COMISIÓN NACIONAL DE LOS MERCADOS Y LA COMPETENCIA

E/CNMC/005/19 ANALYSIS OF THE COMPETITIVE IMPACT OF THE ENTRY OF UNMANNED PETROL STATIONS IN THE RETAIL FUEL MARKET

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I INTRODUCTION

The Spanish automobile fuel industry has frequently been the focus of attention from the perspective of competition and efficient economic regulation, due to the importance of road fuels in consumer spending and their strategic value for national competitiveness and for transport industries.

The CNMC has confirmed the existence of anticompetitive practices among operators and structural problems involving a lack of competition on numerous occasions. In the various reports and studies the CNMC prepared as part of its role in promoting competition, barriers to competition have been identified in all segments of the market. In the retail segment, among other things, the following have been highlighted: high levels of concentration and vertical integration, difficulties in opening petrol stations in urban environments, and long-established links between existing service stations and vertically integrated operators.[1]

Unmanned petrol stations have the potential to introduce more competition into the marketplace, to the benefit of consumers. They carry lower costs and require less physical space than traditional stations, which allows them to replace traditional petrol stations, reducing distribution costs, while at the same time being set up in areas that are less attractive to traditional stations, intensifying competition and increasing the density of retail locations.

Despite of the above, the CNMC has confirmed (CNMC, 2016 and 2018) the existence of numerous regulatory restrictions on the opening and growth of unmanned petrol stations, in both national and regional regulations. Since the first CNMC report on this category of petrol stations (CNMC, 2016), some regulatory barriers have been eliminated, but others have emerged. Today, unmanned stations continue to face multiple rules that limit their growth.

At a qualitative level, there are a few studies, which point to the positive impact of unmanned petrol stations on prices and competitive pressure in European markets,[2] but there is little empirical evidence about their quantitative impact. It is for this reason that the CNMC has deemed it necessary to conduct a study on

[1] CNC (2009, 2011, 2012a, 2012b) and CNMC (2014, 2015 and 2016).

[2] For example, CIVIC Consulting – EAHC (2014).

the impact of unmanned petrol stations on the automobile fuel market, with the aim of estimating the impact of the entry of these petrol stations on prices.

The present study analyses the effects of the entry of unmanned petrol stations utilising econometric techniques. The study seeks to identify the competitive dynamics in local environments, analysing to what degree unmanned stations affect prices at stations in the surrounding area.

Given the uneven extent of the introduction of unmanned petrol stations, as well as regulatory differences and possible cost differences between autonomous communities, the analysis has focused on the territory of Madrid, one of the regions in which unmanned petrol stations are most prevalent. The Community of Madrid (hereinafter, CAM) forms a homogeneous territory from the perspective of regulation of the automobile petroleum products distribution industry, as it has the authority to adopt regulations,[3] for example, with regard to service station safety.

Following this introductory section, the document is divided into another four sections and five appendices. The second section analyses the economic and regulatory context of unmanned petrol stations. In the third, we present the econometric study, which quantifies the impact of the entry of unmanned petrol stations. The final two sections include the report’s conclusions and recommendations.

II ECONOMIC AND REGULATORY FRAMEWORK

II.1 Retail distribution of automobile fuel in Spain

Retail distribution of automobile fuel through petrol stations (hereinafter, PS) is a highly important activity for the Spanish economy, due to its economic weight as well as its effect on population mobility, freight road transport and the competitiveness of our exports. Competitive supply in terms of location, prices,

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3 For further details, see study PRO/CNMC/002/2016 ‘Proposal regarding the regulation of the automobile fuel distribution market through unmanned service stations’ on the different regulations adopted by the autonomous communities in the retail fuel distribution industry.

quality and service has a clear impact in terms of wellbeing (households) and competitiveness (businesses).

The Spanish petrol station network

In recent years, the distribution market in Spain has been notable for a growing number of PS, a trend that is somewhat uncommon in the European context.[4] In late November 2018, there were 11,646 PS in Spain.[5] As Graph 1 shows, the number of PS has gone up by about 16% since 2011.

In terms of operator type, the majority of PS belong to the networks of vertically integrated operators with refining capacity in Spain (Repsol, Cepsa and BP).[6] Another group of PS is linked to wholesalers without refining capacity in Spain and we refer to them as 'other branded stations'[7]. The remainder is made up of independent PS, which are not linked to wholesalers or operators with refining capacity in Spain, nor do they have exclusive supply agreements with any operator.

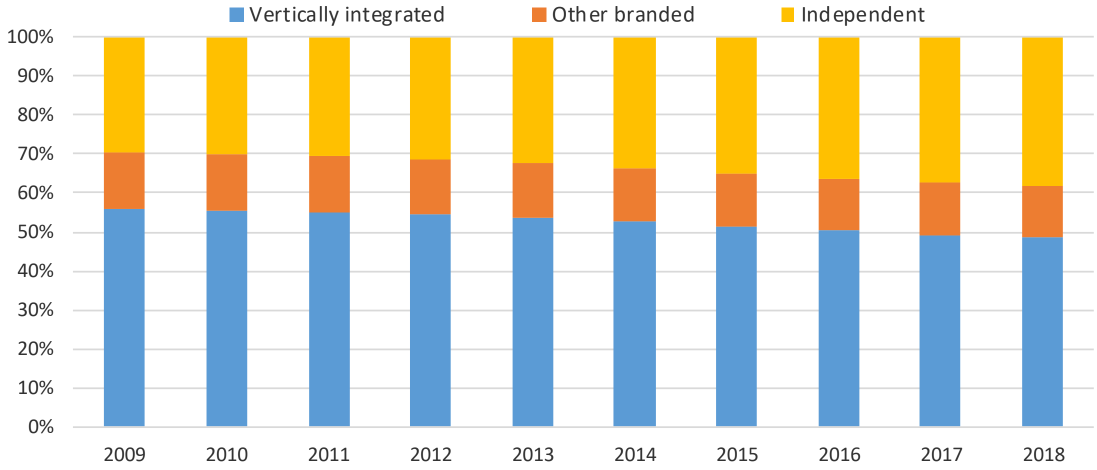
4 Civic Consulting (2014) Chapter 7: 'Analysis of explanatory factors for price changes and divergences between countries'.

5 Source: Information System for Petroleum Product Supply Activities (SIAS).

6 Additionally, Galp has refining activity in Portugal. In this study, Galp is included in the other branded stations group.

7 For example, Disa, Dyneff España S.L., ERG Petroleos S.A., Esergui S.A., Fuel Iberia S.L.U., Galp, Kuwait Petroleum España S.A., Meroil S.A., Noroil S.A., Saras Energía S.A., Shell España S.A., Total España S.A. and Tomoil España S.A.

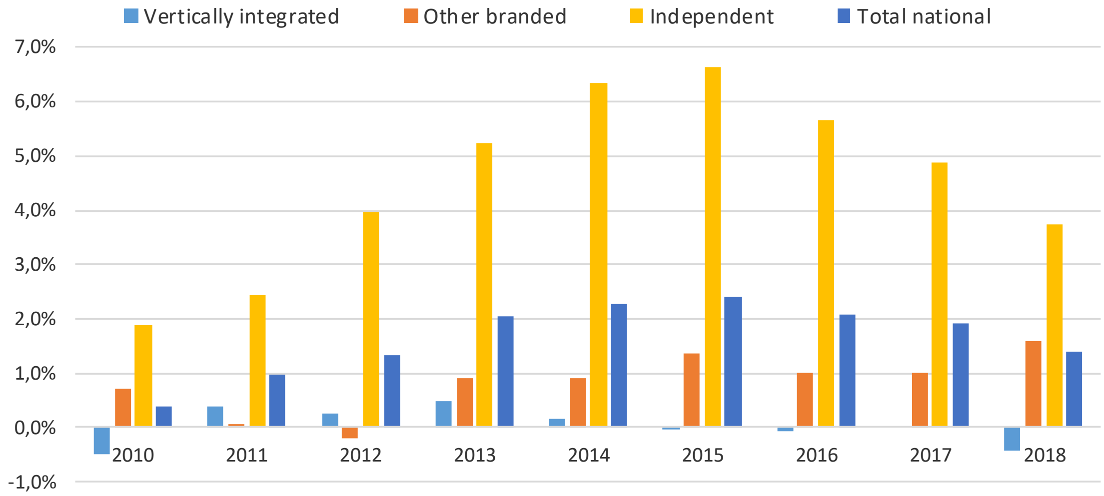
Graph 1. *Variation in the number of petrol stations by operator in Spain, 2011–2018*



Source: compiled by authors from SIAS, CNMC.
Remarks: (1) The 2018 data reflect the number of facilities up to 30/11/2018.
(2) The calculation of the number of PS reflects the number of facilities operating at least 1 day of each year.

When broken down by operator type, we can see substantial differences in the variation in the number of PS. Vertically integrated PS have experienced slight increases or decreases, remaining practically constant in number since 2010. The remaining branded PS grew at rates of 1–2% throughout the period. Independent PS have had much higher growth, close to 2–7% depending on the year.

Graph 2. *Growth rate in the number of PS by operator type in Spain, 2010–2018*



Source: compiled by authors from SIAS, CNMC.
Remarks: (1) The 2018 data reflect the number of facilities up to 30/11/2018.
(2) The calculation of the number of PS reflects the number of facilities operating at least 1 day of each year.

Unmanned petrol stations

Unmanned PS are those where fuel is supplied to the vehicle directly by the user, including both physical refuelling and payment for the fuel. They do not therefore have any staff to perform these duties. Regulations refer to this category of PS as 'unmanned'[8] (a designation, which is used throughout this document interchangeably with 'automatic').

Unmanned PS are distinguished from 'manned' PS (those which have their own staff who do the refuelling and collect payment from customers) and from self-

[8] Regulatory scheme for oil installations, passed by Royal Decree 2085/1994, of 20 October, and supplementary technical instructions MI-IP 03, passed by Royal Decree 1427/1997, of 15 September, and MI-IP 04, passed by Royal Decree 2201/1995, of 28 December. Only those stations, which have no staff attached to the facility during all opening hours (24h), are considered unmanned service stations.

service PS (in which case the vehicle is fuelled by the customer, although the pump is activated by an operator from the station control centre).[9] The regulations consider PS that have staff to activate the fuel pump only during daytime hours – but no staff during night-time hours – to be self-service facilities.

The market penetration of automatic facilities varies considerably within the EU, according to the Civic Consulting study (2014), ranging from 0.7% of all PS in Italy to 69% in Denmark. On this spectrum, Spain comes in under the average with a penetration of 5% of all PS. This level is similar to Germany's and is almost half that of France. These values reflect estimates, as in most countries there are no public databases that collect information on operations under this system. In the case of Spain, owners of unmanned stations are required to report that their operation is unmanned to the autonomous community governments.[10]

Table 1. Representation of PS by country

Country	% unmanned PS out of total PS according to fuel sales
Italy	0,70%
United Kingdom	2,90%
Germany	4,60%
SPAIN	5,00%
France	**8,80%**
Austria	**10,80%**
Belgium	**18,60%**
Netherlands	**23,70%**
Sweden	**61,10%**
Denmark	**65,90%**

Source: Civic Consulting (2014): Consumer Market Study on the Functioning of the market for Vehicle Fuels from a Consumer Perspective
Remarks: The percentage of representation for unmanned PS assigned by the study reflects an estimate of the situation in 2012.

9 Supplementary Technical Instruction MI-IP 04, item 3.

10 Supplementary Technical Instruction MI-IP 04, item 27.

In Spain, unlike other European countries, the automatic station format is a recent development. The majority of these are new establishments, although there are also stations, which have been converted from manned to unmanned. The former ones are primarily linked to independent distributors, and as a result, they have potentially more characteristics of a maverick.[11]

There are no accurate public data from official sources with regard to the number and location of automatic PS in Spain. However, according to AESAE[12] data, there are currently 882 independent unmanned PS in Spain.[13]

The AESAE data show that unmanned PS are heavily concentrated in a few autonomous communities; Catalonia, the Valencian Community, Andalusia and Madrid account for 72% of all unmanned PS in Spain. At the other extreme, it is worth noting the low penetration of automatic PS in the autonomous communities in the northern part of Spain (Galicia, Cantabria, Asturias, Navarre, La Rioja, Aragon), in Extremadura and in the Balearic Islands.

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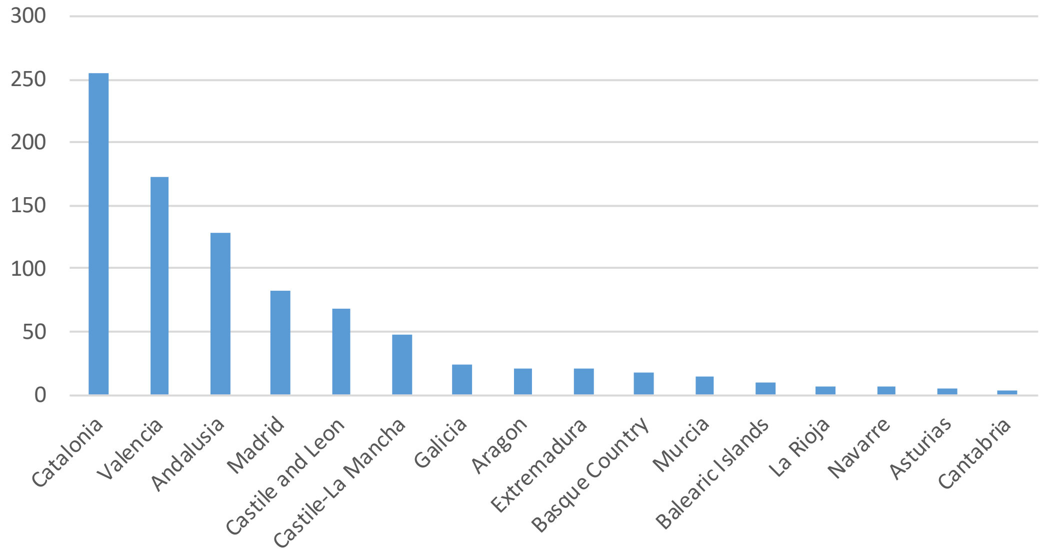
11 A maverick is a firm that is very likely to break up potential coordinated conduct. Such operators play a disruptive role in the marketplace, competing effectively to the benefit of consumers and users. See 'Guidelines on the assessment of horizontal mergers under the Council Regulation on the control of concentrations between undertakings and 'Horizontal Merger Guidelines' from the U.S. Department of Justice and the Federal Trade Commission (2.1.5 Disruptive Role of a Merging Party).

12 National Association of Automatic Service Stations.

13 The main operators of these PS are Ballenoil, Petroprix, Gasexpress, Settram, Plenoil, BonArea, Autonet&Oil, Naftë, Petrocar, Low Gas, Nubex, Sorval, Eureka and Moove Low Cost.

Graph 3. *Geographic distribution of automatic petrol stations in Spain*



Source: AESAE
NB: The data refer to the Peninsula and the Balearic Islands.

II.2 Retail distribution of automobile fuel in the Autonomous Community of Madrid

During the 2011–2017 period, there are two trends both at the national level and in the CAM: one, a slight drop in the representation of PS belonging to the networks of vertically integrated operators, and two, an increasing trend of independent PS.

Table 2. Variation in points of sale for automobile fuel in Spain and the CAM

Territory	Year	Ratio of vertically integrated operators	Ratio of independent operators
SP	2011	56%	30%
CAM	2011	77%	6%
SP	2017	50%	36%
CAM	2017	68%	18%

Source: Compiled by authors from SIAS (CNMC data)

Remarks: The data reflect the number of PS active on 1st January of each year.

In the CAM, the presence of PS belonging to the networks of vertically integrated operators is significantly higher (68%) than the national average (50%), while the penetration of independent ones is much lower than the Spanish average: 18% compared to 36%, as shown in Table 2.

The number of operators in the CAM (10) did not change between 2011 and 2017. However, we can see from Table 3 that three business groups (ESSO Española, Galp Distribución and Shell España) have left this market, while three new stakeholders have entered (Esergui S.A., Fuel Iberia S.L.U. and Petroeuropa S.L.).

Table 3. Variation in the number of PS in the CAM, 2011–2017

Operators	2011	2013	2015	2017	growth rate	% of total in 2011	% of total in 2017
BP OIL ESPAÑA S.A.	75	77	80	73	-3%	12%	10%
DISA PENINSULA, S.L.U	31	34	34	37	19%	5%	5%
GRUPO CEPSA	106	110	109	116	9%	17%	16%
GRUPO REPSOL	284	284	286	290	2%	47%	41%
ESERGUI S.A.	0	0	2	3	50%	0%	0%
EPSO ESPAÑOLA S.A.	19	1	0	0	-100%	3%	0%
FUEL IBERIA S.L.U.	0	1	1	1	0%	0%	0%
GALP DISTRIBUCIÓN OIL ESPAÑA, S.A.U	12	8	0	0	-100%	2%	0%
GALP ENERGÍA ESPAÑA S.A.	31	49	55	56	81%	5%	8%
KUWAIT PETROLEUM ESPAÑA, S.A.	2	1	1	1	-50%	0%	0%
PETROEUROPA, S.L.	0	0	0	1	0%	0%	0%
SARAS ENERGÑA S.A	3	3	2	1	-67%	0%	0%
SHELL ESPAÑA S.A.	5	3	0	0	-100%	1%	0%
INDEPENDENTS	38	50	80	129	**239%**	**6%**	**18%**
Total	**606**	**621**	**650**	**708**	**17%**	100%	100%

Source: Compiled by authors from SIAS

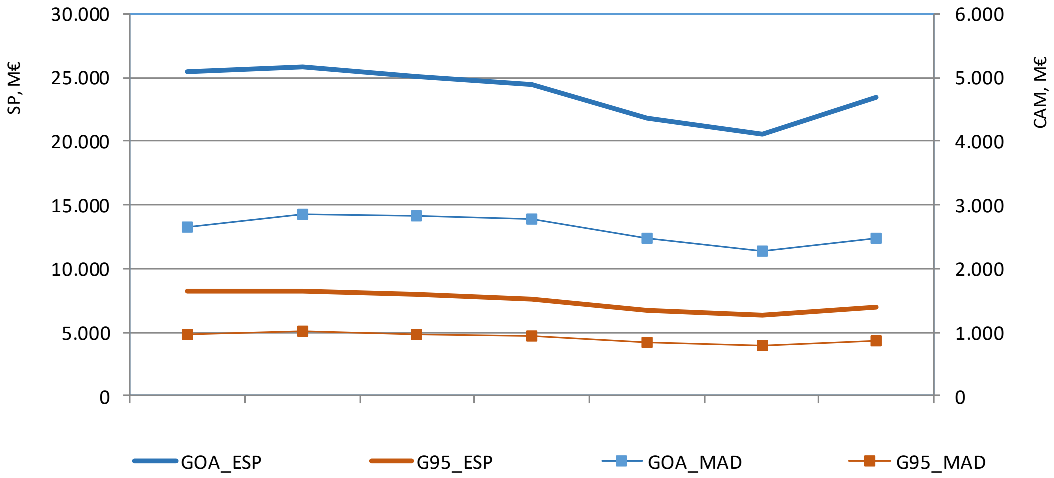
Remarks: The data correspond to the first week of each year. The growth rate reflects the change in the number of PS between the figure other than zero in the first year and the last year in this table.

The most commonly used fuel in the CAM is regular diesel (in Spanish terms it is 'gasóleo A' and – for this reason – it is abbreviated as *GOA* along this document), which accounts for about 75% of annual sales for automobiles. The second most commonly used is 95 gasoline (G95), with a penetration of 18%. Together, these two fuels cover more than 90% of annual demand in CAM, which in turn accounts for 10% of demand for these products in overall Spain. The use of other motor fuels, such as other diesel types, 98 gasoline (G98) and biodiesel (BIOD), is limited.[14] This working paper focuses on studying the price formation for the two main products: regular diesel (hereinafter, GOA) and G95.

Fuel prices have a major impact on the economy, because fuel is an intermediate input for freight transport, which affects a large portion of manufacturing and services. One illustration of the importance of the weight of fuel sales in Madrid's economy is the annual turnover from retail sales of GOA and G95, which together accounted for close to 1.5% of GDP for the CAM in 2017. At national level, annual turnover for these two fuels is around 2.9% of GDP in the same year.

[14] For more details, see Appendix I.

Graph 4. *Turnover from retail sales of GOA and G95 in Spain and the CAM, 2011–2017*



Source: compiled by authors from CNMC data

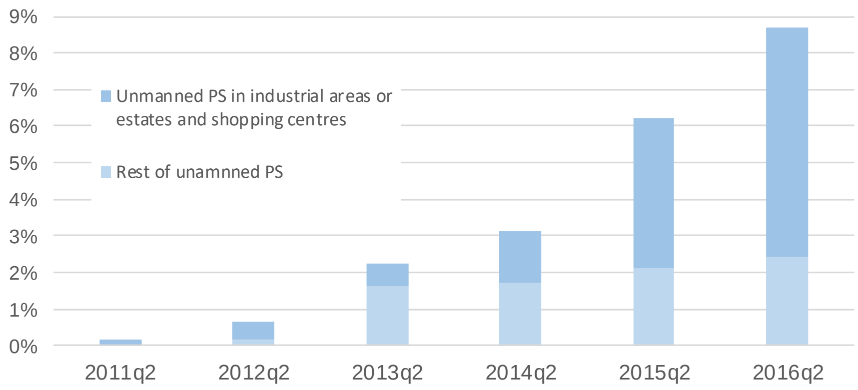
The trend in turnover from retail sales of both GOA and G95 fuel was downward in the period between 2011 and 2016, with a slight rise in the case of GOA in 2017 in both Spain and the CAM. Graph 4 shows this trend (the left vertical axis reflects the scale for turnover values in Spain and the right axis the scale for the CAM). It is worth noting that annual growth of turnover for both fuels and territories was negative between 2011 and 2016, reaching its lowest value in 2015 (GOA: -12%; G95: -11%).

Unmanned petrol stations in the CAM

There were only a few scattered unmanned PS in the CAM before 2013. Beginning in that year, openings of these facilities started to increase, reaching almost 9% of all stations by the second quarter of 2016.[15]

The following graph shows variation in the penetration of unmanned PS, distinguishing between those established in industrial areas or estates and shopping centres (dark blue) and the remaining automatic facilities (light blue). We can see that beginning in 2014, the penetration of unmanned PS was predominantly in industrial estates and shopping centres, which may be the result of Royal Decree-Law 4/2013, which specified these areas for establishing PS with the aim of increasing competition.[16]

Graph 5. *Percentage of unmanned stations out of total PS in the CAM*



Source: compiled by authors from SIAS database and information reported by the CAM

15 In Spain, owners of unmanned PS are required to report that their operation is automatic to the autonomous community governments. Therefore, data on the number of registered unmanned service stations were provided by the CAM DG for Industry, Energy and Mines at the request of the CNMC in July 2016. These data represent the cumulative number of automatic PS in each quarter.

16 Article 40 of RD-Law 4/2013 stipulated that individual or grouped commercial establishments, shopping centres, retail parks, vehicle technical inspection establishments and industrial areas or estates might include at least one facility to supply petrol products to vehicles.

In terms of their origin, there are two types of unmanned PS: new stations that operate without staff from the outset of their activity and PS that were originally manned and later converted (switched) to operate as unmanned.

The new facilities are mainly independent and do not have exclusive agreements with vertically integrated companies. It is expected that this type of unmanned stations will be the ones to exert the greatest competitive pressure on the PS in their surrounding area. The reason is that by entering the market, they lower their prices, accepting smaller margins in order to obtain economies of scale and thus reduce their average procurement and operating costs.

Converted unmanned stations mainly belong to vertically integrated companies or to other brands, but also to independent distributors.

According to the information provided to the CNMC by the CAM Directorate-General for Industry, Energy and Mines (DG IEyM), in late June 2016, there were 69 registered unmanned stations in this autonomous community, of which 41 were new facilities and 28 converted. In addition, it is noteworthy that the new facilities were primarily operated by independents, while those which had been converted were mainly run by vertically integrated companies or other brands.

Table 4. Number of automatic petrol stations in the CAM (up to mid-2016)

Type of operator	**New unmanned PS**	**Converted unmanned PS**	**Total unmanned PS**
Vertically integrated	1	15	16
Other branded	3	2	5
Independent	37	11	48
Total	**41**	**28**	**69**

Source: CNMC database and data reported by the DG IEyM of the CAM

Remarks: The unmanned PS considered are those which have been registered as such by the DG IEyM of the CAM at some point.

Manned and unmanned PS share the same market,[17] as there is an interaction between them when it comes to setting prices. The European Commission notes

[17] M.7603 - STATOIL FUEL AND RETAIL / DANSK FUELS (2016).

that manned PS offer additional services, entailing higher costs than automatic PS. As a result, their prices also tend to be higher.

Are unmanned PS cheaper?

In general, unmanned PS have lower operating costs than traditional PS, largely because they do not incur personnel costs. These cost savings should translate into lower prices, benefiting consumers.

There are few studies quantifying the lower prices at unmanned PS. The study[18] done by the European Commission Executive Agency for Health and Consumers (2014) is not an econometric study, but it does contain some indicative data. It estimates that automatic PS offer prices lower than the prices at manned PS in 13 of the 14 countries analysed.[19] On average, the price differential for 95 petrol between manned and unmanned PS in the countries analysed was 1.9%, and as much as 2.7% in the case of diesel. The most significant price differences were found in Belgium, Austria and Norway, with Greece being the only country of those analysed where the price of 95 petrol was higher at unmanned service stations. In the case of Spain, the price differential is 1.4% for 95 petrol and 3% for diesel.

[18] Civic Consulting (2014): 'Consumer market study on the functioning of the market for vehicle fuels from a consumer perspective'.

[19] Number of observations made: 643. Observations made in 14 countries between January 2005 and January 2013.

Table 5. Price differential for 95 petrol and diesel at unmanned petrol stations by country

Country	Price diff. 95 petrol	Price diff. diesel
Austria	-7.30%	-6.00%
Belgium	-6.10%	-7.30%
Denmark	-1.00%	-3.60%
Slovenia	-0.30%	-0.50%
Spain	**-1.40%**	**-3.00%**
Estonia	-0.40%	-0.20%
Finland	-0.10%	-2.40%
Greece	1.30%	
Netherlands	-3.10%	-3.60%
Iceland	-0.50%	-0.40%
Latvia	-0.70%	-1.00%
Lithuania	-1.40%	-0.20%
Norway	-4.50%	-5.10%
Sweden	-1.50%	-1.40%

Source: CIVIC Consulting (2014)

Remarks: the data for the price comparison were collected via phone calls directly with the PS on selected days (Monday, 26/11/2012; Wednesday, 28/11/2012; and Friday, 30/11/2012)

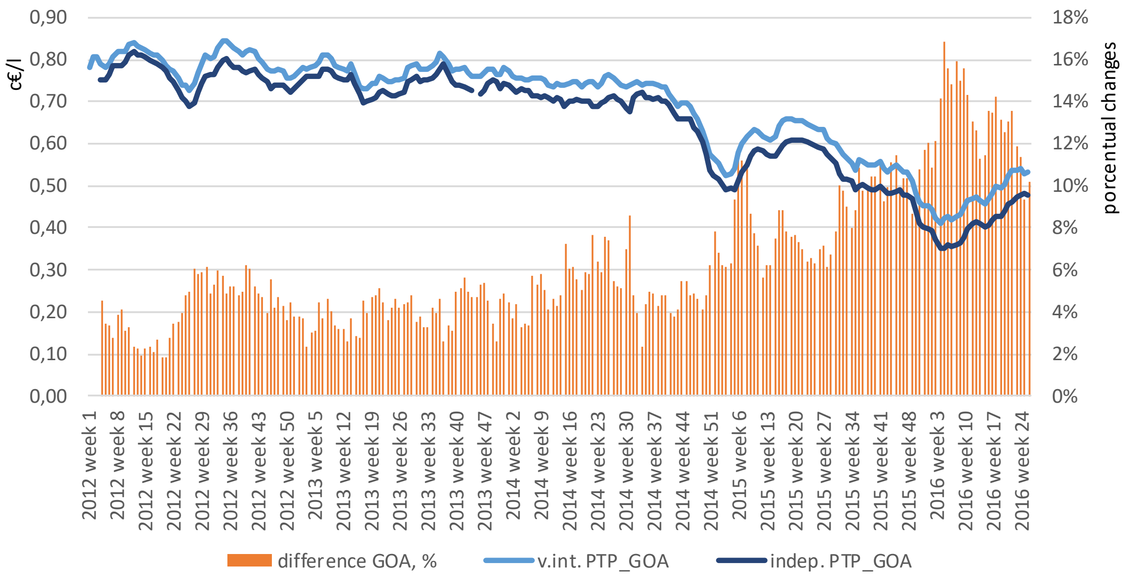
Therefore, there is certain evidence indicating lower fuel prices at unmanned petrol stations in 13 of the 14 European Union countries analysed before 2014.

According to the available data prepared[20] for the empirical study on unmanned stations in the CAM, in the last half year available, between January and June 2016, there is an average pre-tax price difference of 5.1% and 4.2% for GOA and G95, equivalent to 2.1 €cts/lt and 1.9 €cts/lt, respectively. Additionally, the following two graphs illustrate the variation in pre-tax prices for GOA (PTP_GOA) and G95 (PTP_G95) at those unmanned stations, which are operated by

[20] A database has been built using weekly averages for the PTP of diesel and G95 at PS operating in the CAM, which reported information on changes in their prices to the Information System for Petroleum Product Supply Activities (SIAS) run by the Ministry for the Ecological Transition (MITECO).

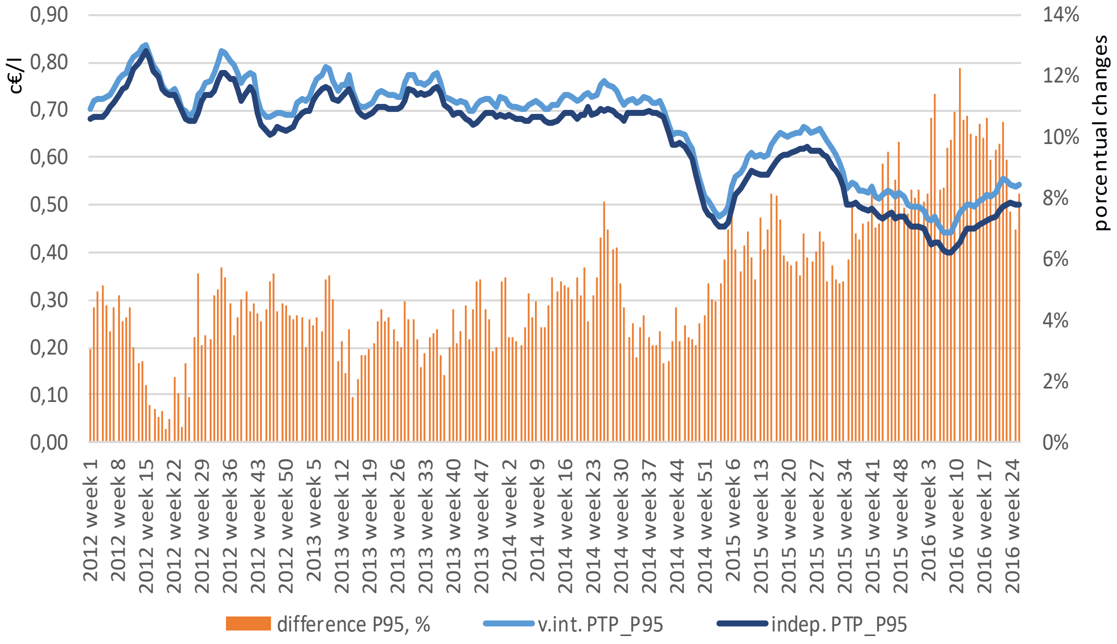
independents (dark blue line) and those manned stations, which belong to the networks of vertically integrated operators (light blue line) between 2012 and mid-2016. The price differential between these two groups ranges from 1.9% to 16.9% for GOA, and from 0.4% to 12.3% for G95. Moreover, we can see that the difference increases over time, alongside the gradual increase in the number of unmanned PS in the CAM.[21]

Graph 6. *Variation in weekly average PTP (€cts/lt) of GOA at independent and unmanned PS and vertically integrated and manned PS in the CAM, 2012 week 1 – 2016 week 26*



[21] The databases created for the empirical study (see section III.2.) consider variables on the characteristics of the local markets (proximity to hypermarket, carriageway, motorway, number of rivals, etc.). However, putting together a robust empirical study, which explains the systematic difference in prices between manned and unmanned stations in these local markets is not the object of the present paper, due to the fact that there is not a sufficient number of automatic PS with the same local characteristics.

Graph 7. *Variation in weekly average PTP (€cts/lt) of G95 at independent and unmanned PS and vertically integrated and manned PS in the CAM, 2012 week 1 – 2016 week 26*



II.3 Regulation of unmanned petrol stations

According to current regulations, all PS must: (i) comply with all mandatory requirements, pursuant to the supplementary technical instructions (STI), which establish the technical and safety conditions for the facilities, (ii) comply with current regulations concerning metrology, (iii) observe regulations relating to consumer and user protection, and (iv) comply with specific regulations implemented by the autonomous communities.

In its report on unmanned PS (CNMC, 2016), the CNMC analysed these regulations and identified a number of measures restricting competition, which could hinder the opening and growth of this type of PS:

- *Metrology regulations:* the regulations require making the officially certified and calibrated measuring container available to PS users, in order to verify the proper measurement and amounts of fuel supplied at all retail supply facilities for automobile gasoline and diesel.

- <u>*Autonomous community regulations*</u>: in some autonomous community regulations[22] there are provisions that require the physical presence of a person at supply locations, directly or indirectly. These included:
    - *Manned service requirement*, particularly to ensure the protection of especially vulnerable users such as persons with some disability.
    - *Supervision of the supply operation*, to perform safety monitoring at the fuel distribution facility in order to prevent refuelling with lights and motor running, or to prevent users from lighting a fire at the facility.
    - Ongoing maintenance of the pump and of the pressure measuring device and water supply device.
    - The requirement to have complaint forms available for users at all times, and the obligation to have single-use gloves and paper available on the fuel supply units.

At the European level, the European Commission also stated its support for the unmanned station format, in line with the CNMC's position. Thus, in March 2017, the European Commission agreed to consider the complaint lodged by AESAE (National Association of Automatic Service Stations) against Spain for its inaction in response to the proliferation of regional regulations contrary to the growth of automatic PS.

Royal Decree 706/2017, of 7 July, passing supplementary technical instruction MI-IP 04 'Vehicle supply facilities' and regulating certain aspects of the regulation of oil facilities, updated the regulation on facilities to supply road fuel. The new regulation established a number of obligations for automatic PS. These included: the need to implement an emergency stop switch, which makes it possible to cut the power, monitoring with security cameras and connection to an alarm monitoring centre. Periodic inspections are carried out in order to detect leaks and additional requirements for service facilities that supply biofuels.

[22] Specifically, Navarre, Andalusia, Castile-La Mancha, Murcia, Valencian Community, Balearic Islands, Aragon, Canary Islands, Madrid, La Rioja, Extremadura, Castile and Leon, Asturias and Cantabria. Canary Islands, Castile and Leon, Asturias, Cantabria, Extremadura and Madrid also had regulations in the works.

In general terms, these obligations are in line with the proposal included in the CNMC report[23] on regulation of unmanned PS. As indicated in the report itself, there are alternative measures to the physical presence of an operator to monitor the existence of leaks and risks associated with the facilities, the correct handling of the fuel supply and ongoing maintenance of the facilities and their equipment.

Despite this, *Royal Decree 706/2017, of 7 July* introduced new restrictions on the activity of unmanned PS in relation to their supply. Specifically, the royal decree limits (i) the retail supply of gasoline and diesel in containers or receptacles to a maximum of 60 litres for petrol and 240 litres for diesel, and (ii) at unmanned facilities it limits supply to 75 litres and 3 minutes refuelling time. All in the interest of safety.

Furthermore, article 13.2 of the royal decree stipulates that:

> 'While petrol stations are operating as unmanned, they shall be connected to a company or outside control centre via a two-way communication system, from which the facility can be remotely monitored in a way that it makes possible to request assistance, transmit instructions, and deal with incidents and emergencies.
>
> The facility shall have a closed-circuit television (CCTV) with image recording and transmission, which makes it possible to see the operation from a remote control centre. There shall be an emergency stop switch. (…) Each unmanned point of supply shall have automatic fire detection and extinguishing equipment.'

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[23] CNMC (2016).

Consequences: The regulation limits the refuelling of lorries, vans and other large cars at automatic PS. Furthermore, it makes difficult to supply fuel for agricultural machinery at the PS of agri-food cooperatives. (According to the Agri-food Cooperative of Spain, 83% of the diesel supplied at PS of agri-food cooperatives consists of supplies in excess of 75 litres.)

With regard to closed-circuit CCTV and automatic fire detection and extinguishing equipment, the CNMC has declared itself to be in favour of the existence of remote safety systems (via closed-circuit), as well as fire detection systems. However, the specific details of the technical aspects of these requirements must reflect the principles of necessity and proportionality.

In fact, the current difficulty of the regulation appears to lie in establishing the specific details of the technical requirements to apply the above obligations. The Technical Guide for Practical Application of Supplementary Technical Instruction MI-IP on Vehicle Supply Facilities was published in January 2019. The guide requires staff of the owner of the unmanned facility to report to the service station quickly in response to any safety contingency, which may in practice lead to the companies needing to have quasi on-site service.

The Agri-food Cooperative of Spain (CAE) lodged an appeal against **Royal Decree 706/2017, of 7 July**, for including unjustified and disproportionate restrictions on cooperatives. Specifically, for limiting supply to 75 litres and 3 minutes refuelling time. However, the Supreme Court's ruling did not support the appellant's arguments.[24]

The judgement, basically, underlines that sufficient evidence was not presented to consider the restriction unjustified or disproportionate, despite the fact that it does mention that there may be other technical resources to guarantee safety. In particular, the judgement concludes the following:

> 'Comparative examination of the aforementioned expert reports leads us to conclude, firstly, that it must be considered fully justified that the regulation treats unmanned petrol stations differently to manned ones, as the absence of staff on-site makes it appropriate to adopt specific safety and preventive measures. However, there is a margin of technical assessment when it comes to specifying exactly what must constitute

[24] Judgement no. 35/2019 of 21st January.

these specific measures, with different solutions or alternatives therefore being conceivable, as well as their application to different degrees or in a modular manner.

For this reason, as we have already indicated, the plaintiff's dissenting position must be considered legitimate. However, the possibility that technical solutions other than those established in Royal Decree 706/2017 exist – of which the comparative jurisprudence offers various examples, to which mention is made in both the expert reports and the written pleadings of the parties – does not make it possible to state that the regulations established in the challenged Royal Decree are unjustified or disproportionate, in the absence of evidence that supports such elimination; and far less is it appropriate to state that the limitations established in the challenged statutory precepts are irrational or arbitrary.'

At the autonomous community level, the Valencian Community was the first to repeal the decision that required having staff attached to petrol stations,[25] echoing the recommendations included in the CNMC report.[26] The Valencian Community was followed by other autonomous communities, such as Castile and Leon[27] and the Basque Country.[28] The Basque decree, despite eliminating compulsory manned service, included new requirements, which could significantly restrict the activity of unmanned PS.

Article 25 of Decree 165/2018 of the Basque Country, of 20 November 2018, requires the temporary cessation of unmanned operation in the event of temperatures below -10 ºC or above 50 ºC, or average wind speeds at one-minute intervals above 18.9 km/h, to ensure that the automatic extinguishers in place at the station can function under optimal conditions in the event of fire. In the event of a weather incident, the unmanned PS will be able to switch to

25 Decree-Law 1/2018, of 2 February, of the Council, repealing additional provision two, on staff at establishments for retail distribution and sale of fuel, of Act 1/2011, of 22 March.

26 CNMC (2016): PRO/CNM/002/16 Proposal concerning the regulation of the automobile fuel distribution market through unmanned service stations.

27 Act 1/2018, of 20 April, amending Act 2/2015, of 4 March, passing the Consumer Statute of Castile and Leon.

28 Decree 165/2018, of 20 November, on requirements, which must be met by unmanned facilities for retail supply of fuel to vehicles.

manned operation, with the responsible government body being notified by email within no more than 24 hours.

Additionally, articles 13 and 14 of the Basque decree require automatic PS to have an immediate physical presence at the facilities at the request of emergency services or in the event of spill incidents.

<u>*Consequences:*</u> It should be noted that the regulation makes no exception with regard to the unmanned PS of agri-food cooperatives, many of which supply only agricultural diesel fuel (which is not flammable at room temperature, and therefore, the risk of fire is practically zero).

Furthermore, on 15th November 2018, the Basque Competition Authority published a *Report on the Decree on Requirements which must be met by Unmanned Vehicle Supply Facilities in the Basque Autonomous Community.*

This report quantified the impact of the proposed measures on wind speed could have on unmanned petrol stations. In particular, the report states: '*In a sampling of wind speed data for the year 2017 from several weather stations located on the coast, at elevation (more than 650 m above sea level) – both areas mentioned in article 26.3 – and in urban and rural environments, we find that an unmanned facility should have closed or provided service as a manned operation an average of 34 days/year – or 1 day out of every 11 – due to wind speeds in excess of 18.9 km/hour. These days are concentrated in January–March (65% of the total), but there are environments in which 18.9 km/h is exceeded practically every month – the least affected location is at 5 months. Therefore, there are locations at which the unmanned facilities would have exceeded, as an annual average, the established wind limit 1 day out of every 6 – and the least affected, 1 day out of every 33. For the January–March period, this becomes 1 day out of every 4 – and the least affected, 1 day out of every 13.*'

The Basque report does not analyse the temperature restriction imposed by the Basque decree, given the unusual occurrence of such temperatures in that autonomous community. However, it should be pointed out that the decree does not justify the choice of the aforementioned temperatures based on the principles of necessity and proportionality. Therefore, its choice appears arbitrary and may be unjustified.

With regard to the immediate presence of staff in the event of an emergency or incident, the obligation practically turns automatic PS into manned stations (the restriction thus being similar to that imposed by the Technical Guide for Application of the STI).

For its part, Castile-La Mancha published a draft decree, which would require all petrol stations to have bathrooms and staff to maintain them.[29] The CNMC recently reported on the draft decree,[30] giving an overall favourable assessment of the measures aimed at improving consumer and user protection, but pointing out the restrictive impact of some of its obligations, specifically those relating to bathrooms.

Consequences: It should be stressed that, in many occasions, unmanned PS are situated in locations distant from urban and rural population centres (the latter is particularly true in the case of the PS of agri-food cooperatives). Therefore, the regulation would require installing bathrooms at most of the unmanned PS, and the obligation to have an employee to monitor the cleanliness, sanitary condition and upkeep of the bathroom, significantly hindering the automatic model.

The CNMC has given its view on the matter in IPN/CNMC/026/18, a report which highlights that this requirement imposes a burden on operators and that it is therefore only justified if the mandatory necessity and proportionality analysis is met. On this matter, it should be remembered that the necessity test does not consist of judging the advisability of operators freely deciding on their business model, which is what the regulation appears to do on indicating that 'it has not been possible to determine any objective reason why the decision to have or not have bathroom facilities should be established as optional'. Rather, it involves evaluating whether there is an imperative reason of overriding public interest (IROPI) whose protection requires the burden imposed. Furthermore, the proportionality test requires evaluating the possible existence of less restrictive alternatives to achieve the said IROPI, such as the obligation for operators to have clearly visible information for users on the existence of toilets or bathrooms and adapted bathrooms.

The abovementioned draft decree for Castile-La Mancha established the obligation for unmanned PS to have remote assistance or on-site service, in the event that the previous was not effective.

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[29] https://www.castillalamancha.es/gobierno/sanidad/actuaciones/proyecto-de-decreto-de-los-derechos-de-las-personas-consumidoras-en-instalaciones-de-suministro

[30] CNMC (2018).

'During the portion of the opening hours when the facility is operating as unmanned, remote assistance must be guaranteed as needed by consumers in relation to refuelling and the payment process for the supply received. When the remote assistance is ineffective to properly resolve the incidents or emergencies that affect consumers during supply, even in the event that the cause is not attributable to the owner of the facility, the consumer must be provided with on-site service as soon as possible, with uninterrupted remote assistance being continued in the meantime.'

Consequences: As the CNMC has judged (CNMC (2018), this provision may lead to in-person, on-site service being required in situations in which it is not clear that this service is the most effective measure possible. For example, in the event of an emergency, a more effective measure than this obligation for on-site service may be the obligation to notify the public safety services (police, fire brigade, etc.). Furthermore, it should be taken into account that this obligation and the safety regulations are redundant, the latter being applicable to both manned and unmanned PS, guaranteeing an appropriate safety level at the facilities, and proper handling of incidents and emergencies.

III QUANTITATIVE ESTIMATE OF THE COMPETITIVE IMPACT OF THE ENTRY OF AUTOMATIC PS

This section studies the effects of the structural change in local competition associated with the entry of unmanned PS in the CAM, considering the price variation for the two most commonly used automobile fuels: regular diesel (GOA) and 95 gasoline (G95).

III.1 Literature review

The economic literature provides a wide variety of empirical studies on the automobile fuel retail market, which show, whether directly or indirectly, that restrictions on entry and operation tend to maintain the market position of vertically integrated operators and hinder the entry of new independent PS.

One of the lines of research about this industry focuses on studying events (*shocks*) – such as company mergers, reforms and different rules in different geographic areas – which make it possible to compare how prices change in response to regulatory intervention. Articles by Hastings (2004), Taylor and Hosken (2007) and Taylor et al. (2010) study price variation in retail fuel markets from different angles, with the common element being that they use the same estimation method: differences in differences (hereinafter, DID). According to Eckert (2011), these models generally detect small changes in the retail price as a response to shocks. The results range from 3.8% (Hastings, 2004) to 0.03% (Sen Choi and Lu, 2009).

The Johnson and Romeo study (2000) compares different U.S. states according to whether or not the establishment of self-service PS is prohibited.[31] The authors demonstrate that margins are higher in those states (Oregon: US$0.008 per litre and New Jersey: US$0.013 per litre) where operating self-service stations are prohibited, and they assert that prohibiting the entry of this type of station in the states of Oregon and New Jersey did not achieve the express objective of increasing protection for smaller stations.

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31 The authors use the term 'self-service gas station'.

The analysis by Cuadrado et al. (2018) on the performance of retail fuel distributors given their type of agreement with the supplier indicates that independent stations in Spain have smaller margins than branded ones. Furthermore, it indicates that following the reforms undertaken in this sector in 2012 and 2013 with the aim of introducing more competition, independent stations appear to have reduced their margins, while branded stations have increased them.

The number of competitors in local markets is crucial and can influence the price elasticity of demand, as Barron et al. point out (2008). Both the standard model of monopolistic competition (Perloff and Salop, 1985) and changes to that model conclude that a rise in the number of competitors increases the elasticity of demand and reduces margin and average price (Barron, Taylor and Umbeck, 2004).

However, the location of petrol stations and their surrounding area are major factors when it comes to studying competition in local markets. In the literature, distances between petrol stations are primarily measured in two ways: i) using Euclidean or aerial linear distances expressed in km, or ii) using isochrones that can quantify travel time in km or in minutes.

Firstly, Bernardo (2017) uses Euclidean distances of 1.6 km in industrial areas in the province of Barcelona to study the impact of RD 11/2013. The article indicates that because of the lifting of regulatory restrictions, the entry of new PS entails a 1.2% drop in pre-tax prices for diesel. The article also notes that the effect on prices is greater in the case of non-branded stations. Barron et al. (2004) apply a radial distance of 1 mile and conclude that a 50% increase in the PS within this distance reduces prices by between 0.3% and 0.6%. In another study on competition between PS in three American cities (2006), the same authors use distances of 2 miles. Kim and Kim (2010) set the relevant market at 1 km in Seoul, when estimating the effect of new entries of unmanned stations. They also distinguish between new automatic facilities and those, which switch from manned to unmanned, finding no differential in price effects.

Secondly, there is also substantial literature, which delimits the affected market using isochrones. The European Commission (EC) uses 2.5-km catchment areas within the city of Budapest, 5 km in the city's suburbs, and 20 km in rural areas in its decision M.7849-MOL/EniHungaria/Eni Slovenija; and 5-minute isochrones to establish the area of relevant competitive interactions in Case M.7603 Statoil Fuel and Retail/Dansk Fuels.

In line with earlier reports from the TDC (Tribunal for the Defence of Competition) and CNC (National Commission on Competition), the CNMC itself recently issued a report (C/0835/17) on the acquisition of petrol stations in Villanueva and Paz by CEPSA, where it applies 10-minute isochrones in urban areas and 20-minute isochrones on motorways. Furthermore, it is important to highlight that in preparing this study, we had additional information about the competitors considered by the PS themselves, which we may term as 'price markers', referring to those companies whose prices are taken into consideration ('monitored') when it comes to setting the prices of their rivals. Therefore, the choice of 10- and 20-minute isochrones was not random, but associated with expert conclusions taken from the available information as a whole. Another CNMC report (UM/070/15), on the denial of authorisation to establish a petrol station at a shopping centre in the municipality of Marratxí (Mallorca), likewise determined the relevant market using 10-minute isochrones.

For its part, the British competition authority, in its 2014 study on the Shell–Rontec merger, utilises highly valuable information on price markers used by the companies themselves when monitoring their rivals. The study cites the company Shell, which delimits its competitors within the United Kingdom using 10-, 20- or 30-minute isochrones. Additionally, the CMA applies 10-mile radiuses (linear distances) in urban areas and 20 miles in rural areas to delimit local markets for counting the number of competitors.

The Catalan Tribunal for the Defence of Competition (2008) applied isochrones of 6–7 minutes in urban areas and 12 minutes on motorways. In addition, of note is a recent article by Pedriguero and Borrell (2018), which proposes justifying the criterion applied to distances and puts the focus on estimating the distance, which determines the relevant market. The conclusions indicate that in the case of those PS located next to carriageways in Catalonia (excluding motorways, urban areas and cities) the relevant market is found between the 5- and 6-minute isochrones.

III.2 Estimation of the competitive impact

This section seeks to identify to what extent the entry of unmanned PS has a structural impact on prices at PS in the surrounding area.

The analysis focuses on the impact of unmanned PS in local environments, such that each entry of an automatic station is considered as a local shock[32] for the manned PS in its catchment area. The aim is to identify what impact each of the 69 PS has had on the manned PS in their surrounding area over a 5-year period, from mid-2011 to mid-2016.

The methodology applied is known as differences in differences (hereinafter, DID). It compares the variation of prices for those PS that have experienced a shock (treatment group) (comparing the prices before and after the shock), as well as comparing this variation with stations that have not experienced any shock (control group).

III.2.1 Methodology

Delimitation of the catchment area

Retail demand for fuel at petrol stations has the characteristics of being dispersed and atomised[33], and show a marked local component as consumers generally refuel their vehicles near their homes or working places. Automobile fuels are essentially homogeneous because their composition is highly standardised and there is no substitutability – in the short term – between different products (for example, gasoline and diesel).

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[32] In the literature, it is common practice to indicate a point in time that identifies the moment when a regulatory change or any other event (shock) changing the circumstances in a market occurs. See Bernardo (2017), OFT (2014), Hastings (2004) or Johnson and Romeo (2000).

In the case of the petrol stations in the Madrid region, as indicated in section II.2 above, until recently (RD 706/2017), there was no specific regulation either at the national or autonomous region level that offered direct and specific incentives for establishing unmanned stations, or any prohibitions. Royal Decree-Law 4/2013 may have had an indirect impact on the proliferation of unmanned PS, but its passage does not make it possible to draw a clear 'before' and 'after' for the analysis of unmanned PS.

[33] OECD (2013).

What is more, according to the precedents of competition[34], on the supply side there is in fact substitutability at a local level, as almost all PS have the same types of fuel.

Therefore, the main differentiating factor between PS is their location. In this, their proximity to population centres, hypermarkets, carriageways and highways plays a very important role. The additional services offered, such as convenience shops, restaurants or car washes, can also be important in differentiating PS.

Thus, price-setting mechanisms are highly local in nature. Determining this catchment area is crucial to the structure of this study, as it defines which stations are considered to be affected by the entry of an unmanned station and which are not.

In both the domestic[35] and international[36] literature, there is a great variety of definitions with regard to the distances, which can delimit the relevant market. Following the CNMC practice (2015 and 2017), here we opt for delimiting the relevant market around each petrol station using 10-minute isochrones[37, 38]. In this study it is equivalent to an average distance of 5.77 km on the ground or 3.76 km of aerial (Euclidean) distance between automatic stations and those manned stations whose competitors include at least one unmanned station (treatment group).

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[34] Among others, COMP/M.3291 – Preem / Skandinaviska Raffinaderi (2003).

[35] Pedriguero and Borrell (2018), Bernardo (2017).

[36] Barron (2004); Kim and Kim (2010), OFT (2014), European Commission Decision M.7849 (2016).

[37] An isochrone refers to the line that connects the points on a map, which can be reached in the same period starting at one point and with a given mode of transport.

[38] The following conditions were used in calculating the isochrones:

Departure time (departureTime): following day at 12:00

Traffic model used (trafficModel): bestguess. This indicates that the duration value shown must be the best calculation in terms of travel time based on what is known about past traffic conditions and real-time traffic. The closer the departureTime is to the present value, the more important real-time traffic will be.

Mode (TravelMode): using a vehicle [DRIVING]

avoidHighways: not indicated

avoidTolls: not indicated

Control group and treatment group

The starting point is to identify the manned PS affected by the entry of at least 1 of the 69 unmanned PS that began operating during the research period. One key aspect of constructing the model is that each station affected by the entry of an unmanned station is studied for one year: 26 weeks before and 26 weeks after this entry occurred.

First, the treatment group is defined. This includes all the PS that experienced the entry of an unmanned petrol station within a 10-minute isochrone. Taking into account that a manned station may be affected by the entry of different unmanned PS at different times, these are included in the treatment group if

a) the different entries occurred within the same week, or

b) in the event that the entries did not take place within the same week, the establishment can only form part of the treatment group if

b.1) there is at least a 52 weeks' difference between one entry and the next, or

b.2) only the first entry is considered if the second entry takes place between 27 and 52 weeks.

Using this procedure, we select 288 PS for GOA and 287 stations for G95[39] over the five years of the study. These were affected by the entry of unmanned PS, which are not uniformly distributed over time. Of this set of stations, 222 PS were affected by a single entry of an unmanned PS (in the case of G95, there is one fewer station, 221), 58 PS were affected by two entries and 8 PS by three. Given that each time a station is exposed to an entry by an unmanned station and fulfils the conditions described above, it is included in the treatment group. This way, the number of elements in the treatment group is greater than the number of affected PS: thus, we have a total of 362 elements in the treatment group for GOA and 361 elements for G95.[40]

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[39] The difference between diesel and G95 stations is due to the absence of G95 prices reported by petrol stations.

[40] GOA: 222 (affected by one entry) + 58 x 2 (two entries) + 8 x 3 (three entries).

G95: 221 (one entry) + 58 x 2 (two entries) + 8 x 3 (three entries).

Second, the control group is defined. This set is made up of those manned stations, which do not have any unmanned stations within a 10-minute isochrone. A station that does not have an unmanned station within its catchment area can be in the control group for up to 26 weeks before it experiences a shock (in the event that it does).

Lastly, once a station has been part of the treatment group, after the 52 weeks have elapsed, it is excluded from the sample and we stop monitoring its prices (unless there are new entries of unmanned stations in its surrounding area and it again becomes part of the treatment group, according to the criteria described above). The number of stations ultimately included in the control group is much higher than that of the treatment group. In the case of GOA it is 601 stations, and for G95 it is 597.

Petrol stations classified by operator

This study classifies petrol stations into three groups according to type of relationship with the wholesale operator that supplies the fuel. The first group (‘vertically integrated’) includes those PS, which belong to the retail distribution network of vertically integrated companies with refining capacity in Spain: Repsol, Cepsa and BP. The second group (‘other branded stations’) is made up of the branded stations of other wholesalers such as DISA, Esergui, ESSO, Fuel Iberia, GALP, Kuwait, Petroeuropa, Saras and Shell. And the third group (‘independents’) contains independent PS, which are those facilities that do not have exclusive purchase agreements and therefore, are establishments which adapt more freely and flexibly to changes in the local market.

The following table shows the number of petrol stations by type of operator that are included in the study in each of the groups: control and treatment. It should be noted that the distribution of stations by operator type is very similar in the two groups (see percentages in parentheses).

Table 6. Information about the number of PS in the sample by operator

Type of operator	Control group		Treatment group	
Vertically integrated	447	[71%]	224 (-1)*	[77%]
Other branded	120 (-2)*	[19%]	53 (-1)*	[18%]
Independent	66 (-3)*	[10%]	14 (+1)*	[5%]
Total number of stations**	633 (-5)*	[100%]	291 (-1)*	[100%]
Total number of stations without *'repeats'***	601 (-4)*		288 (-1)*	

Remarks: (*) The number of PS is different depending on the fuel due to unreported data. The difference between GOA and G95 is in parentheses.

(**) Considering that PS operators may change over the course of the period, the *real* number of PS in the control group is 601 (-4) and the number in the treatment group 288 (-1).

Base model: DID1

The object of the empirical analysis is to identify the impact of the entry of an unmanned petrol station (*shock*) on manned PS in its catchment area.

The DID methodology applied compares the variation – in this case – in pre-tax prices (hereinafter, PTP) at those PS that have experienced a shock (treatment group) before and after the same. It also contrasts this variation with that of PS, which have not experienced any shock (control group).

The DID1 base model takes the form of the following equation:

$$ln(ptp_{it}) = \alpha_0 + \sum_{i=1}^{618} \mu_i \cdot PS_i + \sum_{t=1}^{260} \lambda_t \cdot week_t + \beta \cdot DiD_{it} + \theta \cdot X_{it} + \varepsilon_{it}$$

The explained variable, $ln(ptp_{it})$, is the Napierian logarithm of the PTP of the fuels at the PS in the treatment group in week *t*. Two different estimations are made: one for GOA prices and another for G95 prices. The equation incorporates station specific and time specific fixed effects[41], μ_{i} and λ_{t}, respectively, which make it possible to control for unobservable.

The variable of interest is DiD_{it}, whose coefficient, β, provides information about the average percentage changes in prices if the station is affected by the entry of an unmanned petrol station in its local competitive environment.

X_{it} is a matrix with variables that can influence the behaviour of PS and which are related to the local competitive environment. These variables include the following characteristics:

i) type of operator (vertically integrated, other branded or independent);

ii) maximum number of independent and non-independent rivals for each service station within a 10-minute isochrone in each year;

iii) PS location, using the following binary dummy variables: if the station is located next to a carriageway or motorway, and if it is located in a large city, mid-sized city or small town;

iv) the complementary services offered by the PS (using binary dummy variables) such as car wash, water & air, shop and café; and lastly

v) annual electricity consumption (TWh) of the municipality, where the station is located, in order to proxy its economic activity.[42]

The estimates in this study consider the possibility of a serial correlation, which could lead to overestimating the standard errors of the estimators, giving rise to potential type 1 errors (false positives). In order to correct potential biases

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41 Using the DID methodology by definition introduces fixed effects. The assumption of a DID estimate is $[\ln(ptp_{i,t<shock})|\, i,t] = \mu_i + \lambda_t$, which means that in the absence of the shock (or before the shock), the fuel price is determined by means of the individual effect (and not variable over time) of each petrol station and the fixed effect of week *t*.

42 We considered including the variable of whether or not the petrol station was next to a supermarket. However, due to the limited number of observations with these characteristics for the PS in the treatment group, it was necessary to eliminate this variable.

deriving from serial correlation, the standard errors are clustered[43] according to the postcodes of the location of the PS in all estimations.[44]

In addition, to verify that the effect of the shocks on prices at the PS in the treatment group has been isolated from any other eventuality, parallel trends between price variations in the two groups are demonstrated for the period prior to the entry of the unmanned stations. Appendix II contains the analysis of the existence of parallel trends.

Model with interaction: DID_interaction

The database allows for differentiating the PS and identifying those that are independent and those that belong to the networks of vertically integrated operators or of other branded stations. In order to break down the average effect of the entry of unmanned PS on price formation of manned PS in its surrounding area (DID1 model), we defined the DID_interaction model. The hypothesis to be confirmed is firstly, whether independent PS have a more sensitive reaction to the entry of unmanned stations than vertically integrated and other branded stations. If so, independent PS's prices will be affected more (drop more) by the entry of an unmanned station than vertically integrated and other branded stations. Secondly, we seek to confirm the hypothesis that stations, which belong to the networks of vertically integrated companies, have less incentive to change their prices as a response to the entry of automatic stations.

In the DID_interaction model, an additional term is introduced in comparison with the DID1 model. This captures the interaction between the variable DID_{it} and the variables that reflect the operator type of the station affected by the entry. This structure allows for comparing the impact of the entry of unmanned stations on the average price at the affected manned stations of different operators (vertically integrated, other branded or independent). The three equations estimated are as follows:

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43 Clustering enables to neutralise the estimated errors mutually between the different PS. This gives clustered standard errors, which – as noted in Nichols et al. (2007) – converge to the true values of standard errors when the number of clusters tends to infinity.

44 According to Kézdi (2005), a sample with some 50 clusters of similar size is sufficiently large (sufficiently close to infinity) to obtain an accurate inference. This criterion is met in all the estimates carried out in this study.

Interaction with the variable [$Independent\ PS_{it}$]:

$$\ln(\mathrm{ptp_{it}}) = \alpha_0 + \sum_{i=1}^{618} \mu_{\mathrm{i}} \cdot SS_i + \sum_{t=1}^{260} \lambda_{\mathrm{t}} \cdot week_t + \beta \cdot DID_{it} + \gamma \cdot Independent_{it} + \delta \cdot DID_{\mathrm{it}} \cdot Independente_{it} + \theta \cdot X_{\mathrm{it}} + \varepsilon_{it}$$

Interaction with the variable [$Other\ branded\ PSs_{it}$]:

$$\ln(\mathrm{ptp_{it}}) = \alpha_0 + \sum_{i=1}^{618} \mu_{\mathrm{i}} \cdot SS_i + \sum_{t=1}^{260} \lambda_{\mathrm{t}} \cdot week_t + \beta \cdot DID_{it} + \gamma \cdot Branded_{it} + \delta \cdot DID_{\mathrm{it}} \cdot Branded_{it} + \theta \cdot X_{\mathrm{it}} + \varepsilon_{it}$$

Interaction with the variable [$Vertically\ integrated\ PSas_{it}$]:

$$\ln(\mathrm{ptp_{it}}) = \alpha_0 + \sum_{i=1}^{618} \mu_{\mathrm{i}} \cdot SS_i + \sum_{t=1}^{260} \lambda_{\mathrm{t}} \cdot week_t + \beta \cdot DID_{it} + \gamma \cdot Integrated_{it} + \delta \cdot DID_{\mathrm{it}} \cdot Integrated_{it} + \theta \cdot X_{\mathrm{it}} + \varepsilon_{it}$$

Based on the structure of an econometric model with interaction, the sum of the coefficients β and δ indicates the average differences in price between the different groups (by operator) in the treatment group and the petrol stations in the control group.

With the aim of verifying the proper selection of stations in both the control group and the treatment group,[45] an additional analysis is carried out for the selection of stations for the control group by using Propensity Score Matching (PSM). Appendix III shows its results.

[45] It is essential to include variables related to the local market in the *probit* estimate we use in the PSM. As detailed in Appendix III, we apply the following variables: i) number of rivals within a 3-minute isochrone, ii) annual electricity consumption in each municipality, iii) size of the city or town, and iv) whether the station is next to a carriageway or motorway. With these variables, we select a 'custom match' for each affected station so that the distribution of the aforementioned variables is balanced between the two groups (treatment and control).

Next, the DID_interaction econometric model is re-estimated for the two different groups, before and after the PSM selection. The results obtained are very similar, indicating the validity of the DID_interaction econometric model.

DID_switch model comparing the impact of new unmanned PS versus converted stations

The data on unmanned PS included enables to identify, one, those which operated as unmanned from the very start of their operations (which we shall call *new*) and two, those which were originally manned and were converted into unmanned *a posteriori*. This information allows us to confirm the hypothesis that new unmanned stations exert more competitive pressure on other PS than converted ones.

For practical purposes, both the DID1 base model and the interaction model are run by dividing the set of observations of the treatment group into, one, those establishments, which are affected by the entry of new unmanned petrol stations and two, those affected by a converted unmanned petrol station. This makes it possible to estimate the two effects at the same time using the same control group. Table 7 below provides information about the number of PS affected by new and converted unmanned stations.

Table 7. Information on the number of PS affected by new and/or converted unmanned PS

Status of unmanned PS	# of affected (manned) PS in the treatment group
New	101 (-2)*
Converted	185 (+1)*
New & Converted **	2
Total	**288 (-1)***

Remarks: (*) The number of PS is different in the estimates for PTP_GOA and PTP_G95 due to the lack of reported data. The difference between the two fuel types (GOA-G95) is shown in parentheses.
(**) When creating the treatment and control groups, a station can be affected by more than one unmanned station on more than one occasion according to the criteria described in the former chapter.

III.2.2 Sources and description of the data in the sample

This study is fed by data from three sources. First, the Information System for Petroleum Product Supply Activities (hereinafter SIAS) provided individual data on prices and retail quantities for GOA and G95 fuels at each petrol station. It also provided information about the individual characteristics and geographic coordinates of the stations. SIAS is a replica of the MITECO database, whose technical terms are defined in Order ITC/2308/2007.[46,47]

Second, the CAM DG for Industry, Energy and Mines – at the request of the CNMC – provided information on unmanned PS and on the dates as of which they operate as unmanned, also indicating whether the PS were new facilities or converted ones.

Third, the Municipal and Area Databank (ALMUDENA) of the CAM Institute of Statistics was used for numerous variables, including population and electricity consumption for each municipality in this autonomous community.

[46] Order ITC/2308/2007, of 25 July, determining the method of reporting information to the Ministry for the Ecological Transition (MITECO) about activities involving the supply of petroleum products.

[47] The SIAS database also supports the daily fuel prices published online for Spain on a geoportal (http://geoportalgasolineras.es).

Taking into account the geographic location of the 708 stations in the CAM, which were active during the study period, by using the Google API a distance matrix was calculated between all of them.

The following table shows the descriptive statistics for the variables used in the models. The number of observations for GOA and G95 differ slightly due to the lack of data reported by the stations. Taking into account that the differences are small, Table 8 shows the descriptive variables for GOA.

Table 8. Descriptive statistics of the sample

	Obs.	Mean	SD	Min	Max
Pre-tax price G95	113.081	0,68265	0,09160	0,37714	0,86600
Pre-tax price GOA (diesel)	113.844	0,71295	0,10718	0,32700	0,88617
Independent PS	113.844	0,06250	0,24206	0	1
Other branded PS	113.844	0,18442	0,38783	0	1
Vertically integrated PS	113.844	0,75308	0,43122	0	1
Large cities (>150K inhab.)	113.844	0,43387	0,49561	0	1
Mid-sized cities (>=15K inhab. & <=150K inhab.)	113.844	0,37384	0,48383	0	1
Small towns (<15K inhab.)	113.844	0,19229	0,39410	0	1
Carriageway / Motorways	113.844	0,30504	0,46043	0	1
Car Wash	113.844	0,52187	0,49952	0	1
Water & Air	113.844	0,62854	0,48320	0	1
Shop	113.844	0,67162	0,46963	0	1
Coffee shop	113.844	0,17081	0,37635	0	1
# rivals within 3-minute isochrone	113.844	0,72714	1,04480	0	6
# independent rivals within 3-minute isochrone	113.844	0,07155	0,28528	0	3
# non-independent rivals within 3-minute isochrone	113.844	0,65558	0,98470	0	6
# rivals within 10-minute isochrone	113.844	18,25138	13,85455	0	77
# independent rivals within 10-minute isochrone	113.844	1,86970	2,58433	0	20
# non-independent rivals within 10-minute isochrone	113.844	16,38168	12,50500	0	66
Municipal annual electricity consumption, TWh	113.844	4, 088187	5,86842	0,0005	13,8619

III.2.3 Results of the empirical analysis

The average difference between the prices at those manned stations, which were affected by the entry of at least one unmanned station in their local area during the five-year period analysed (between mid-2011 and mid-2016), and the remaining manned PS was estimated in model DID1[48]. Table 9 below shows the results:

[48] One variant of the DID1 model is DID0, where the only explanatory variable is DID1 showing whether the manned station is in the treatment group or in the control group. This way, DID0 omits all the rest of the explanatory variables included in DID1. The results for DID0 are included in Table 9 for reference.

Table 9. Results for the DID1 model [period: 2011w27 – 2016w26]

Explained variables: ln(PTP_GOA) // ln(PTP_G95)	DID0_GOA	DID1_GOA	DID0_G95	DID1_G95
DID1	-0,0063 *** [0.0014]	-0,0048 *** [0.0013]	-0,0033 *** [0.0012]	-0,0021 * [0.0012]
Independent PS		-0,0364 *** [0.0068]		-0,0252 *** [0.0053]
Other branded PS		-0.0007 [0.0082]		0,0011 [0.0061]
# independent rivals within 10 min		-0,0038 *** [0.0010]		-0,0029 *** [0.0008]
# non-independent rivals within 10 min		0.0005 [0.0012]		0,0004 [0.0010]
Mid-sized cities (>=15K inhab. & <=150K inhab.)		-0,0792 ** [0.0310]		-0,0435 * [0.0248]
Small towns (<15K inhab.)		-0,0889 *** [0.0319]		-0,0446 * [0.0258]
Carriageway / Motorway		0,0101 *** [0.0026]		0,0085 *** [0.0022]
Car Wash		0.0036 [0.0056]		0,0011 [0.0050]
Water & Air		-0.0009 [0.0069]		-0,0052 [0.0053]
Shop		-0.0057 [0.0076]		0,0009 [0.0062]
Coffee shop		-0,0210 ** [0.0086]		-0,0095 [0.0066]
Municipal annual electricity consumption, TWh		-0,0076 *** [0.0025]		-0,0039 ** [0.0020]
Constant	-0,6379 *** [0.0022]	-0,5440 *** [0.0307]	-0,6997 *** [0.0029]	-0,6276 *** [0.0367]
N	113.844	113.844	113.081	113.081
R2	0.9867	0.9876	0,9848	0,9855

Remarks: 1) * p<0.1; ** p<0.05; *** p<0.01;
2) Standard error in parentheses; 3) Errors clustered by postcode;
4) Fixed effects of PS & weeks.

The main result of the analysis is that **the entry of an unmanned petrol station produces a reduction of the pre-tax prices at the stations in its catchment area**. On average, **this competitive impact is around 0.48%** (0.32 €cts/lt) **for GOA and 0.21%** (0.13 €cts/lt) **for G95** (DID1 model, 'DID1' variable).

The model predicts that **independent stations apply prices for GOA and G95 that are 3.64%** (2.04 €cts/lt) **and 2.52%** (1.46 €cts/lt) **lower, respectively, than vertically integrated stations**; while there is no difference between the price level at vertically integrated and other branded petrol stations.

The estimates produce values in line with the papers cited from the relevant literature with regard to the effect of the structural variables. Specifically, fuel prices appear to be higher next to carriageways and motorways, while each independent rival in the local area implies a reduction in prices (GOA by 0.38% and G95 by 0.29%).

The analysis using the DID_interaction model also shows that the effect is different depending on whether the affected station is independent, branded or vertically integrated. In particular, in response to the entry of an unmanned PS in the surrounding area, **independent PS reduce their prices by 2.16% for GOA and 1.80% for G95**. For their part, **branded and vertically integrated PS reduce their prices by 1.15% and 0.26%**, respectively, **for GOA, and 0.79% and zero,**[49] respectively, **for G95**. This result supports the thesis that independent PS have more freedom and flexibility to adapt their prices to market determinants than do branded and vertically integrated PS. Additionally, it is this last group, vertically integrated PS, which react the least to the presence of unmanned stations. Table 10 below summarises the results for the DID_interaction model (more details in Appendix IV) in comparison with those of the DID1 model described above.

[49] The coefficient associated with this variable is not statistically significant.

Table 10. Summary of results for the DID1 and DID_interaction models

Models		**GOA**	**G95**
DID1	Average effect on the group of affected manned PS compared to unaffected PS (controls)	-0,48% ***	-0,21% ***
DID_interaction	i) Effect on affected and independent PS compared to unaffected PS (controls)	-2,16% ***	-1,80% **
	ii) Effect on affected and other branded PS compared to unaffected PS (controls)	-1,15% ***	-0,79% ***
	iii) Effect on affected and vertically integrated PS compared to unaffected PS (controls)	-0,26% *	0,00% n.s.

Remarks: (1) * p<0.1; ** p<0.05; ***p<0.01; (2) Errors clustered by postcode;
(3) Fixed effects for PS and for weeks; and
(4) In the case of regressions with interaction, the standard errors are calculated separately.

Furthermore, now focusing our attention on the different types of unmanned stations, new or converted, it can be concluded – in line with expectations – that **new unmanned stations exert greater competitive pressure on prices in their catchment area than do converted ones**. Table 11 summarises the results for the DID_switch model (see details in Appendix V). The table shows that new stations trigger bigger price reductions in all scenarios, except in the case of manned and vertically integrated PS. Specifically, **new unmanned stations cause an average reduction of 0.82% and 0.52% in prices for GOA and G95**, respectively, at the PS affected by their entry. Breaking down this average effect, we can see that manned and independent PS are those that most reduce their prices (for GOA by 3.5% and for G95 by 2.93%), compared to the reduction at branded stations (for GOA by 2.1% and for G95 by 1.63%).

Table 11. Summary of results for the DID_switch model

Original models		GOA		G95	
		NEW	CONV.	NEW	CONV.
DID1	Average effect on the group of affected manned PS compared to unaffected PS (controls)	-0,82% ***	-0,28% **	-0,52% **	0,00% n.s.
DID_interaction	i) Effect on affected and independent PS compared to unaffected PS	-3,50% ***	1,16% *	-2,93% ***	0,00% n.s.
	ii) Effect on affected and other branded PS compared to unaffected PS	-2,10% ***	-0,30% *	-1,63% ***	0,00% n.s.
	iii) Effect on affected and vertically integrated PS compared to unaffected PS	0,00% n.s.	-0,30% **	0,00% n.s.	0,00% n.s.

Remarks: (1) * p<0.1; ** p<0.05; ***p<0.01; (2) Errors clustered by postcode;
(3) Fixed effects for PS and for weeks; and
(4) In the case of regressions with interaction, the standard errors are calculated separately.

III.2.4 Consumer savings due to introducing competition through the entry of unmanned PS in the CAM

Consumer savings on GOA and G95 fuels in the CAM are calculated by using the results obtained in the econometric analysis (performed on a selection of PS), extending them to all PS that experienced the entry of at least one unmanned station within a 10-minute isochrone between week 27 of 2011 and week 26 of 2016. Thus, by applying the estimated average difference in prices between the manned PS affected and those not affected, we find the gains in terms of consumer wellbeing in the CAM attributed to the increase in competitive pressure, which the affected PS would perceived by the entry of unmanned stations.

After selecting all the PS affected by an unmanned station in the CAM during the research period, individual turnover[50] is obtained for each one in the year

[50] Individual turnover is obtained by multiplying average annual prices by the quantities of each motor fuel sold annually and reported by the petrol stations. During the period covered by the study, reporting the quantities of fuel sold was not compulsory, which is why in the case of

following said entry (shock). Next, it is determined individually for each station what the level of their turnover would have been in the absence of the unmanned stations; this enables us to calculate the gains in consumer wellbeing using the difference between actual and hypothetical turnover.

Table 12. Consumer savings on GOA and G95 in the CAM between 2012 and 2016

	GOA	G95	TOTAL
1. All affected PS within 10-min isochrone			
Estimated difference between prices at affected PS vs. control PS (unaffected), %	-0.48%	-0.21%	
Savings, million €	**13.715**	**2.149**	**15.864**
2. TOTAL SAVINGS considering the type of operator, million €	**20.782**	**4.1**	**24.882**
2.a Affected & independent PS			
Estimated difference between prices at affected PS vs. control PS (unaffected), %	-2.16%	-1.80%	
Savings, million €	**10.858**	**3.474**	**14.332**
2.b Affected & other branded PS			
Estimated difference between prices at affected PS vs. control PS (unaffected), %	-1.15%	-0.79%	
Savings, million €	**4.889**	**0.626**	**5.515**
2.c Affected & vertically integrated PS			
Estimated difference between prices at affected PS vs. control PS (unaffected), %	-0.26%	0.00%	
Savings, million €	**5.035**	**0.000**	**5.035**

diesel it is only possible to obtain between 70% and 78% of total annual sales in the CAM, while in the case of G95, it is possible to identify between 90% and 98% of total sales.

The calculations presented here are conservative in that they are based solely on the data available to the Department for Promotion of Competition. Therefore, no additional cases have been used to fill out the missing data. Consequently, the savings calculated represent minimum levels, which may be higher in reality.

Taking into account that on average the affected PS had prices 0.48% and 0.21% lower for GOA and G95, respectively, than the PS without competition from unmanned stations, consumer savings were 15.86 million euros between 2012 and 2016, as shown in Table 12. Furthermore, considering the breakdown of the average effect according to the operator type of the affected stations (independent, other branded and vertically integrated) we find a total saving of 24.88 million euros. These calculations represent a cautious and conservative approximation of the gains in consumers` welfare, which – in any event – under-estimate actual savings because they consider the prices only during the year following the shock, and they are based solely on the data reported, without filling out any missing ones.

IV CONCLUSIONS

The study performed analyses the impact on competition of the entry of unmanned petrol stations, focusing on automobile fuel prices. The study was performed on the database of the petrol station network in the CAM during a five-year period between 2011 and 2016. Beyond the precise numerical results for the CAM and the period investigated, the study conclusions confirm that unmanned stations are an important element driving competition in the marketplace, and that they make a positive contribution for consumers by keeping automobile fuel prices down.

Unmanned petrol stations tend to be less expensive than traditional stations, so that they create new demand and attract consumers from other petrol stations in the surrounding area. This effect is especially keen when the comparison is made between unmanned stations of independent operators and manned stations of vertically integrated operators, a situation in which the biggest differences are as much as 16.9% for GOA and 12.3% for G95. Consumers, who visit unmanned stations, fill their tanks at lower prices, entailing a net gain in wellbeing.

Furthermore, unmanned petrol stations increase the competitive pressure on stations in the local area, indirectly benefitting the consumers who visit them (spillover effect).

The study analyses this second category of effects in detail and obtains interesting results regarding the competitive dynamics of the markets.

Firstly, consumers who visit a manned petrol station benefit from lower prices, when an unmanned petrol station opens in the catchment area. Thus, on average, prices at manned stations during the period analysed dropped by around 0.5% for GOA and 0.21% for G95.

Secondly, petrol stations operated by independents react more to price competition from unmanned stations. At the opposite extreme, the petrol stations of vertically integrated operators (Repsol, Cepsa, BP) react less to the entry of an unmanned station in their surrounding area. It is possible that these operators, whose petrol station networks are much more established and larger than the rest, are less affected by competition from cheaper rivals. The presence of reputation effects, brand loyalty or loyalty systems (cards, etc.) can explain part of this effect. The existence of pricing strategies, at the wholesale or retail level, for territorial areas larger than the local can also explain the greater rigidity in terms of lowering prices for this type of operator.

Thirdly, independent operators are one of the main sources of competition in local markets. The more rival independent operators a petrol station has, the lower its prices are.

Lastly, the analysis performed allows for calculating the potential savings due to the entry of an unmanned station in the 10 minute-isochrone catchment area around all manned petrol stations in the region of Madrid between 2012 and 2016: this saving equals to 15 and 24 million euros.

Faced with this evidence, the situation of unmanned petrol stations in Spain is striking. Spain is among the European Union countries with the lowest penetration of this type of petrol stations, which in 2014 only represented 5% of the total (compared to almost 9% in France, 19% in Belgium, 24% in the Netherlands, 61% in Sweden and 66% in Denmark). Currently, it is around 9%. As we can see for the CAM, the 2013 regulatory reform, which facilitated the opening of petrol stations in shopping centres and industrial estates, seems to have boosted the number of petrol stations in this type of location.

However, current regulations are restrictive with this category of petrol station in Spain. Since 2016, there have been amendments to national regulations and those in certain autonomous communities, which have reduced some barriers to competition, but they have introduced others.

Thus, the new national regulations have set limits on refuelling of lorries, vans and other large cars at unmanned PS, hindered the supply of fuel for agricultural machinery at the PS of agri-food cooperatives, and strengthened the requirements with regard to safety contingencies.

Autonomous community regulations have seen disparate development. The Valencian Community and Basque Country eliminated regulations, which prohibited unmanned service. However, the Basque Country introduced new requirements, which could *de facto* restrict the activity of unmanned PS.

Based on all of the foregoing, it is the opinion of the CNMC that it remains advisable to conduct an in-depth review of regulations concerning unmanned petrol stations, under the principles of necessity and proportionality, in order to foster the level of effective competition in the marketplace, to the benefit of consumers and users.

V RECOMMENDATIONS

One. Review state metrology regulations

We recommend reviewing the obligations contained in Royal Decree 706/2017, of 7 July, passing supplementary technical instruction MI-IP 04 'Vehicle supply facilities' and regulating certain aspects of the regulation of oil facilities, with regard to the limits on refuelling of lorries, vans and other large cars at unmanned PS, as they may hinder the growth of unmanned PS.

We also recommend reviewing the Technical Guide for Practical Application of Supplementary Technical Instruction MI-IP on Vehicle Supply Facilities, as it establishes requirements for action in the event of safety contingencies, which may hinder the operation of unmanned PS in an unnecessary and disproportionate manner.

Two. Introduce reporting of manned or unmanned status for petrol stations to MITECO

We consider it advisable to amend the content of Appendix IV to Order ITC/2308/2007, with the aim of incorporating whether petrol stations are unmanned, self-service or manned into the census information, which owners and/or managers of supply facilities must report to MITECO, as well as the hours of operation for the different categories.

Three. Review and achieve greater uniformity in autonomous community regulations governing unmanned petrol stations

We recommend completing the process of reviewing autonomous community regulations to eliminate all prohibitions on the operation of unmanned PS or obligations, which is impossible for this format to fulfil.

Additionally, we recommend conducting an exhaustive review of the necessity and proportionality of the different technical restrictions, which have been included in autonomous community regulations, including the requirement to close facilities for safety reasons.

In this process, it would be highly desirable for the government and the autonomous communities to make use of existing channels of communication and collaboration to reduce the existing regulatory disparity between territories.

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APPENDIX I. DATA RELATED TO THE RETAIL FUEL DISTRIBUTION MARKET

Table 13. Retail sale of main fuels in Spain and the CAM, 2011–2017 [thousand tonnes]

year	GOA		RED		G95		P98		BIODIESEL	
	SP	CAM	SP	CAM	SP	CAM	SP	CAM	SP	CAM
2011	22,432	2,102	5,047	188	4,844	558	448	38	181	33
2012	21,040	2,116	3,812	137	4,545	545	359	31	156	34
2013	20,333	2,120	3,658	126	4,315	521	314	26	31	2
2014	20,798	2,150	3,594	107	4,286	513	315	26	22	1
2015	21,640	2,193	3,754	115	4,289	514	342	30	17	0
2016	22,116	2,217	3,861	160	4,341	519	376	32	18	0
2017	23,007	2,226	4,145	174	4,471	533	387	33	23	0

Source: Compiled by authors from CNMC data

Remarks: The consumption in this table reflects total sales for the domestic market through the three distribution channels (PS, out-of-network channels: distributors & direct consumers).

APPENDIX II. PARALLEL TREND IN PRICE VARIATION IN THE TREATMENT AND CONTROL GROUP BEFORE THE SHOCKS

The verification of the parallel trend focuses on studying the variation in fuel prices during the period immediately preceding the shock that each petrol station experiences with the entry of rival unmanned stations. Confirming that prices at PS in the treatment group and in the control group showed a similar variation before the shock demonstrates the validity of the DID1 model.

We estimate[51] the following PRE_DID1 model, which differs from the DID1 model in two aspects: 1) the variable DiD_{it} is replaced by the variable PRE_DiD_{it}; and 2) the estimate is only made for the period prior to the shock (26 weeks in each case).

$$ln(ptp_{it}) = \alpha_0 + \sum_{i=1}^{618} \mu_i \cdot SS_i + \sum_{t=1}^{260} \lambda_t \cdot week_t + \beta \cdot PRE\_DiD_{it} + \theta \cdot X_{it} + \varepsilon_{it}$$

Here the only new variable is PRE_DiD_{it}, which is equal to 1 for 26 weeks prior to a station experiencing the shock (entry of an unmanned station within a 10-minute isochrone). It is equal to zero in the event the station is part of the control group.

The following table shows the results for the PRE_DID1 model, where β is not significantly different from zero. Therefore, the prices at treatment and control stations are not distinguishable. At the same time, we can see that the rest of the coefficients have values very similar to those estimated in the DID1 model. These results enables us to conclude that prices at stations in the treatment group had

[51] This exercise is similar to that which Ashenfelter et al. (2013) apply to validate their comparative groups in the analysis of the Maytag–Whirlpool merger in the household appliance industry. The authors estimate a parameter for the '*treatment*' variable for each month of the analysis and demonstrate that the treatment variable in the period prior to the merger is equal to zero. In the present study, we estimate a single coefficient for '*treatment*', because we are looking for the average effect of the entry of automatic stations.

been evolving in the same way as those at control stations while no rival unmanned stations entered their catchment area.[52,53]

[52] The graphic representation, frequently used in the literature (e.g. OFT, 2014; Ashenfelter et al., 2013), cannot be reproduced due to the structure of the data and the changing number of observations.

[53] DG COMP (2015): ‘Expost analysis of two mobile telecom mergers: T-Mobile/tele.ring in Austria and T-Mobile/Orange in the Netherlands’.

Table 14. Results for the PRE-DID1 model

Results to verify the parallel trend **GOA** & G95, 2011w27–2016w26				
Explained Variables: **ln(PTP$_{_GOA}$) // ln(PTP$_{_G95}$)**	**PRE_DID1 GOA**		**PRE_DID1 G95**	
PRE_DID1	-0.0029 [0.0019]		-0.0016 [0.0014]	
Independent PS	-0.3520 [0.0067]	***	-0.0240 [0.0052]	***
Other branded PS	0.0030 [0.0070]		0.0043 [0.0055]	
# independent rivals within 10 min	-0.0037 [0.0011]	***	-0.0028 [0.0009]	***
# non-independent rivals within 10 min	0.0005 [0.0012]		0.0004 [0.0010]	
Mid-sized cities (>=15K inhab. & <=150K inhab.)	-0.0718 [0.0331]	**	-0.0353 [0.0273]	
Small towns (<15K inhab.)	-0.0816 [0.0345]	**	-0.0370 [0.0288]	
Carriageway / Motorway	0.0101 [0.0028]	***	0.0087 [0.0024]	***
Car Wash	0.0041 [0.0060]		0.0008 [0.0055]	
Water & Air	-0.0010 [0.0071]		-0.0059 [0.0056]	
Shop	-0.0056 [0.0083]		0.0016 [0.0068]	
Coffee shop	-0.0226 [0.0089]	**	-0.0102 [0.0069]	
Municipal annual electricity consumption, TWh	-0.0071 [0.0027]	***	-0.0034 [0.0022]	
Constant	-0.7201 [0.0449]	***	-0.5747 [0.0256]	***
N	104,354		103,636	
R2	0.9876		0.9854	

Remarks: 1) * p<0.1; ** p<0.05; *** p<0.01;
2) Standard error in parentheses; 3) Errors clustered by postcode;
4) Fixed effects of PS & weeks.

APPENDIX III. SELECTION OF UNITS USING PSM AND VERIFICATION OF THE INTERACTION MODELS FOR LIMITED PERIODS

The Propensity Score Matching methodology (hereinafter, PSM), introduced by Rosenbaum and Rubin (1983), is used to balance the distribution of the descriptive variables (covariates) observed in the treatment group and control group in order to find the most similar pair to each treatment unit among the control units (peers). This selection makes it possible to obtain a set of homogeneous observations in terms of the variables selected (X_i). The key to the PSM method is to calculate the probability of belonging to the treated group, which is formally written as:

$$p(X_i) \equiv \Pr(Tr_i = 1|X_i) \equiv F(X_i'\beta) \quad ,$$

where $[p(X_i)]$ is the score for each observation unit (i), which indicates the probability of being in the treatment group (Tr_i) taking into account the observable variables, X_i. If the treatment group and the control group have the same distribution as their PSM scores, then the distribution of the covariates observed is also the same, as in the case of random experiments.

To perform the PSM, we used STATA (*teffects psmatch*), requiring a probit estimate with repetition looking for the station with the closest score (Next Neighbour 1). The week selected was week 14 of 2014, when there are 114 stations in the treatment group for GOA (one fewer observation for G95), compared to 273 (5 fewer observations for G95) stations in the control group.

The descriptive variables on matrix (X_i) are the following: i) number of rivals within a 3-minute isochrone, ii) annual electricity consumption in each municipality, iii) size of the city or town, and iv) whether the station is next to a carriageway or motorway. Using these descriptive variables, 114 and 113 stations, which best matched the PS in the treatment group were selected from the control group for GOA and G95, respectively.

Table 15. Standardised differences and variance ratio of the groups before and after PSM

	GOA		G95	
Week selected:	2014w14		2014w14	
	Raw	**Matched**	**Raw**	**Matched**
# PS in treatment gr.	114	114	113	113
# PS in control gr.	273	114	268	113
Standardised differences				
# rivals within 3 min	0.2242	0.0000	0.2034	4.19E-17
Electricity consumption	0.0302	0.0007	0.0175	0.0007
Small town	-0.6135	0.0000	-0.6395	3.36E-17
Carriageway / Motorway	-0.2455	0.0000	-0.2966	6.66E-17
Variance ratio				
# rivals within 3 min	1.9626	1.0000	1.6315	1.0000
Electricity consumption	1.0027	0.9991	0.9871	0.9991
Small town	0.2232	1.0000	0.2183	1.0000
Carriageway / Motorway	0.8007	1.0000	0.7568	1.0000

The validity of the selection is measured using differences in the means and variance ratio before and after the selection reported above. It is expected that following the PSM, the standardised differences should be close to zero and the variance ratio to one. As Table 15 shows, this is fulfilled in all the cases presented.

Table 16. Summary of results for the DID_interaction model estimate with and without PSM

Week selected: 2014w14	**GOA**		**G95**	
Period compared: 2014w16–2015w15	**without PSM**	**with PSM**	**without PSM**	**with PSM**
i) Effect on affected and independent PS compared to control PS	-0.0074 ***	-0.004 **	-0.0022 n.s.	0.0000 n.s.
ii) Effect on affected and other branded PS compared to control PS	-0.0048 n.s.	-0.0048 n.s.	-0.0022 n.s.	-0.0033 n.s.
ii) Effect on affected and vertically integrated PS compared to control PS	0.037 ***	0.0039 ***	0.0023 n.s.	0.0009 n.s.

Remarks: n.s. = the coefficient is not significantly different from zero

After applying PSM, the DID_interaction model is estimated only for the 52-week period (2014w16–2015w15). Table 16 shows the results, which, despite reducing the number of observations by 70% (GOA from 19,185 to 5,832 observations, and G95 from 19,026 to 5,735 observations), are similar in the case of GOA for independent and vertically integrated stations, which validates the specification of the DID_interaction model. For a complete validation, PSM could be performed for each entry of an unmanned station. However, we consider this exercise to be a satisfactory justification as it incorporates a high number of affected PS.

APPENDIX IV. DETAILED RESULTS FOR THE DID_INTERACTION MODELS

Results for the DID_interaction model: GOA, period: 2011w27–2016w26

Variables explained: ln(PTP_B7) // ln(PTP_P95)	**Affected & independent PS**	**Affected & other branded PS**	**Affected & vertically integrated PS**
1.DID	-0.0043 *** [0.0014]	-0.0033 ** [0.0013]	-0.0127 *** [0.0027]
1. Independent PS	-0.0344 *** [0.0069]		
1. DID # 1. Independent PS	-0.0172 *** [0.0083]		
1. Other branded PS		-0.0003 [0.0080]	
1. DID # 1. Other branded PS		-0.0083 *** [0.0030]	
1. Vertically integrated PS			0.0002 [0.0079]
1. DID # 1. Vertically integrated PS			0.0102 *** [0.0028]
Independent PS		-0.0365 *** [0.0068]	-0.0351 *** [0.0099]
Other branded PS	-0.0006 [0.0082]		
# independent rivals within 10 min	-0.0038 *** [0.0010]	-0.0038 *** [0.0010]	-0.0038 *** [0.0010]
# non-independent rivals within 10 min	0.0005 [0.0012]	0.0006 [0.0012]	0.0006 [0.0012]
Mid-sized cities (>=15K inhab. & <=150K inhab.)	-0.0796 ** [0.0310]	-0.0783 ** [0.0309]	-0.0784 ** [0.0309]
Small towns (<15K inhab.)	-0.0894 *** [0.0320]	-0.0881 *** [0.0319]	-0.0883 *** [0.0319]
Carriageway / Motorway	0.0102 *** [0.0026]	0.0100 *** [0.0026]	0.0100 *** [0.0026]
Car Wash	0.0033 [0.0054]	0.0038 [0.0056]	0.0036 [0.0055]
Water & Air	-0.0009 [0.0069]	-0.0009 [0.0069]	-0.0009 [0.0069]
Shop	-0.0055 [0.0077]	-0.0058 [0.0076]	-0.0057 [0.0076]
Coffee shop	-0.0202 ** [0.0083]	-0.0211 ** [0.0087]	-0.0207 ** [0.0085]
Municipal annual electricity consumption, TWh	-0.0077 *** [0.0025]	-0.0076 *** [0.0025]	-0.0076 *** [0.0025]
Constant	-0.6808 *** [0.0379]	-0.6806 *** [0.0379]	-0.6819 *** [0.0381]
N	113,844	113,844	113,844
R2	0.9876	0.9876	0.9876

Remarks: 1) * p<0.1; ** p<0.05; *** p<0.01;
2) Standard errors in parentheses; 3) Errors clustered by postcode;
4) Fixed effects of PS & weeks.

Results for the DID_interaction model: G95, period: 2011w27–2016w26

Explained Variables: ln(PTP_GOA) // ln(PTP_P95)	**Affected & independent PS**	**Affected & other branded PS**	**Affected & vertically integrated PS**
1.DID	-0.0017 [0.0012]	-0.0008 [0.0012]	-0.0092 *** [0.0027]
1. Independent PS	-0.0233 *** [0.0053]		
1. DID # 1. Independent PS	-0.0164 ** [0.0076]		
1. Other branded PS		0.0014 [0.0059]	
1. DID # 1. Other branded PS		-0.0071 ** [0.0030]	
1. Vertically integrated PS			-0.0016 [0.0059]
1. DID # 1. Vertically integrated PS			0.009 *** [0.0028]
Independent PS		-0.0253 *** [0.0053]	-0.0258 *** [0.0072]
Other branded PS	0.0013 [0.0061]		
# independent rivals within 10 min	-0.0029 *** [0.0008]	-0.0029 *** [0.0008]	-0.0029 *** [0.0008]
# non-independent rivals within 10 min	0.0003 [0.0010]	0.0004 [0.0010]	0.0004 [0.0010]
Mid-sized cities (>=15K inhab. & <=150K inhab.)	-0.0439 * [0.0248]	-0.0426 * [0.0248]	-0.0426* * [0.0247]
Small towns (<15K inhab.)	-0.0451 * [0.0258]	-0.0438 * [0.0257]	-0.0439 * [0.0257]
Carriageway / Motorway	0.0086 *** [0.0022]	0.0085 *** [0.0022]	0.0085 *** [0.0022]
Car Wash	0.0007 [0.0049]	0.0012 [0.0050]	0.0010 [0.0050]
Water & Air	-0.0053 [0.0053]	-0.0053 [0.0053]	-0.0053 [0.0053]
Shop	0.0011 [0.0062]	0.0009 [0.0062]	0.0009 [0.0062]
Coffee shop	-0.0089 [0.0063]	-0.0096 [0.0066]	-0.0093 [0.0065]
Municipal annual electricity consumption, TWh	-0.0040 ** [0.0020]	-0.0039 * [0.0020]	-0.0039 * [0.0020]
Constant	-0.6348 *** [0.0390]	-0.6348 *** [0.0390]	-0.6333 *** [0.0375]
N	113,081	113,081	113,081
R2	0.9855	0.9855	0.9855

Remarks: 1) * p<0.1; ** p<0.05; *** p<0.01;
2) Standard errors in parentheses; 3) Errors clustered by postcode;
4) Fixed effects of PS & w eeks.

APPENDIX V. DETAILED RESULTS FOR THE DID_SWITCH MODELS

Results for the DID_switch model
GOA & **G95**, period: 2011w27–2016w26

Variables explained: ln(PTP_GOA) // ln(PTP_G95)	**GOA** DID_switch NEW	**GOA** DID_switch CONV.	**G95** DID_switch NEW	**G95** DID_switch CONV.
DID	-0.0082 *** [0.0024]	-0.0028 ** [0.0014]	-0.0052 ** [0.0022]	-0.0005 [0.0013]
Independent PS	-0.0374 *** [0.0069]	-0.0347 *** [0.0068]	-0.026 *** [0.0053]	-0.0235 *** [0.0053]
Other branded PS	-0.0012 [0.0082]	0.0013 [0.0076]	0.0008 [0.0061]	0.0031 [0.0056]
# independent rivals within 10 min	-0.0038 *** [0.0011]	-0.0038 *** [0.0010]	-0.0029 *** [0.0008]	-0.0029 *** [0.0008]
# non-independent rivals within 10 min	0.0006 [0.0012]	0.0005 [0.0012]	0.0005 [0.0010]	0.0003 [0.0010]
Mid-sized cities (>=15K inhab. & <=150K inhab.)	-0.0731 ** [0.0328]	-0.0780 ** [0.0310]	-0.0376 [0.0266]	-0.0421 * [0.0250]
Small towns (<15K inhab.)	-0.0833 ** [0.0338]	-0.0880 *** [0.0322]	-0.0397 [0.0277]	-0.0435 * [0.0261]
Carriageway / Motorway	0.0102 *** [0.0026]	0.0103 *** [0.0026]	0.0086 *** [0.0022]	0.0089 *** [0.0022]
Car Wash	0.0048 [0.0058]	0.0028 [0.0054]	0.0016 [0.0052]	0.0002 [0.0049]
Water & Air	-0.0007 [0.0071]	-0.0009 [0.0069]	-0.0055 [0.0055]	-0.0054 [0.0053]
Shop	-0.0062 [0.0079]	-0.0053 [0.0078]	0.001 [0.0065]	0.0013 [0.0064]
Coffee shop	-0.0233 *** [0.0088]	-0.0203 ** [0.0082]	-0.0113 * [0.0067]	-0.0084 [0.0063]
Municipal annual electricity consumption, TWh	-0.0072 *** [0.0026]	-0.0075 *** [0.0025]	-0.0035 * [0.0021]	-0.0038 * [0.0020]
Constant	-0.7173 *** [0.0460]	-0.7156 *** [0.0453]	-0.6022 *** [0.0280]	-0.5484 *** [0.0237]
N	108,548	111,172	107,765	110,476
R2	0.9876	0.9875	0.9854	0.9854

Remarks: 1) * p<0.1; ** p<0.05; *** p<0.01;
2) Standard errors in parentheses; 3) Errors clustered by postcode;
4) Fixed effects of PS & weeks.

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