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Determinants of fuel prices: dominant firms, local monopolies and 'captive' demand

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ABSTRACT
This paper analyses the effect on retail fuel prices of factors such as belonging to dominant firms, the position of a local monopoly or oligopoly, and service station location. We study the effect of belonging to the dominant firms in the market, Repsol and Cepsa, of enjoying a local natural monopoly or oligopoly in rural areas, and of being located in places with captive demand, such as highways and motorways, as well as in the city centre. We apply this study to service stations in the province of Seville (Spain). The main findings are that the two main distributors, Repsol and Cepsa, set a higher price. We also find market power at a local level, which appears through monopoly or duopolies in rural areas, and which also results in higher prices, albeit to a much lesser degree. In addition, we see that stations servicing users on high-capacity roads as well as stations located in Seville city centre also set higher prices.

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INTRODUCTION

Throughout its recent history, the retail fuel distribution market in Spain has seen major state intervention and high concentration.[1] Between 1927 and 1984, the state held a monopoly in the sector, managed by the Compañía Arrendataria del Monopolio de Petróleos Sociedad Anónima (CAMPSA), which imported, refined, stored, distributed and sold petroleum products, in addition to engaging in exploration and producing hydrocarbons. In 1984, before joining the European Economic Community (EEC), Spain initiated a transitional process of demonopolization, regulated under Law 45/84, governing the reorganization of the oil sector, which lasted until 1992, during which the system of fixed prices was replaced by a system of maximum prices.

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In 1992, Law 34/1992, governing the Organization of the Oil Sector dissolved CAMPSA's state monopoly, segregating the company's activities and liberalizing all the activities which until then had been managed by public monopoly, except management of the transport and storage network, which came under the supervision of the newly created Compañía Logística de Hidrocarburos (CLH). Full liberalization of fuel prices came about in 1996 and for other fuels in 1998.

Despite the sector's intense transformation over the last two decades, which has witnessed liberalization and privatization, there are clear indications of significant market power. In terms of production, of the nine refineries in Spain, eight are owned by the two largest Spanish oil companies (Repsol owns five and Cepsa owns three), with the other being owned by British Petroleum (BP). In terms of distribution, of the 7631 stations in Spain in 2015, 3544 (46.4%) were Repsol and 1512 (19.8%) were Cepsa. In other words, Repsol and Cepsa monopolized two-thirds (66.6%) of all service stations in the country in 2015, and if we add BP (8.2% of stations), Galp (7.5%) and Disa (7.2%), the top five brands cornered 90% of all service stations (Spanish Association of Operators of Petroleum Products, 2015).

Such a high level of market concentration substantially increases the likelihood of collusive duo- or oligopoly that would lead to higher prices (Borenstein & Shepard, 1996; Castanias & Johnson, 1993; Haltiwanger & Harrington, 1991; Maskin & Tirole, 1988; Rotemberg & Saloner, 1986; Slade, 1987, 1992). This behaviour can be reproduced in the case of small areas. In rural areas, reduced demand can lead to natural local monopoly or duopolies, and fuel prices may be higher.

Together with the market power afforded by a concentration of supply in the hands of just a few companies, the location of stations plays a key role in the retail fuel market, and can also lead to higher prices. Models of spatial competition, such as Haining (1983, 1985), Haining et al. (1996), Anderson and de Palma (1992), Capozza and Van Order (1989), Greenhut et al. (1987) or Norman (1986), have been taken as a basis to study this issue.

With regard to higher prices linked to the location of stations, some researchers posit the analysis as a problem of product differentiation[2] and, therefore, as a problem of monopolistic market competition, explored in models such as those of Hotelling (1929), Salop (1979), Perloff and Salop (1985) or Anderson et al. (1992), among others.

Our objective in this work is to jointly present different factors that may lead to higher fuel prices associated with firms' market dominance and location factors, in an attempt to determine how much more consumers pay due to these factors associated with market structure. In particular, we estimate the effect of belonging to a firm with a high market share, Repsol and Cepsa, of being a local monopoly or oligopoly in a rural area, and of being located on high-capacity roads, that is, highways and motorways, and in Seville city centre, where demand is captive. As control variables, we include the fleet of vehicles registered in the municipality where the station is located, as a proxy of demand factors; the number of stations within a radius of 2 km, controlling for spatial competition in the market and, as a robustness test, we also include crude oil prices.

For our work, we use the net tax price of gasoline 95 and diesel at service stations in the province of Seville from 26 March to 21 July 2015. We excluded stations as well as days for which we did not have full daily price data for both fuels. This led us to remove 13 service stations out of a total of 353 stations involved in the study period, and 24 days of the period considered, leaving a 94-day sample.

We estimate a panel data model with time-specific fixed effects in order to control for the variation in wholesale costs and temporary fluctuations in demand. In addition, as a robustness test, we perform two additional estimates using panel-corrected standard errors (PCSE) estimated by Prais–Winsten regression, and feasible generalized least squares (FGLS), including delayed oil prices, which, in addition to confirming the previous results, provides a high degree of explanatory power.

The dependent variables are the daily prices of gasoline 95 and diesel A, with the variables representing potential sources of higher prices being incorporated in the form of dummy variables.

The previous literature exploring price differences in stations in Spain is scarce and includes only four studies: Bello Pintado and Cavero Brújula (2007, 2008), Bello Pintado and Contín-Pilart (2010) and Albalate and Perdiguero (2015). The first three examine the impact of brands with refineries in Spain, namely Repsol, Cepsa and BP, density of stations by regions, those within 2 km, or the distance to the nearest station. As regards location, they analyse whether the station is located on a toll road, a national road, in the city centre and peripheral areas of the city with large distribution centres. However, Albalate and Perdiguero (2015) is much more specific, since it focuses on the difference in fuel prices of stations located on toll motorways compared with those located on toll-free motorways. The aim of our work is to add fresh empirical literature for Spain in the field.

The main results we obtain from our analysis are: the two main distributors, Repsol and Cepsa, with dominant positions in the market, set higher prices; and that local monopoly or duopolies in rural areas also set higher prices, although these are smaller. As for the effect of location, prices are set higher in stations serving users of high-capacity roads, such as toll motorways and free motorways. Service stations located within the ring formed by the SE-30 ring road and the northern ring road in the city of Seville also set higher prices.

The paper is organized as follows. The next section reviews the previous literature. The third section presents the methodology and describes the variables used, as well as the data processing. The fourth section presents the results. Finally, in the fifth section concludes.

REVIEW OF THE EMPIRICAL LITERATURE

The empirical literature on retail fuel prices has experienced significant growth over the last 20 years. Following Eckert (2013), said literature can be classified into two main groups: empirical studies of fuel price dynamics; and studies of the determinants of retail prices and price differences.

The first group contains studies examining the asymmetric response of retail prices to wholesale prices or the price of crude oil and the literature of the Edgeworth price cycles. As regards the former, it has empirically been shown that the response is faster to price increases than to decreases ('rocket and feather effect'). The classic work on this subject is Borenstein et al. (1997).

As for the Edgeworth cycles, which deal with rises and falls in prices and which occur cyclically, the phenomenon is formalized theoretically by Maskin and Tirole (1988), although these have their origin in Edgeworth (1925), and have led to extensive empirical research (Atkinson, 2009; Castanias & Johnson, 1993; Eckert, 2002, 2003; Lewis, 2012; Noel, 2007; Wang, 2008; Zimmerman et al., 2010; or more recent works by Byrne et al., 2015; Foros & Steen, 2013; and Isakower & Wang, 2014, among others).

Within the second group of works, related to determinants of retail prices and price differences and within which the present work is framed, Eckert (2013) distinguishes four types of empirical studies: the first involves estimates of reduced-form price equations which relate prices to market structure at the national or municipal level (Chouinard & Perloff, 2007; Sen, 2003, 2005); the second involves empirical analyses of the effects of mergers and regulations on prices, normally using *difference-in-difference* estimates (Coloma, 2002; Hastings, 2004; Silvia & Taylor, 2010; Taylor et al., 2010, among others); the third deals with structural estimates of market power (Houde, 2012; Manuszak, 2010); and the fourth addresses estimates of price determinants at the station level, as well as their dispersion and uniformity.

Our work is framed within this latter group of studies that seek to analyse price determinants. For the purposes of this work, these factors can be grouped according to market concentration, the degree of spatial competence or the spatial differentiation of the product.

In terms of market concentration, studies tend to consider the existence of one or more main brands. The conclusion to emerge from most works is that stations belonging to brands with the highest number of service stations set higher fuel prices. This is reported in Van Meerbeeck (2003) for Shell throughout Belgium; in Barron et al. (2004) for Chevron, Exxon Mobil/BP, Shell, Texaco and Unocal in the United States (San Francisco urban areas, Tucson, Phoenix and San Diego); in Haucap et al. (2017) for Aral, Shell, Esso, Total and Jet in Germany; in Cooper and Jones (2007) for BP, Chevron, Exxon, Marathon or Shell in Lexington (Kentucky); in Bello Pintado and Contín-Pilart (2010) for BP and Gulf in Spain; and in Bello Pintado and Cavero Brújula (2007, 2008) for Repsol, Cepsa and BP for 22 Spanish provinces. In contrast, the work of Remer (2019) in Kentucky and Virginia concludes that the margins are lower in the stations of major brands.

Together with the above, another type of work analyses the effects on fuel prices of indicators that are representative of the degree of market concentration. Clemenz and Gugler (2009) use the Herfindahl index[3] and the concentration percentage of the main brand and the four major oil companies in 2856 stations in Austria, and conclude that concentration increases price. The same conclusion is reached by Haucap et al. (2017) for a sample of stations in Germany, and by Remer (2019) for Kentucky and Virginia, using market participation indicators. Kihm et al. (2016) use the Herfindahl index in interaction with the Brent crude price for a sample of 13,000 stations in Germany, and again conclude that market concentration bumps up prices. Certain works use opposite indicators to market concentration, such as opening out of the market, by counting the presence of independent companies, such as Clemenz and Gugler (2009), with their conclusion being that the participation of independent companies drives prices down, and Haucap et al. (2017), who obtain the opposite result.

The analysis of factors related to spatial competition encompasses a wide range of works. In order to identify the effect of competition, different types of variables are used. One group of papers uses variables representative of the density of stations over a given area. Most of these studies report that the higher the density of stations, the lower the prices, which would indicate that competition pushes prices down. A range of variables is used: Van Meerbeeck (2003) uses the number of competing stations in the same municipality; Barron et al. (2004) use the number of stations within 1.5 miles (2.4 km); Clemenz and Gugler (2009) use the number of stations per square kilometre; Haucap et al. (2017) use the number of competitors within 2 km; Remer (2019) use the number of stations in each county of Virginia and Kentucky; Bello Pintado and Cavero Brújula (2007) use the number of stations in the same region; and Cooper and Jones (2007) use the number of stations to the central business district of Lexington (Kentucky) and the number of stations located outside commuter roads.

However, there is a lack of consensus in the results. In Remer (2019), who uses the number of competing stations within a 1.5-mile variable, and Bello Pintado and Contín-Pilart (2010), who use the number of competitors within a 2 km variable, density is seen to increase prices, whereas in Hosken et al. (2008), using the number of stations within a radius of 1.5 miles has no statistically significant effect.

A second type of variable used in the literature is distance to the nearest stations. In these works, the majority result is that the greater the distance, the higher the price. Such is the case in Barron et al. (2004), Haucap et al. (2017), Cooper and Jones (2007) and Bello Pintado and Cavero Brújula (2008). However, the result in Hosken et al. (2008) is not statistically significant. One variation of this type of variable is to measure the distance in travel time or travel cost to the nearest station. When using this variation, neither Clemenz and Gugler (2009) nor Hosken et al. (2008) find the variables to be statistically significant.

Finally, when analysing spatial location and using it as a differentiating element, the conclusion to emerge is that price is higher: if the station is located on a toll road (Bello Pintado & Cavero Brújula, 2007, 2008; Haucap et al., 2017); the station is located on a national road or in a city centre (Bello Pintado & Cavero Brújula, 2007, 2008); and if the station is located on a ring road, on a non-main road, at a supermarket or on the corner between two roads (Ning & Haining, 2003).[4]

METHODOLOGY AND DATA

Our objective is to verify empirically the existence of higher prices in the retail fuel sector deriving from belonging to a firm that dominates the market, resulting from either the monopolistic or oligopolistic structure of the market, both in the whole of the geographical area considered and at the level of small localities, or through being located where demand is captive. For this, we take a sample of prices from stations in the province of Seville for the period 26 March–21 July 2015, and which excludes 24 days[5] due to lack of available data for those dates, such that the study covers a total of 94 days. During that period in the province of Seville there were 353 stations,[6] of which we removed 13 stations[7] that did not simultaneously supply the price of diesel and gasoline or for which not all the daily fuel prices were available and it was not possible to perform interpolation. For the final 340 stations, see Table A1 in Appendix A in the supplemental data online.

For stations with incomplete data, and whenever possible, we performed interpolation between the previous and subsequent price in order to determine the price on days that lacked data. This was the most common data-processing procedure used and was applied to 37 stations.[8] For stations where prices varied very infrequently, we assumed that prices did not change until the next recorded price difference, and we used the price before the next data variation. This was applied to prices at nine stations.[9]

Given the high level of taxation affecting the sector, we felt it preferable to use the net tax price. Fuel taxation in 2015 consisted of the state tax on hydrocarbons (general and special type), regional levy of the same tax, and value added tax (VAT), which is applied to the net tax price on fuels plus the previously mentioned hydrocarbon tax rates. We first deducted VAT (the standard 21%) and subsequently deducted the hydrocarbon tax. In our case, for gasoline 95, it is a general state tax rate of €400.49 per 1000 litres and a special tax rate of €24 per 1000 litres, to which must be added €48 regional levy per 1000 litres. As for diesel A, in 2015, the general rate of hydrocarbon tax was €307 per 1000 litres, the special rate was €24 and the regional tax was €48 per litre.[10]

The econometric specifications of the model for the two dependent variables of gasoline and diesel in each scenario are:

Scenario 1:

$$dieselprice_{i,t}(gasolineprice_{i,t}) = \beta_0 + \delta_t + \beta_1 repsol\text{-}cepsa_{i,t} + \beta_2 localmonopoly/duopoly_{i,t} + \beta_3 motorways_{i,t} + \beta_4 citycentre_{i,t} + \beta_5 stationdensity_{i,t} + \beta_6 vehicles1(2)_{i,t} + u_{i,t}$$

Scenario 2:

$$dieselprice_{i,t}(gasolineprice_{i,t}) = \beta_0 + \delta_t + \beta_{11} repsol_{i,t} + \beta_{12} cepsa_{i,t} + \beta_2 localmonopoly/duopoly_{i,t} + \beta_3 motorways_{i,t} + \beta_4 citycentre_{i,t} + \beta_5 stationdensity_{i,t} + \beta_6 vehicles1(2)_{i,t} + u_{i,t}$$

where $repsol\text{-}cepsa_{i,t}$ is a dummy variable that takes the value 1 if the station is owned by Repsol or Cepsa, and 0 if owned by a different brand; $repsol_{i,t}$ is a dummy variable that takes the value 1 if the station is owned by Repsol, and 0 if owned by a different brand; $cepsa_{i,t}$ is a dummy variable that takes the value 1 if the station is owned by Cepsa, and 0 if owned by a different brand; $localmonopoly/duopoly_{i,t}$ refers to stations with a local monopolistic or oligopolistic position – it is a dummy variable that takes the value 1 if it is the only station in the area or, at most, competes with one other station in the same area, and takes 0 for the rest; $motorways_{i,t}$ is a dummy variable that takes the value 1 when the station is on toll motorways or toll-free motorways, and 0 when located on other types of road; $citycentre_{i,t}$ is a dummy variable equal to 1 if the station is in the centre of Seville, which is deemed to be the area within the confines of the city ring road, the SE-30; $stationdensity_{i,t}$ is defined as the number of stations within a radius of 2 km, as a proxy for spatial competition; $vehicles\ 1(2)_{i,t}$ is the number of registered vehicles in the municipality where the station is located; diesel or gasoline engine, respectively; β_0 is the constant term; and δ_t is time-specific fixed effects.

By using the variable *repsol-cepsa*, our aim is to capture the existence of higher prices derived from the market structure and the market power these brands might have when compared with other stations. The percentage of stations belonging to these two brands, which already represents a majority in Spain (66.6%), reached 75.6% in the province of Seville (42.4% the former and 33.2% the latter). This is followed, quite some way behind, by BP (10.4%) and Galp (7.3%) (Spanish Association of Operators of Petroleum Products, 2015). As anticipated by the theoretical and empirical literature, the stations of these main brands establish a significantly higher fuel price. Additionally, we estimate the effects of Repsol and Cepsa separately in order to capture the possibility that Repsol is acting as leader of the duopoly.

With the dummy variable *localmonopoly/duopoly* our aim is to capture the effect on the price of being in a monopolistic or oligopolistic position in small towns, when the stations are the sole suppliers or, at most, when they share the local market with one other station. This type of station is located in areas with little traffic, such as in small towns found mainly in the country, or in the mountains to the north and south of the province. There are 66 such towns and 88 stations involved (Figure 1).[11] This variable has not been used in the previous literature. However, it is expected to have a similar effect to that of the previous variable, such that in these stations the price should be higher. The closest variables employed in the literature are the number of local competitors, used by Van Meerbeeck (2003), and the number of stations in a county, used by Remer (2019). In both studies, the relationship with price proves to be negative; the greater the number of competitors, the lower the price, which is consistent with the expected effect described for our variable.

With regard to the variables designed to capture higher prices associated to the location of service stations, the variable *motorways* aims to detect the possible existence of higher prices associated with long-distance travel, where not knowing the locations of the stations and the price differences between them makes drivers tend to refuel at the station adjacent to the toll and toll-free motorways. This is what we might refer to as ‘trapped’ demand (Albalate & Perdiguero, 2015). As we have seen, the empirical literature has included this variable and has confirmed its positive impact on fuel price (Bello Pintado & Cavero Brújula, 2007, 2008; Bello Pintado & Contín-Pilart, 2010; Haucap et al., 2017).[12] In this paper, we therefore expect a similar effect. In Seville, there are 61 service stations located in the vicinity of this type of road (Figure 2).[13]

With the dummy variable *citycentre*, we assign a value of 1 to stations located within the area bounded by the Seville ring road, the SE-30, and the Ronda Urbana Norte (Figure 3).[14] With this variable, we aim to capture the effect of a type of demand, which, in a certain sense, is also ‘trapped’ by the difficulty of travelling within the city, by the massive influx of vehicles and by the small number of stations compared with the large number of trips made. This variable has been used by Bello Pintado and Cavero Brújula (2007) and we expect to obtain a similar result of higher fuel prices.

As control variables, we first include v*ehicles1* and *vehicles2*, representing the number of registered vehicles in the municipality where the station is located (we distinguish between diesel (1) and gasoline (2) engine cars depending on the type of fuel prices we are estimating), as a proxy of demand factors.[15] Finally, we include a factor representative of the degree of spatial competition: the density of stations within a radius of 2 km, which is a variable commonly used in empirical

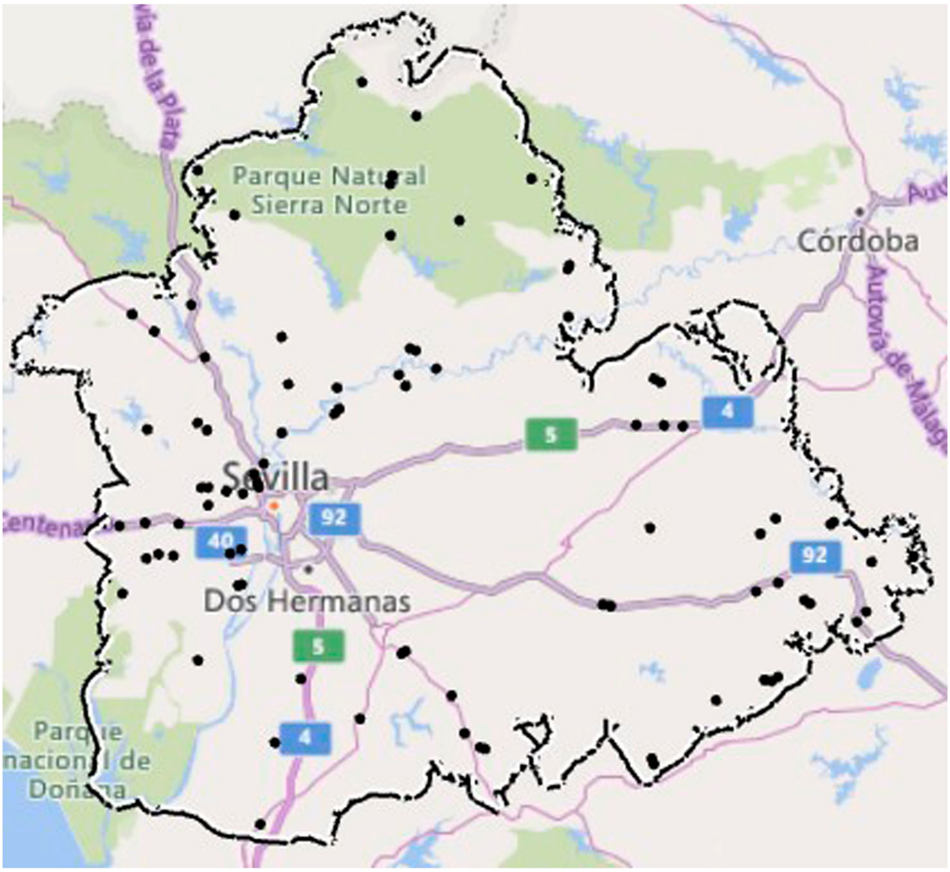

Figure 1. Station localization: local monopoly/oligopoly.

literature (Barron et al., 2004; Bello Pintado & Contín-Pilart, 2010; Haucap et al., 2017; Hosken et al., 2008; Ning & Haining, 2003; Remer, 2019).[16]

Additionally, as a robustness test, we include the Brent oil price, which is the cost of basic fuel production and the benchmark for European markets. We use the variable with a one- and two-day delay since, as Borenstein and Shepard (1996) point out, companies do not react to changes in oil price immediately. A delay of at least one day is required to adjust fuel prices and, bearing in mind that intermediary refining companies are also involved, at least one further day's delay is needed (Borenstein & Shepard, 1996).

Model variables, including those in the robustness test, and their sources are shown in Table 1. To allocate the values of the dummy variables on location, we use the coordinates of each station provided by the Geoportal web.

RESULTS

For our analysis, we use a panel database that combines the temporal dimension (fuel price for 94 days) and the cross-section (340 stations in the province of Seville). This is a balanced panel, such that each station has the same number of observations for all variables.

The econometric method applied consists of a panel data model with time-specific fixed effects to control for wholesale cost variations, mainly due to oil price variations, as is

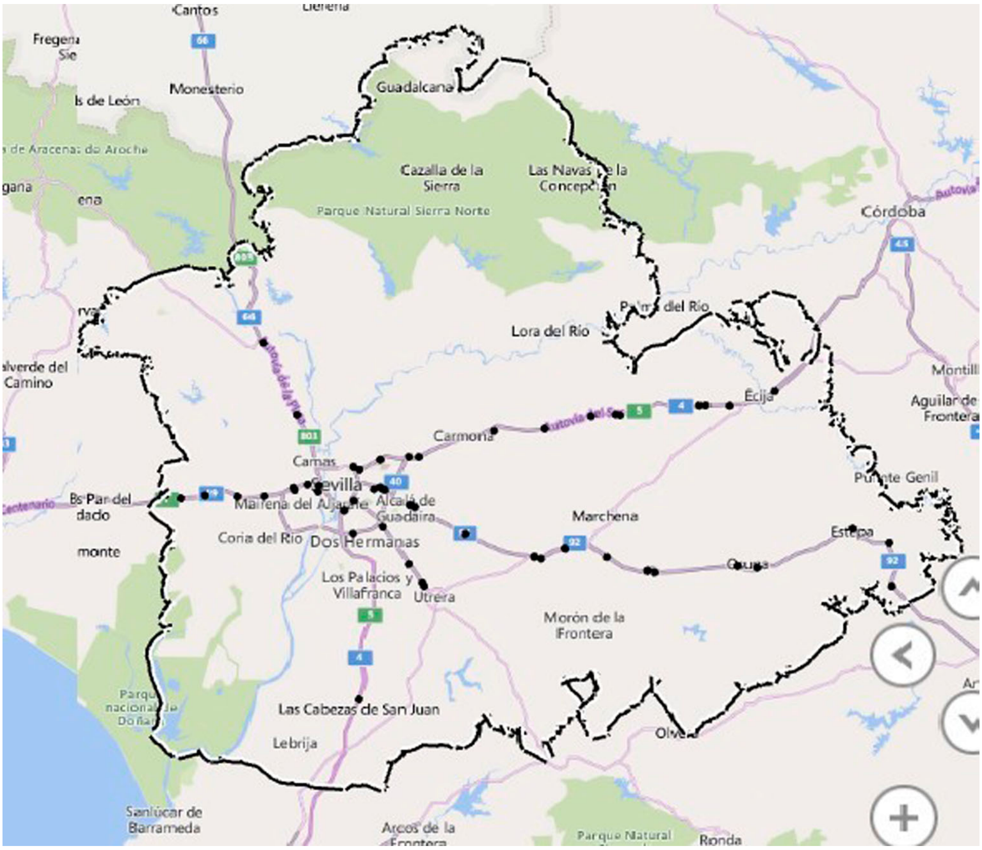

Figure 2. Station localization: toll and toll-free motorways.

common in the literature. Furthermore, we also estimate a different specification as a robustness test.

Table 2 shows the descriptive statistics for each variable. The fuel price range, namely the difference between the maximum and minimum, reveals there was considerable price variation in the 94 days analysed. For gasoline, the percentage difference is 48.8% between the minimum and maximum, while for diesel it is 47.3%. The Brent oil price difference between the minimum and maximum was 23.54%. That is, the time sample corresponds to a period which, due to price oscillation, allows us to infer significant price-variation behaviour.

Table 3 shows the results obtained when applying panel data with time-specific fixed effects. The estimates of the two specifications, diesel and gasoline, and in the two scenarios, are jointly statistically significant, as shown by the Chi^2 Wald test with a p-value of 0. Likewise, R^2 is around 0.40 in the first scenario and 0.31 in the second scenario. In order to enhance the robustness of the results, Table 4 shows the results obtained from the PCSE and FGLS estimation, as explained above. All the estimates in the robustness test are jointly significant, with a Wald Chi^2 test p-value of 0. It should also be noted that the R^2 in these estimates is much higher than in the baseline estimates using time fixed effects, and now reaches an R^2 of 0.81 in the case of diesel and 0.75 in the case of gasoline. Finally, it is worth noting that the estimated coefficients of the variables are practically the same when using both time fixed effects as well as PCSE and FGLS.

Almost all the variables considered as determinants of higher prices are statistically significant at 1%.[17]

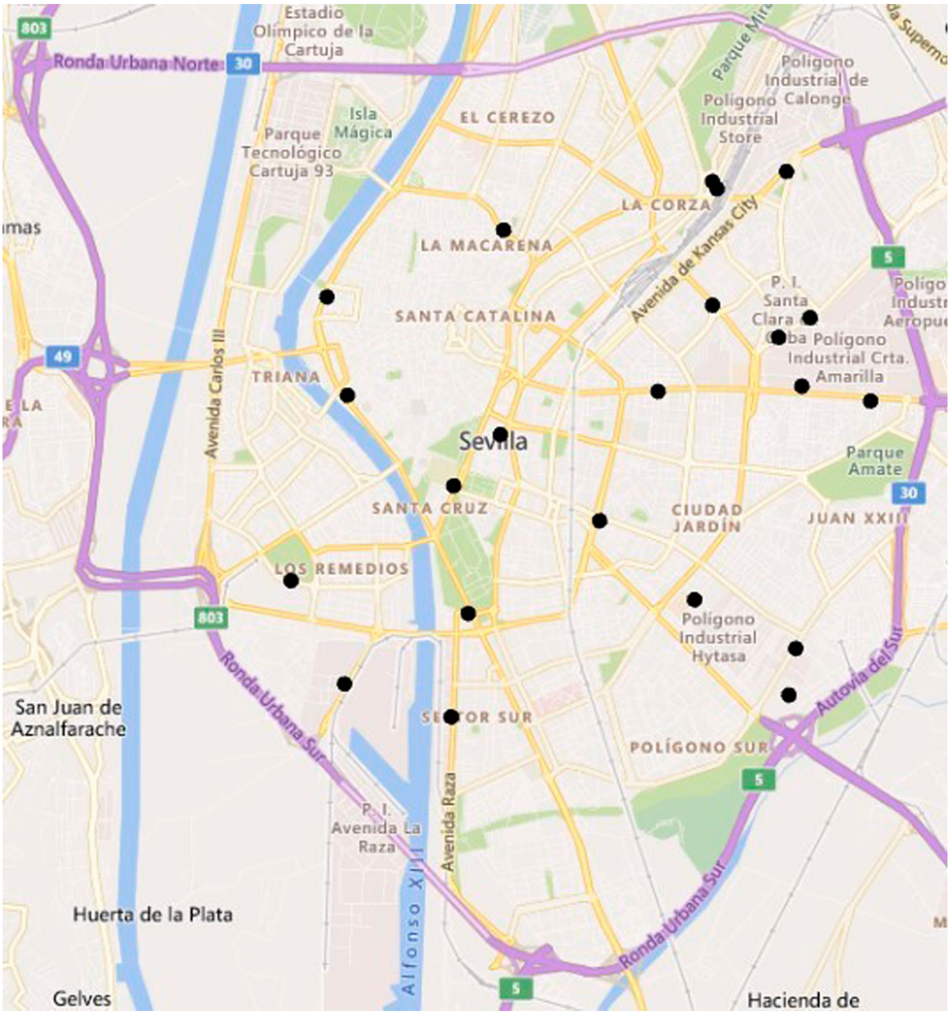

Figure 3. Station localization: city centre.

If we consider the variable 'Repsol-Cepsa', the results show that they charge a price of 2.8 (diesel A) and 2.7 (gasoline 95) cents higher than the average of all the service stations. When separating the two brands 'Repsol' and 'Cepsa', we found that Repsol sets the highest price which is, on average, 2.1 and 2.0 cents higher, respectively, whereas Cepsa stations set higher but significantly lower prices than Repsol. Cepsa sets a price per litre that is 0.6 cents higher for diesel and 0.3 cents higher for gasoline. Service stations enjoying a local monopolistic or oligopolistic position set a price that is between 0.25 and 0.35 cents higher than other service stations and between 0.18 and 0.25 cents higher in the case of diesel.

With regard to location, the highest prices are those obtained by stations located in Seville city centre, whereas service stations located on toll or toll-free motorways establish a price that is 0.9 cents higher for diesel as well as for gasoline.

As regards the control variables, the fleet of registered vehicles according to the type of fuel, which represents demand factors, has a coefficient that is found to be positive and statistically significant. With regard to spatial competition, which is represented by the number of stations

Table 1. Variables considered in the econometric specification and sources.

Variables	Description	Source
Dieselprice, *Gasolineprice*	Daily prices of diesel and gasoline	Ministry of Energy, Tourism and Digital Agenda. Retrieved 2018 from http://www.geoportalgasolineras.es/#/Inicio
Repsol-cepsa	1 if it is a brand of Repsol or Cepsa; 0 otherwise	Spanish Association of Operators of Petroleum Products (2015). Retrieved 2018 from http://www.aop.es/publicaciones/informes/
Repsol	1 if it is a brand of Repsol; 0 otherwise	Spanish Association of Operators of Petroleum Products (2015). Retrieved 2018 from http://www.aop.es/publicaciones/informes/
Cepsa	1 if it is a brand of Cepsa; 0 otherwise	Spanish Association of Operators of Petroleum Products (2015). Retrieved 2018 from http://www.aop.es/publicaciones/informes/
localmonopoly/ duopoly	1 if the station is unique in the locality or if it only has another competitor; 0 otherwise	Ministry of Energy, Tourism and Digital Agenda. Retrieved 2018 from http://www.geoportalgasolineras.es/#/Inicio
motorways	1 if the station is in the access or exit of a toll or toll-free motorway; 0 otherwise	Ministry of Energy, Tourism and Digital Agenda. Retrieved 2018 from http://www.geoportalgasolineras.es/#/Inicio
Citycentre	1 if the station is located within the area bounded by the Seville ring road, the SE-30, and the Ronda Urbana Norte; 0 otherwise	Ministry of Energy, Tourism and Digital Agenda. Retrieved 2018 from http://www.geoportalgasolineras.es/#/Inicio
Vehicles1	Number of diesel vehicles in the municipality where the station is located	Dirección General de Tráfico. Ministry of Interior. Retrieved from https://sedeapl.dgt.gob.es/WEB_IEST_CONSULTA/buscadorInformePredefinido.faces
Vehicles	Number of gasoline vehicles in the municipality where the station is located	Dirección General de Tráfico. Ministry of Interior. Retrieved from https://sedeapl.dgt.gob.es/WEB_IEST_CONSULTA/buscadorInformePredefinido.faces
Stationdensity	Number of stations within a radius of 2 km	Ministry of Energy, Tourism and Digital Agenda. Retrieved 2018 from http://www.geoportalgasolineras.es/#/Inicio
pp_1	Brent oil price with a one-day delay	US Energy Information Administration. Retrieved 2018 from https://www.eia.gov/dnav/pet/pet_pri_spt_s1_d.htm
pp_2	Brent oil price with a two-day delay	US Energy Information Administration. Retrieved 2018 from https://www.eia.gov/dnav/pet/pet_pri_spt_s1_d.htm

Source: Authors' own elaboration.

within a radius of 2 km, we find negative and significant coefficients. Both results are in line with the empirical literature.

Robustness test

The econometric specifications for the two dependent variables, gasoline and diesel, for the robustness test are as follows:

Scenario 1:

Table 2. Summary of the descriptive statistics of the variables.

Variable	Observations	Mean	Standard deviation	Minimum	Maximum
Gasoline price	31,960	0.6307	0.0360	0.5099	0.7587
Diesel price	31,960	0.6159	0.0341	0.4714	0.6945
Oil price t−1	31,960	60.82	3.3184	53.69	66.33
Oil price t−2	31,960	60.79	3.3701	53.61	66.33
motorways	31,960	0.1794	0.38368	0	1
Repsol	31,960	0.2500	0.4330	0	1
Cepsa	31,960	0.1882	0.3909	0	1
Localmonopoly/ duopoly	31,960	0.2294	0.4204	0	1
city centre	31,960	0.0648	0.2462	0	1
Vehicles gasoline	31,960	26,637.4	51,875.52	114	149,347
Vehicles diesel	31,960	34,818.19	59,963.6	274	175,679

Source: Authors' own elaboration.

Table 3. Estimate of the price of diesel A and gasoline 95.

	Diesel A		Gasoline 95	
Variable	**Scenario 1**	**Scenario 2**	**Scenario 1**	**Scenario 2**
Repsol-Cepsa	0.028372***		0.027378***	
Repsol		0.021367***		0.020690***
Cepsa		0.006753***		0.003770***
Localmonopoly/duopoly	0.002498***	0.001786***	0.003512***	0.002519***
Toll motorways	0.009546***	0.009180***	0.009611***	0.008975***
City centre	0.019702***	0.02373***	0.016393***	0.020610***
Station density	−0.000260***	−0.000369***	−0.000423***	−0.000594***
Vehicles	1.12e–08***	9.44e–09***	4.06e–08***	3.75e–08***
Cons	0.579680***	0.585950***	0.582553***	0.589609***
F	296.91	196.11	205.57	149.56
p-value	0.0000	0.0000	0.0000	0.0000
R^2	0.4083	0.3062	0.3974	0.3130
Hausman test, *p*-value	0.1765	0.0005	0.1135	0.0908

Notes: ***$p < 0.01$, **$p < 0.05$ and *$p < 0.1$ are significant at 1%, 5% and 10%, respectively.
P-value estimation by panel-corrected standard errors (PCSE) and feasible generalized least squares (FGLS).
Source: Authors' own elaboration.

$$dieselprice_{i,t}(gasolineprice_{i,t}) = \beta_0 + \beta_1 repsol\text{–}cepsa_{i,t} + \beta_2 localmonopoly/duopoly_{i,t} + \beta_3 motorways_{i,t} + \beta_4 citycentre_{i,t} + \beta_5 stationdensity_{i,t} + \beta_6 vehicles1(2)_{i,t} + \beta_7 pp\_1_{i,t} + \beta_8 pp\_2_{i,t} + u_{i,t}$$

Scenario 2:

$$dieselprice_{i,t}(gasolineprice_{i,t}) = \beta_0 + \beta_{11} repsol_{i,t} + \beta_{12} cepsa_{i,t} + \beta_2 localmonopoly/duopoly_{i,t} + \beta_3 motorways_{i,t} + \beta_4 citycentre_{i,t} + \beta_5 stationdensity_{i,t} + \beta_6 vehicles1(2)_{i,t} + \beta_7 pp\_1_{i,t} + \beta_8 pp\_2_{i,t} + u_{i,t}$$

where $pp\_1_{i,t}$ *and* $pp\_2_{i,t}$ is the daily price per barrel of Brent oil in dollars in $t-1$ and $t-2$.

Given the nature of the model, it is not possible to use individual fixed effects since they would capture all the information from the dummy variables whose significance we are seeking to estimate. We therefore use random effects.

Table 4. Estimate of the price of diesel A and gasoline 95.

	Diesel A				Gasoline 95			
	FGLS		PCSE		FGLS		PCSE	
Variable	**Scenario 1**	**Scenario 2**	**Scenario 1**	**Scenario 2**	**Scenario 1**	**Scenario 2**	**Scenario 1**	**Scenario 2**
Repsol-Cepsa	0.027719***		0.027778***		0.026540***		0.026570***	
Repsol		0.020549***		0.020732***		0.020190***		0.020310***
Cepsa		0.006597***		0.006562***		0.003307***		0.003357
Localmonopoly/duopoly	0.002720***	0.002171***	0.002583***	0.001926***	0.003360***	0.002310***	0.003405***	0.002429**
Toll motorways	0.009315***	0.008580***	0.009252***	0.008812***	0.009027***	0.008488***	0.009129***	0.008391***
City centre	0.018180***	0.022048***	0.018746***	0.022204***	0.014840***	0.018718***	0.015098***	0.018710***
Station density	–0.000263***	–0.000380***	–0.000277***	–0.000385***	–0.000421***	–0.000583***	–0.000400***	–0.000570***
Vehicles	1.54e–08***	1.37e–08***	1.44e–08*	1.39e–08	4.21e–08***	3.84e–08***	4.11e–08 ***	3.92e–08**
oilprice t–1	0.001065***	0.000980***	0.001038***	0.000947***	0.000661***	0.000617***	0.000660**	0.000641**
oilprice t–2	0.001634***	0.001530***	0.001624***	0.001531***	0.001107***	0.001079***	0.001116***	0.001088***
Cons	0.435470***	0.453082***	0.437800***	0.454930***	0.507567***	0.518535***	0.507034***	0.516675***
Wald chi	28812.77	4044.05	479.62	369.91	13741.06	13113.05	258.19	214.24
p-value	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
R^2			0.8166	0.8057			0.7648	0.7544
Hausman test, *p*-value	0.1765	0.0005			0.1135	0.0908		

Notes: $^{***}p < 0.01$, $^{**}p < 0.05$ and $^{*}p < 0.1$ are significant at 1%, 5% and 10%, respectively.
P-value estimation by panel-corrected standard errors (PCSE) and feasible generalized least squares (FGLS).
Source: Authors' own elaboration.

In order to detect the presence of heteroscedasticity, autocorrelation and contemporary correlation, we use the modified Wald test for heteroskedasticity, the Wooldridge (2002) test for autocorrelation in panel data, and the Pesaran (2004) test in the case of contemporary correlation. The existence of these problems is confirmed, such that we correct them using PCSE estimated by Prais–Winsten regression and FGLS.

Table 4 includes the results obtained from the robustness test, including oil prices as a proxy of the variation in production costs, to replace the estimates using time fixed effects.

As regards the results, it can be seen that the coefficients and their significance are similar and that the oil price variables also show similar results as well as displaying their expected sign. For the PCSE estimates, we obtain a high R^2.

CONCLUSIONS

In this study we analyse the effect on retail fuel prices of factors such as belonging to a dominant firm in the market, holding a monopolistic or oligopolistic position in small municipalities, and service station location on high-capacity roads or in the city centre. We study the two most common fuels, diesel A and gasoline 95, separately for stations in the province of Seville. As control variables, we include the number of registered vehicles in the municipality, as a demand factor, and the density of stations, which is representative of spatial competition.

As regards the effect of belonging to dominant firms, in the case of both REPSOL and CEPSA who control 75.6% of all service stations in the province, we found that they set higher prices. In this regard, our study also concurs with the results usually reported in the literature (Barron et al., 2004; Bello Pintado & Cavero Brújula, 2007, 2008; Bello Pintado & Contín-Pilart, 2010; Cooper & Jones, 2007; Haucap et al., 2017; Kihm et al., 2016; Remer, 2019; Van Meerbeeck, 2003).

When separating the two brands, we found that Repsol leads the market and that charges the highest prices. It should be remembered that Repsol is the company that inherited the former public hydrocarbon monopoly.

Stations that enjoy local monopoly and duopolies, in other words stations which provide services in rural areas (municipalities where only one or two service stations exist), and for which there is no previous literature, are also found to set higher prices, albeit lower than those of Repsol and Cepsa.

As regards service station location, as is common in the literature (Bello Pintado & Cavero Brújula, 2007, 2008; Haucap et al., 2017), we considered that lack of both information and awareness on long journeys undertaken on high-capacity ways leads to motorists not trying to find the best offer, and thereby generating captive demand. This then allows service stations to set higher prices. This phenomenon of trapped demand also occurs in the city centre, in this case due to problems of movement and the shortage of supply in relation to demand. Results confirm these hypotheses. That is, for the area and period studied, stations located in the centre of Seville and on high-capacity roads show higher prices.

Finally, with regard to control variables, the fleet of registered vehicles, a proxy of demand factors, shows a positive and significant relationship. The greater the fleet of vehicles, the higher the fuel price. As regards station density, our results concur with the most common results reported in the literature, showing that greater density leads to lower fuel prices. Finally, in the robustness test, the relationship between crude oil prices and fuel prices is seen to be positive and significant, again concurring with the findings to emerge from other studies which explore the issue (Cooper & Jones, 2007; Haucap et al., 2017; Kihm et al., 2016; Remer, 2019).

In sum, the results obtained show that, in rural areas, where supply is limited, prices are higher, although the difference is not excessive. The lack of demand determines a situation of natural monopoly/duopoly, which makes introducing competition impossible. Much the same is true of petrol stations in the city centre as well as on toll and toll-free motorways, where demand is captive and the possibility for competition is limited due to the physical and legal restrictions placed on the installation of service stations and the high investment costs. In fact, of all the factors that determine higher prices, those 'assailable' are those deriving from the market power exercised by Repsol and Cepsa. There is no economic logic to justify why refining and bigger companies, which theoretically face the lowest marginal costs, should be those charging the highest price. The most plausible explanation is their control of the market, which is why it seems appropriate that they should be subject to scrutiny by the competition authorities.

However, we should remember that this paper is intended to measure the influence that different factors exert on the setting of higher or lower fuel prices and not the market power exercised in the retail fuel market. For the latter purpose, it would be necessary to follow a different approach, such as those of Manuszak (2010), Houde (2012) or Slade (1987), as Eckert (2013) points out.

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No potential conflict of interest was reported by the authors.

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NOTES

[1] For a good description of the historical evolution of the market, see National Energy Commission (2006) and also Bello Pintado and Cavero Brújula (2008).

[2] For the theoretical distinction between vertical (differences in product quality) and horizontal differentiation (differences in location or preferences), see Tirole (1988).

[3] The Herfindahl index is an indicator of market concentration. It is defined as:

$$H = \sum\nolimits_{i=1}^{n} c_i^2,$$

where c_i is the market share of firm i in the relevant market.

[4] Another type of differentiation analysed regarding service stations refers to additional services offered. In almost all cases, a positive effect of such services on fuel prices is observed. The variables included, which are representative of differentiation by additional services, are: vehicle repair (Barron et al., 2004; Clemenz & Gugler, 2009; Ning & Haining, 2003; Remer, 2019; Shepard, 1993); convenience store (Barron et al., 2004; Clemenz & Gugler, 2009; Haucap et al., 2017; Shepard, 1993; Remer, 2019); car wash (Haucap et al., 2017; Ning & Haining, 2003; Remer, 2019); station capacity (Barron et al., 2004; Clemenz & Gugler, 2009; Shepard, 1993; Ning & Haining, 2003); car sales (Ning & Haining, 2003); 24-hour service (Haucap et al., 2017; Remer, 2019); and self-service or service by an operator (Barron et al., 2004; Shepard, 1993).

[5] The days excluded are: March: 29; April: 4, 6, 15 and 20; May: 11, 15, 23 and 27; June: 6–8, 13, 22–24, 26 and 29; and July: 6, 8, 12, 16, 17 and 19.

[6] Information provided by the Ministry of Energy, Tourism and Digital Agenda (http://www.geoportalgasolineras.es/#/Inicio).

[7] For the list of stations removed, see Table A2 in Appendix A in the supplemental data online.

[8] The numbers of the stations are as follows (see Table A1 in Appendix A in the supplemental data online): 28, 34, 36, 38–40, 42, 52, 59, 82, 83, 85, 86, 92, 94, 96, 100, 102, 115, 126, 132, 137, 144, 151, 163, 180, 182, 184, 224, 225, 245, 247, 282, 297, 301, 315 and 316.
[9] The station numbers are as follows (see Table A1 in Appendix A in the supplemental data online): 24, 48, 54, 58, 116, 147, 168, 169 and 273.
[10] As regards national hydrocarbon tax, see Article 50 of Law 38/1992, of 28 December, governing excises (this article was amended, with effect from 1 January 2013, and remains in force indefinitely under para. 3 of final provision no. 20 of Law 2/2012 of 29 June on the General State Budget for 2012). Moreover, as regards the regional tax, from 1 January 2013 the Tax on Retail Sales of Certain Hydrocarbons was repealed (Repealing Provision Three of Law 2/2012 of 29 June, State Budget for 2012), which was integrated into the tax on hydrocarbons. With effect from 1 January 2014, the new Andalusian regional excise on hydrocarbons was adopted (https://www.juntadeandalucia.es/haciendayadministracionpublica/tributos/impuestos/cedidos/hidrocarbuos.htm). See Tax Agency, *El Impuesto sobre Hidrocarburos* 2015 (https://www.agenciatributaria.es/static_files/AEAT/Aduanas/Contenidos_Privados/Impuestos_especiales/estudio_relativo_2015/4_HIDROC.pdf).
[11] Station numbers are as follows (see Table A1 in Appendix A in the supplemental data online): 1–4, 6, 7, 13–17, 20–23, 31, 37, 39, 40, 42–47, 49, 56–58, 71, 87–90, 92, 100, 102, 104, 107, 109, 110, 113, 115, 120–122, 138, 139, 154, 155, 157, 210, 241, 251, 253, 259, 260, 265, 272, 277, 284, 287, 303–305, 310, 317, 319, 320, 325–327, 330–333, 335, 336, 340–346, 350, 352 and 353.
[12] In addition, Albalate and Perdiguero (2015) specifically estimate the differences in fuel prices between stations located on toll motorways and those located on toll-free motorways.
[13] Station numbers are as follows (see Table A1 in Appendix A in the supplemental data online): 4, 5, 7, 22, 27, 32, 33, 36, 38, 43–46, 50, 51, 56, 59, 69, 70, 75, 78–80, 90, 98, 99, 123, 124, 127, 130, 133, 134, 136, 137, 152, 154–159, 161, 195, 197, 205–207, 227, 228, 256, 258, 279, 295, 298–300, 315, 317, 327, 333 and 340. Only two of these 61 service stations are located in a toll motorway, so we found it more appropriate to classify them in a single category.
[14] Station numbers are (see Table A1 in Appendix A in the supplemental data online): 202, 210–212, 214, 215, 218, 220–223, 225, 231, 238, 239, 241, 243, 244 and 249–252.
[15] Alternatively, if we replace the variable *vehicles* with the variable *population density*, the results show that the coefficients of the latter present the same sign as those of the former, whereas the coefficients of the rest of variables, as well as the goodness-of-fit statistics, hardly change. We do not include this robustness test for reasons of space.
[16] There is only one case, gas station 16 in the list shown in Table A1 in Appendix A in the supplemental data online, in whose radius of 2 km is found another station from a different province, Cordoba. Its inclusion does not alter the results.
[17] The only exceptions are found in scenario 1 in the PCSE estimate for gasoline price: 'Cepsa', which is not statistically significant, and 'localmp', which is significant at the 5% level.

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