hat{\theta}) - \pi(0, \hat{\theta}) = \frac{\mu}{6} \left[c^e(\hat{\theta}) - \underline{c} \right] > 0, \tag{12}$$

implying that Retailer R_0 has an incentive to misreport low costs for any $\hat{\theta} \in [0, 1]$. Consequently, Retailer R_0 has a dominant strategy. Because of sequential rationality, Wholesaler W_1 believes that Retailer R_0 misreports low costs.

The average prices chosen by Wholesalers 0 and 1 with strategic Retailer R_0 are, respectively, $P_0^S = q\bar{p}(1) + (1-q)\underline{p}^O(1)$ and $P_1^S = \bar{p}_1(1)$. Moreover, the average prices chosen by Wholesalers 0 and 1 when Retailer R_0 is not strategic are, respectively, $P_0^{NS} = q\bar{p}(1) + (1-q)\underline{p}$ and $P_1^{NS} = q\bar{p}_1(1) + (1-q)\underline{p}_1$.

Proposition 1 *In the Perfect Bayesian Equilibrium of the Retail fuel game, retailer* R_0

always misreports low costs ($\theta = 1$). Wholesaler W_1 believes that the retailer is misreporting ($\hat{\theta} = 1$), and retail prices are given by (5)-(9).

Proof Clear from the text. ■

A main consequence of Proposition 1 is that a strategic retailer is an obfuscator: this retailer will not report a price drop whenever he can. From Proposition 1 we have the following predictions:

Prediction 1 *Prices posted by a strategic retailer are higher than prices posted by a non-strategic one: $P_0^S > P_0^{NS}$;*

Prediction 2 *Wherever a retailer is competing with a strategic retailer, the prices posted are higher than those of a retailer that does not face a strategic competitor: $P_1^S > P_1^{NS}$.*

In the following sections we empirically study the pricing behavior of Italian gas stations in relation to the implications of the model.

4 The data

To test the predictions of the model, we collected daily data on prices and dates of communication from the MED for the year 2015. For each day we have a snapshot of the information available on the Ministerial platform, i.e., the nominal end-customer price in euros per litre (including all tax and duties) and the last date in which such price was published on the platform. Moreover, the MED provides information on retailers' closures, while new openings are detected from the first date of communication. Figure 2 reports the average daily price for diesel and gasoline over 2015. While prices do fluctuate, we do not find evidence of regular Edgeworth cycles in both aggregate and retail level data, which could be indicative of tacit collusion, as Byrne and de Roos (2019) find in Australia.

[INSERT FIGURE 2 ABOUT HERE]

The geographical coordinates of each gas station provided by the MED allow us to identify n different chain-linked local markets (Rothschild, 1982), each centred at the location of retailer n. These markets are defined as a circular area of varying radius, depending on the urbanization level of the Municipality in which the retailer is located. As in Pavan et al. (*forth.*), we consider a radius of 1 km for stations in urban areas, 2 km for suburban areas, and 4 km for rural areas.[8] Following the previous literature, we exclude gas stations located along highways since they belong to markets having a different competitive environment (Lach and Moraga- González, 2017). Moreover, we focus on the self-service prices only, since the full-service, due to its higher costs, is less common.[9]

We thus consider prices for 15,628 retailers selling diesel, and 15,686 selling gasoline. We look at these two markets independently, defining as an obfuscator any diesel or gasoline retailer that has less than 5 unnecessary communications of either price drops or unchanged prices in one year (respectively 17.16% and 17.57% of the sample). As a robustness check, we then focus on the 15,611 retailers offering both diesel and gasoline, adopting a more stringent definition of "obfuscator", i.e., any retailer that has less than 5 unnecessary communications in both diesel and gasoline prices. These obfuscators are 16.79% of the sample.

On average, in our sample each retailer faces 2.83 other retailers in its local market of interest. As reported in Table 2, the share of obfuscators seems to be slightly larger as the urbanization level decreases, while there is no noticeable difference between diesel and gasoline markets in this respect.

[INSERT TABLE 2 ABOUT HERE]

The MED provides the list of Italian retailers, their addresses, their geographical coordinates, the type of road on which they are located, and wholesaler affiliation. Using Google

[8]The official classification of municipalities according to their degree of urbanization is provided by the Italian Statistical Institute (ISTAT).

[9]On average, gasoline and diesel full-service prices are about 7 euro cents higher than self-service prices, and the difference is almost constant (its standard deviation is 0.004 euro cents).

Maps' Street View, we manually collected information on additional amenities offered by the retailers: 49% have a café and 28% a car wash, while the average number of pump towers is 2.8.[10] As is common in this literature, we do not have access to retailers' sales volumes; our analysis thus focuses on how the communication rule, and the possibility to obfuscate price drops, affects the prices of nearby retailers.

Table 3 reports some descriptive statistics for the variables adopted in the econometric analysis. To control for the intensity of competition, we also compute the share of unbranded retailers and the share of retailers sharing the same wholesaler in the local market, as well as the market size, defined as the logarithm of the number of retailers in a given market. To tackle possible errors of imputation of prices, in this table and in the empirical analysis, we have removed the highest and lowest 1% of reported prices.

[INSERT TABLE 3 ABOUT HERE]

5 The methodology

The obfuscation of price drops affects the online posted price through two different channels. First, we expect to observe higher reported prices by obfuscators on the official platform. Indeed, these are the strategic agents that do not report price cuts, unless the communication is compulsory; as Predicition 1 suggests, the average reported prices of strategic retailers, who obfuscate price drops, will be higher than the average reported prices of other retailers, who communicate each price drop. The second, non-obvious, prediction of our theoretical framework is that a retailer surrounded by obfuscators has higher posted prices. While the retailer might know that its nearby competitors have lower prices than those reported on the website, the wholesaler cannot, as it collects the information on prices from the platform, and sets the retail price based on such information.

[10] Usually, each pump tower offers two to three different fuels: diesel, gasoline, and some premium diesel and/or premium gasoline.

To test the two predictions, we estimate the following model for the posted price on the online platform:

$$\begin{aligned} p_{nd} &= \alpha_{gd} + \beta_1 obf_n + \beta_2 share\_obf_{nt} + \beta_3 share\_unbranded_{nt} + \beta_4 share\_same_{nt} + \\ &+ \beta_5 size_{nt} + \delta_6 pump_n + \delta_7 bar_n + \delta_8 wash_n + \phi_m \sum_{m=1}^{7} wholesaler_n + \epsilon_{nd}, \end{aligned} \quad (13)$$

where p_{nd} is the price posted by retailer n on day d; α_{gd} is the set of municipality-day dummies; obf_n is a dummy equals to 1 if retailer n is an obfuscator; $share\_obf_{nt}$ is the share of obfuscators competing with n in month t; $share\_unbranded_{nt}$ is the share of unbranded retailers competing with n in month t; $share\_same_{nt}$ is the share of retailers supplied by the same wholesaler competing with n in month t, where t=1,...,12 refers to different months of the year. Shares are time-varying, as we see some entry and exit over the year.

To better model prices in each local market we have to account for the presence of unbranded retailers, who generally offer fuels at a lower price and are expected to negatively affect p_{nd}, as well as retailers who share the same wholesaler, whose presence is likely to soften competition. Additionally, we control for the intensity of competition with $size_{nt}$, which is defined as is the logarithm of the number of retailers being in the local market of n in month t.[11] We include the municipality-day dummies, α_{gd}, to further control for local factors that could affect prices (e.g., local demand characteristics, time-varying factors that could affect provision costs for the retailers).

Finally, to model retailer pricing strategies, we follow the literature and control for the presence of additional services and amenities, which have been found to affect the price (for a survey, see Ecker, 2013). The retailer-specific controls we include are the logarithm of the total number of pumps ($pump_n$), to account for the size of the retailer, and the presence

[11] We have also considered a different measure of competition, the Herfindhal index calculated using the number of pumps located in the local market of n in month t. The results do not substantially change. Estimates are available upon request.

of additional services, such as a café or a car wash. These factors are generally found to be negatively correlated with prices (Barron et al., 2004; Eckert and West, 2005; Hosken et al., 2008); indeed, retailers who offer additional services are more likely to profit and charge higher margins on these, keeping lower fuel prices to attract customers. Since prices are chosen by the wholesaler, we add a set of dummies to identify the wholesaler m that is supplying n. Finally, standard errors are clustered at the municipality-week level to account for common shocks in the wholesale costs.

6 The results

Table 4 reports in columns 1 and 3 the estimates on the, respectively, 15,801 diesel retailers and the 15,860 gasoline retailers operating in Italy in 2015. In both cases, the *obf* dummy has a positive and statistically significant coefficient: obfuscators notify gasoline and diesel prices that are, respectively, around 3.5 and 2.8 euro cents per litre higher than those of non-obfuscators. This result is in line with Prediction 1: reported prices by strategic retailers (obfuscators) are higher, on average, than those by non-strategic ones.

The estimates show that the share of nearby obfuscators, *share_obf*, is positively correlated with higher posted prices, suggesting that obfuscators are indeed surrounded by competitors who set higher prices, thus confirming the second theoretical prediction of Proposition 1.

We also include some additional controls on the competitors in the relevant market of each retailer. We find that the presence of unbranded pumps increases competition and leads retailers to lower posted prices. We control for the wholesaler m patronized by the direct competitors, and we consider the share of neighboring firms of the same color (*share_same*), finding that it has a positive and significant effect on posted prices. This is in line with the literature on vertical relations with localized competition which shows that competition between retailers of the same color is less fierce (Houde, 2012). We control for the strength of competition through *size*: the variable displays a negative and significant coefficient, which suggests that more populated markets have lower average prices, as generally found in the empirical literature (Barron et al., 2004; Hosken et al., 2008; Pennerstorfer and Weiss, 2013; Lach and Moraga-González, 2017).

Finally, firm level characteristics all display the expected sign and are statistically significant. Retailers that are larger, i.e., that have more pumps, tend to have lower prices (Barron et al., 2004; Eckert and West, 2005).[12] Additional services allow retailers to offer lower prices at the pump, as they can get higher margins from sales of ancillary products. Indeed, we find that retailers offering the car wash or a café charge lower fuel prices, in line with the existing literature (Barron et al., 2004; Eckert and West, 2005; Hosken et al., 2008). These results include province-day dummies, to proxy for subnational pricing by wholesalers, as reported in AGCM (2013). We also add a set of wholesaler dummies, which are statistically significant, to control for potential heterogeneity among wholesalers, who may differ in their costs and pricing behavior.

In columns 2 and 4 of Table 4 we aim to provide a more direct test of the predictions of our theoretical model. We thus restrict the analysis to those local markets with only two retailers, where, at most, one of them is an obfuscator and the two patronize different branded wholesalers. We find that the predictions are also supported in this narrower sample: obfuscators' posted prices are on average 3.1 and 2.4 euro cents per litre higher than those of non-obfuscators in the diesel and gasoline markets, respectively. Moreover, the share of nearby obfuscators is again positively related to posted prices, again supporting prediction 2.

[INSERT TABLE 4 ABOUT HERE]

To further inspect how obfuscation affects prices, we distinguish different conditions that might change the effectiveness of this strategy. First, when prices are increasing, it is more

[12]We report the results with the number of pumps. The results are, however, robust using a dummy equal to 1 if a retailer has more than two pumps.

difficult to implement an obfuscation strategy, since the number of price drops is limited; vice versa, in periods in which prices are decreasing, the number of cuts is large, and therefore there is more room to veil some price reduction. We test this by distinguishing between weeks in which prices have, on average, increased versus weeks that reported an average decrease of prices. Evidence reported in Table 5 confirms our argument: obfuscators have, in general, higher prices relative to non-obfuscators in periods of decreasing prices. Moreover, the effect on neighboring retailers is more pronounced when prices are decreasing, i.e., obfuscators, who have more room to implement their strategy in periods of falling prices, are more likely to induce competitors to maintain high prices. This effect disappears when prices are increasing, i.e., when price cuts are less likely and obfuscators have less opportunities to hide such price drops.

[INSERT TABLE 5 ABOUT HERE]

Strategic retailers who choose to obfuscate price drops might be favored by a setting in which price dispersion is high. Indeed, more dispersed prices may be due to larger costs differentials and/or more frequent price changes, which give, respectively, larger incentives and more opportunities to veil price drops to obfuscators. The evidence reported in Table 6 supports this intuition. We take the weekly standard deviation of diesel or gasoline prices and split the sample along the median value. In those weeks characterized by below the median price dispersion, the price charged by obfuscators is around 2.1 or 0.7 euro cents higher for diesel and gasoline, respectively. These values increase to around 5 euro cents in the weeks with above-median price dispersion in both markets. Similarly, the effect on competitors is slightly more pronounced when price dispersion is higher.

[INSERT TABLE 6 ABOUT HERE]

Finally, we discuss the robustness of our findings considering alternative definitions of our variables of interest. As a first check on the sample of retailers considered in the analysis, we report the results of the main specification obtained on a subset of 15,611 retailers that offer both diesel and gasoline. Note that, here, we adopt a more restrictive definition of obfuscator, requiring that the retailer is an obfuscator in both fuels. The results, reported in columns 1 and 3 of Table 7, are unaffected.

Then, we delve deeper into the definition of local markets. In previous analyses these markets were defined by circles of varying radius. In this way, we also included retailers located on all the different kinds of non-payment roads in Italy. These roads range from urban to "state highways" (*Strade statali, SS*) which are similar to highways in that there are entrances and exits, and speed limits are higher than for urban and local roads (up to 90-110 Km/h compared to 130 km/h for highways and 50 km/h in urban centres). Thus, retailers on *SS* roads could actually face a different form of competition than those in urban and suburban areas. For this reason, in columns 2 and 4 of Table 7 we report the results after dropping those retailers on *SS* roads, as defined in the data provided by the MED. Again, our results are unaffected.

[INSERT TABLE 7 ABOUT HERE]

7 Conclusions

The existence of a transparency rule requiring gasoline stations to communicate fuel prices on an online platform has significantly modified the competition in the Italian fuel market: it has given wholesalers the ability to directly monitor prices of all pumps at low costs, with high reliability and timeliness; and it has provided strategic retailers with some room for manoeuvre to cheat rival wholesalers by mis-representing prices.

Although retailers have no control on final prices, which are set by the wholesalers, Italian law offers retailers the opportunity to limit the communication of price drops. In practice, such missing communication has only a minimal impact on consumers, as they usually look at the gas stations' price boards, but online prices can be effortlessly monitored by wholesalers to help them decide how to set retail prices on their network. In the retail fuel market, competition is spatially localized. Predetermined retail margins in the downstream market imply that gas stations which have larger market shares can gain larger profits. Thus, there is a clear incentive for them to veil their price drops. Our theoretical model analyses the consequences of having a vertically-related market in which price communication is subject to an asymmetric transparency rule, and shows that the prices charged by strategic retailers and their neighboring competitors are higher than prices in markets without strategic retailers. Empirical evidence on the universe of fuel retailers in 2015 confirms this theoretical prediction. Many different robustness checks support these findings.

Our analysis provides some advances for the comprehension of how the design of a transparency rule affects firm behaviour and of its implications for competition policy legislation. Such an asymmetric transparency rule creates differences among markets: those with strategic retailers have higher prices. Thus, consumers may face different prices due to the manipulation of information. In this respect, such an exemption from price communication, which reduces the price transparency at the expense of some consumers, should be banned. The present analysis does not discuss, however, other relevant issues in competition policy, such as welfare implications, collusion and asymmetric price transmission, whose analysis is beyond the goals of the paper and is left to future research.

The existence of an asymmetric transparency rule combined with the presence of some strategic retailers might lead to lower production costs and higher welfare due to a better allocation of production among wholesalers. For example, in the Hotelling model, in order to implement the first-best scenario with market prices, price differentials should be set to equalize costs differences. Free market competition leads to inefficiently lower price gaps and, therefore, to market shares, which are too much similar. Asymmetric information between wholesalers could be exploited by the informed wholesaler to set high or low prices on the basis of private information and her own costs. With respect to the full information case, she would have larger (smaller) market shares when she has low (high) costs. Although appealing, such an argument should be verified under more general modeling assumptions including elastic demand and different forms of local competition.

Finally, it is worth noting that studies concerning a different behavior of retail prices in the vein of the rocket-feather argument (Bacon, 1991; Lewis, 2011) should be carefully interpreted for the Italian market because of the existence of this asymmetric communication rule. Also in this case, a specific modeling strategy to properly tackle the problem should be developed.

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Tables and Figures

Figure 1: The retail fuel price game

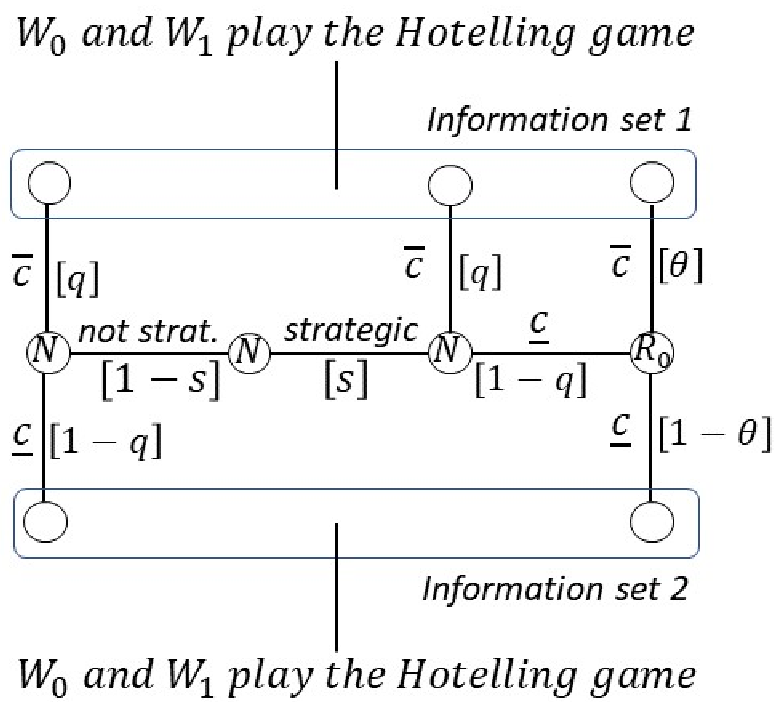

Figure 2: Daily average retail prices in 2015

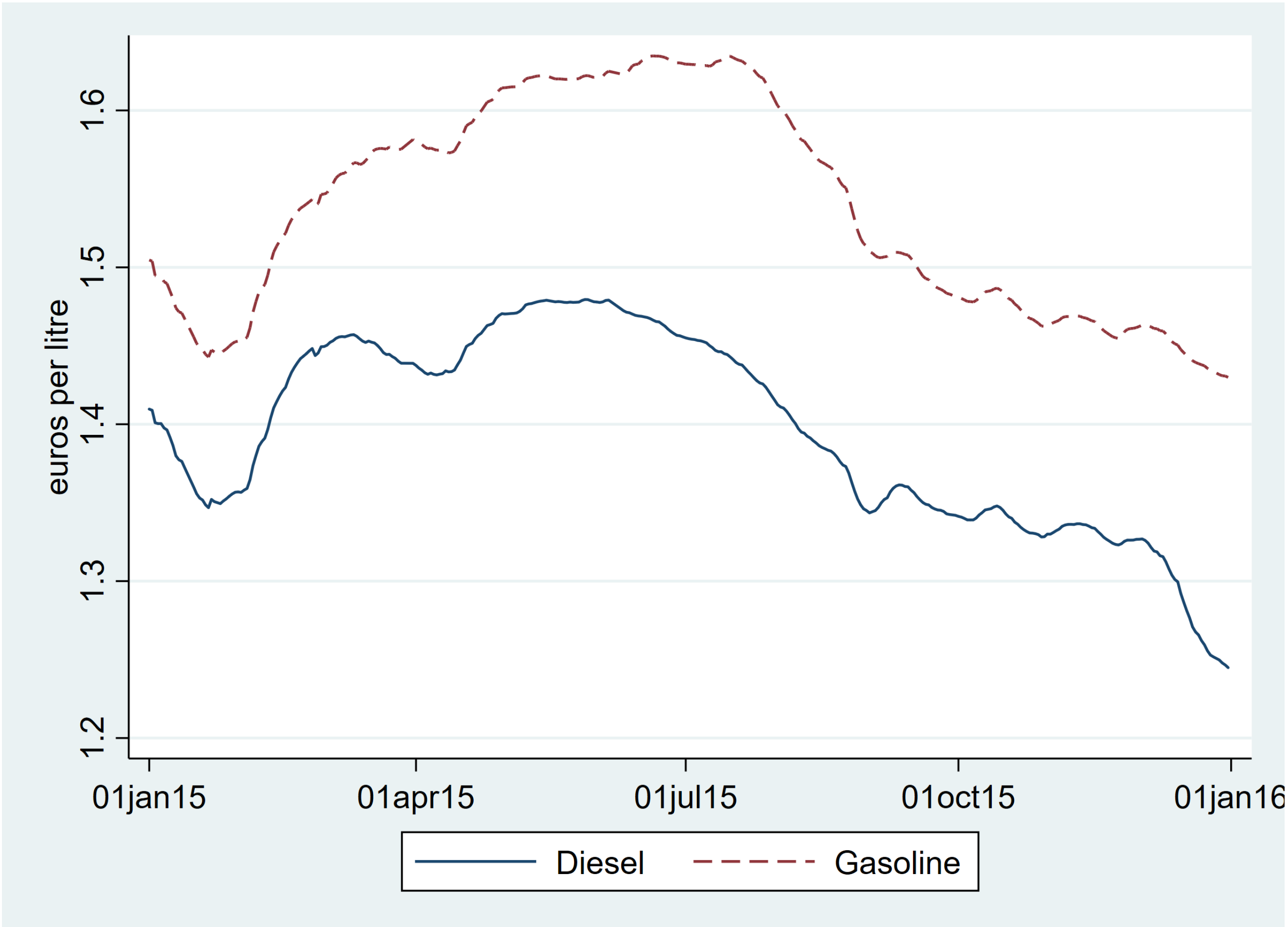

Table 1: The survey

Panel A	Branded	Unbranded	Total
Prices are directly set by the wholesaler with a non-mobifiable price	89.53	40.63	81.86
Prices are set modifying a reference price set by the wholesaler	9.30	18.75	10.78
Prices are set independently, without any price recommendation by third parties	1.16	40.63	7.35
Total	100	100	100
Panel B	**Branded**	**Unbranded**	**Total**
Retailer is in charge of the communication	91.86	84.38	90.69
Wholesaler is in charge of the communication	6.98	9.38	7.35
Retailer is not aware of the transparency rule	1.16	6.25	1.96
Total	100	100	100

Notes: Percentage values are reported. Statistics computed on 204 valid responses.

Table 2: Descriptive statistics on the nature of retailers

Area	Variable	Obs	Mean	Std. Dev.	Min	Max	Obs	Mean	Std. Dev.	Min	Max
		Diesel					***Gasoline***				
Full sample	retailers	15,628	3.830	2.865	1	29	15,686	3.830	2.856	1	29
Urban	retailers	4,145	3.772	2.400	1	16	4,152	3.772	2.402	1	16
Suburban	retailers	6,889	4.124	2.819	1	22	6,909	4.131	2.823	1	22
Rural	retailers	4,594	3.443	3.245	1	29	4,625	3.435	3.208	1	29
Full sample	# obfuscators	15,628	0.567	0.846	0	9	15,686	0.582	0.860	0	10
Urban	# obfuscators	4,145	0.538	0.832	0	6	4,152	0.561	0.857	0	7
Suburban	# obfuscators	6,889	0.561	0.848	0	9	6,909	0.579	0.873	0	10
Rural	# obfuscators	4,594	0.603	0.856	0	7	4,625	0.604	0.844	0	7
Full sample	# non-obfuscators	15,628	3.264	2.616	0	26	15,686	3.249	2.612	0	26
Urban	# non-obfuscators	4,145	3.234	2.167	0	14	4,152	3.211	2.161	0	14
Suburban	# non-obfuscators	6,889	3.563	2.609	0	19	6,909	3.552	2.608	0	19
Rural	# non-obfuscators	4,594	2.840	2.920	0	26	4,625	2.830	2.912	0	26
Full sample	share obfuscators	15,628	0.084	0.152	0	0.800	15,686	0.086	0.154	0	0.800
Urban	share obfuscators	4,145	0.079	0.146	0	0.750	4,152	0.083	0.150	0	0.750
Suburban	share obfuscators	6,889	0.083	0.149	0	0.750	6,909	0.086	0.152	0	0.750
Rural	share obfuscators	4,594	0.089	0.161	0	0.800	4,625	0.090	0.162	0	0.800

Table 3: Descriptive statistics on the estimation sample

Variable	Mean	Std. Dev.	Min	Max	Mean	Std. Dev.	Min	Max
	Diesel				***Gasoline***			
price	1.404	0.087	1.209	1.654	1.546	0.090	1.375	1.797
obf	0.152	0.359	0	1	0.156	0.363	0	1
share_obf	0.087	0.151	0	0.800	0.090	0.153	0	0.833
share_unbranded	0.104	0.166	0	0.833	0.104	0.166	0	0.833
share_same	0.099	0.157	0	0.833	0.098	0.156	0	0.833
size	4.062	3.034	1	31	4.064	3.038	1	31
Agip	0.227	0.419	0	1	0.229	0.420	0	1
Api-IP	0.132	0.338	0	1	0.132	0.339	0	1
Esso	0.124	0.330	0	1	0.125	0.330	0	1
Q8	0.154	0.361	0	1	0.153	0.360	0	1
Tamoil	0.066	0.249	0	1	0.066	0.249	0	1
Total Erg	0.112	0.315	0	1	0.111	0.314	0	1
Unbranded	0.184	0.388	0	1	0.184	0.387	0	1
pump	2.831	1.149	1	14	2.831	1.147	1	14
café	0.517	0.500	0	1	0.517	0.500	0	1
wash	0.282	0.450	0	1	0.282	0.450	0	1

Notes: Statistics for the full estimation sample of Diesel and Gasoline prices on, respectively, 4,558,581 and 4,570,238 observations. Prices are in euros per liter, altitude is defined in meters above sea level.

Table 4: Main results

	(1) *Diesel* *Full sample*	(2) *Diesel* *Testing the model*	(3) *Gasoline* *Full sample*	(4) *Gasoline* *Testing the model*
obf	0.037***	0.038***	0.030***	0.034***
	(0.001)	(0.002)	(0.001)	(0.002)
share_obf	0.008***	0.017***	0.007***	0.026***
	(0.001)	(0.004)	(0.001)	(0.004)
share_unbranded	-0.013***		-0.011***	
	(0.001)		(0.001)	
share_same	0.007***		0.006***	
	(0.001)		(0.001)	
size	-0.009***		-0.009***	
	(0.000)		(0.000)	
pump	-0.007***	-0.012***	-0.006***	-0.010***
	(0.000)	(0.002)	(0.000)	(0.001)
café	-0.006***	-0.004***	-0.006***	-0.004***
	(0.000)	(0.001)	(0.000)	(0.001)
wash	-0.006***	-0.007***	-0.005***	-0.007***
	(0.000)	(0.001)	(0.000)	(0.001)
constant	1.424***	1.425***	1.568***	1.567***
	(0.000)	(0.002)	(0.000)	(0.002)
Observations	4,558,581	613,096	4,570,238	616,590
R2	0.690	0.840	0.714	0.857

Notes: The dependent variable is the retail price of diesel in columns 1 and 2 and of gasoline in columns 3 and 4. Prices are in euros per liter. The variables *size* and *pump* are transformed in logs. Columns 2 and 4 report the results on the subsample of markets with two retailers patronized by two different branded wholesalers and at most one obfuscator. All models include wholesaler dummies and municipality-day dummies. Standard errors are clustered at the municipality-week level. *** , **, and * denote, respectively, the 1%, 5% and 10% significance levels.

Table 5: Decreasing vs increasing prices

	(1) *Diesel* *Decreasing prices*	(2) *Diesel* *Increasing prices*	(3) *Gasoline* *Decreasing prices*	(4) *Gasoline* *Increasing prices*
obf	0.046***	0.020***	0.046***	0.012***
	(0.001)	(0.001)	(0.001)	(0.001)
share_obf	0.010***	0.005**	0.009***	0.005***
	(0.002)	(0.002)	(0.002)	(0.002)
share_unbranded	-0.012***	-0.014***	-0.010***	-0.012***
	(0.001)	(0.002)	(0.001)	(0.001)
share_same	0.007***	0.006***	0.007***	0.006***
	(0.001)	(0.001)	(0.001)	(0.001)
size	-0.010***	-0.007***	-0.010***	-0.007***
	(0.000)	(0.000)	(0.000)	(0.000)
pump	-0.007***	-0.006***	-0.006***	-0.005***
	(0.000)	(0.001)	(0.000)	(0.000)
café	-0.007***	-0.005***	-0.007***	-0.005***
	(0.000)	(0.000)	(0.000)	(0.000)
wash	-0.006***	-0.006***	-0.005***	-0.005***
	(0.000)	(0.000)	(0.000)	(0.000)
constant	1.412***	1.444***	1.550***	1.589***
	(0.001)	(0.001)	(0.001)	(0.001)
Observations	2,834,545	1,724,036	2,390,205	2,180,033
R2	0.722	0.625	0.744	0.669

Notes: The dependent variable is the retail price of diesel in columns 1 and 2 and of gasoline in columns 3 and 4. Prices are in euros per liter. The variables *size* and *pump* are transformed in logs. All models include wholesaler dummies and municipality-day dummies. Standard errors are clustered at the municipality-week level. *** , **, and * denote, respectively, the 1%, 5% and 10% significance levels.

Table 6: Low vs high price dispersion

	(1) *Diesel* *Low dispersion*	(2) *Diesel* *High dispersion*	(3) *Gasoline* *Low dispersion*	(4) *Gasoline* *High dispersion*
obf	0.022***	0.050***	0.009***	0.049***
	(0.001)	(0.001)	(0.001)	(0.001)
share_obf	0.006***	0.010***	0.004***	0.010***
	(0.002)	(0.002)	(0.002)	(0.002)
share_unbranded	-0.013***	-0.013***	-0.013***	-0.010***
	(0.001)	(0.001)	(0.001)	(0.001)
share_same	0.006***	0.007***	0.006***	0.007***
	(0.001)	(0.001)	(0.001)	(0.001)
size	-0.009***	-0.008***	-0.009***	-0.008***
	(0.000)	(0.000)	(0.000)	(0.000)
pump	-0.006***	-0.007***	-0.005***	-0.007***
	(0.000)	(0.000)	(0.000)	(0.000)
café	-0.006***	-0.007***	-0.006***	-0.006***
	(0.000)	(0.000)	(0.000)	(0.000)
wash	-0.005***	-0.007***	-0.004***	-0.006***
	(0.000)	(0.000)	(0.000)	(0.000)
constant	1.469***	1.380***	1.630***	1.510***
	(0.001)	(0.001)	(0.001)	(0.001)
Observations	2,205,669	2,270,899	2,199,166	2,275,979
R2	0.645	0.588	0.634	0.553

Notes: The dependent variable is the retail price of diesel in columns 1 and 2 and of gasoline in columns 3 and 4. Prices are in euro per liter. The variables *size* and *pump* are transformed in logs. All models include wholesaler dummies and municipality-day dummies. Standard errors are clustered at the municipality-week level. *** , **, and * denote, respectively, the 1%, 5% and 10% significance levels.

Table 7: Robustness using alternative definitions

	(1) *Diesel* *Both fuels*	(2) *Diesel* *No SS roads*	(3) *Gasoline* *Both fuels*	(4) *Gasoline* *No SS roads*
obf	0.037***	0.037***	0.030***	0.031***
	(0.001)	(0.001)	(0.001)	(0.001)
share_obf	0.009***	0.012***	0.006***	0.011***
	(0.001)	(0.001)	(0.001)	(0.001)
share_unbranded	-0.012***	-0.013***	-0.011***	-0.011***
	(0.001)	(0.001)	(0.001)	(0.001)
share_same	0.006***	0.008***	0.006***	0.009***
	(0.001)	(0.001)	(0.001)	(0.001)
size	-0.009***	-0.009***	-0.009***	-0.009***
	(0.000)	(0.000)	(0.000)	(0.000)
pump	-0.007***	-0.006***	-0.006***	-0.006***
	(0.000)	(0.000)	(0.000)	(0.000)
café	-0.006***	-0.006***	-0.006***	-0.005***
	(0.000)	(0.000)	(0.000)	(0.000)
wash	-0.006***	-0.006***	-0.005***	-0.005***
	(0.000)	(0.000)	(0.000)	(0.000)
constant	1.424***	1.424***	1.568***	1.568***
	(0.000)	(0.001)	(0.000)	(0.001)
Observations	4,554,870	3,978,632	4,554,498	3,986,582
R2	0.690	0.691	0.714	0.715

Notes: The dependent variable is the retail price of diesel in columns 1 and 2 and of gasoline in columns 3 and 4. Prices are in euros per liter. The variables *size* and *pump* are transformed in logs. Columns 1 and 3 report the results on retailers selling both diesel and gasoline. Columns 2 and 4 report the results excluding pumps located on state highways (SS). All models include wholesaler dummies and municipality-day dummies. Standard errors are clustered at the municipality-week level. *** , **, and * denote, respectively, the 1%, 5% and 10% significance levels.

Appendix

Table A.1: Representativeness of the sample of retailers interviewed

Geographical Area	Universe	Sample
North-West	24.46	33.82
North-East	21.58	22.06
Centre	22.14	20.1
South	20.98	16.18
Islands	10.84	7.84
Wholesaler	**Universe**	**Sample**
Agip Eni	19.72	25.49
Api-Ip	14	4.9
Esso	11.89	20.1
Q8	14.38	20.1
Tamoil	6.93	6.86
Total Erg	11.47	6.86
Unbranded	21.6	15.69

Notes: Percentage values are reported.