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"Entry Regulation Asymmetries and Gasoline Competition in a Mixed Motorway Network"

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Abstract

Regulatory and funding asymmetries in the Spanish motorway network produce huge differences in the structure of gasoline markets by motorway type: free or toll. While competition is encouraged among gas stations on free motorways, the regulations for toll motorways allow private concessionaires to auction all gas stations to the same provider, thereby limiting competition and consolidating market power. This paper reports how this regulatory asymmetry results in higher prices and fewer gas stations. Specifically, we show that competition is constrained on toll motorways by the granting of geographical monopolies, resulting in a small number of rivals operating in close proximity to each other, and allowing gas stations to operate as local monopolies. The lack of competition would seem to account for the price differential between toll and free motorways. According to available evidence, deregulation measures affecting toll motorway concessions could help to mitigate price inefficiencies and increase consumer welfare.

JEL classification: L11, L12, L43
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Introduction

The gasoline market is a major energy market in any economy, both for its domestic consumers (since the product represents a significant expense for families) and for its productive sector (since it represents an essential input in most production processes[1]). Given the importance therefore of fostering an efficient gasoline market, competition policies must serve to prevent the development of market power and anticompetitive strategies that might harm consumer welfare. Likewise, it is essential to guarantee the efficient performance of the specific gasoline market made up by the motorway network, given that motorways hold a particularly high volume of consumers that also require protection.

The European Commission goes as far as recognizing that fuel retailing on motorways should be considered a separate product market owing to the distinctive competitive conditions that characterize a motorway[2]. First, demand is captive, insofar as motorists rarely leave the motorway to buy fuel from a gas station sited in a location off the motorway; and, second, motorists travel on motorways for reasons of speed, and so are disinclined or less willing to waste time in refueling. If, moreover, the motorists have paid a toll, this outlay serves as a further deterrent to their exiting the motorway. These characteristics, which combine to make gasoline retailing on motorways a separate market, usually result in higher prices at the pump.

The gasoline retailing market is local in scope and the substitutability between gas stations is geographically limited. Nonetheless, the overlap between the areas of influence of the stations provides potential for competition on a motorway. This competition is constrained in two ways: first, by high entry barriers due to the "insulated" nature of the motorway and the specific characteristics of the infrastructure that make building a new site on a motorway (sunk costs) more expensive; and, second, the regulatory framework that limits free entry. The first of these constraints are industry-based, while the latter are legal and regulatory barriers.

Yet, even with these entry barriers and the characteristics that make a motorway a separate market, in most European countries no significant price differences are found between gas stations located on and off the motorway network. In fact, price differences are only significant in countries in which large shares of the network are privately tolled. For instance, prices are between 5 and 10% higher in French gas stations located on toll motorways. Additionally,

[1] According to the Ministry of Industry, Tourism and Trade the consumption of petroleum products in 2008 represented 56.6% of final energy consumption and 47.9% of primary energy consumption.
[2] European Commission decisions on September 29th, 1999 and February 9th, 2000 regarding concentration operations affecting Exxon/Mobile and TotalFina/Elf, respectively.

according to the EC (1999), their retail prices are unconnected to price trends in the neighboring market of off-motorway stations.

Clearly, the fact of having paid a motorway toll makes motorists reluctant to leave the motorway in search of low price gas stations on the adjacent roads. However, these gas stations are not the only potential source of competition for gas stations located on motorways. Indeed, the motorway's competitive framework can also influence gasoline retail price setting. This justifies policies encouraging the liberalization and the promotion and defense of competition not only on conventional (rural or urban) roads, but also on high capacity roads.

Concerns related to such competition on toll motorways have recently been raised in Spain, a country that operates a mixed funding model of motorways with a large part of the network being privately tolled. Both the *National Commission for Energy* (CNE) and the *National Competition Commission* (CNC) – Spain's regulatory agencies responsible for the energy market and competition policy respectively, have explored market power and price settings on toll motorways. Their conclusions warn of significant markups (i.e., high prices charged by gas stations on toll motorways) and stress the high concentration indices that exist on roads of this type. However, these studies are based on a single or, at most, a few specific toll motorways and typically they compare prices at gas stations on toll motorways with the national mean for all gas stations.

The aim of this paper is to determine whether the fuel prices charged to toll motorway users are significantly higher than those charged to non-toll motorway users in Spain given this apparent lack of competition. We construct and exploit a new database for all gas stations located on motorways – both free and toll – and estimate a price equation controlling for the real competitive framework enjoyed by each gas station. As the mixed funding model of motorways (free and privately tolled) results in a regulatory asymmetry as regards the respective legal entry barriers in place, the hypothesis we test is that gas stations on toll motorways charge higher prices not only because of their demand and cost characteristics, but also because of the uncompetitive market in which they operate as a consequence of this regulatory asymmetry.

The contribution of this paper is twofold. This is the first study to attempt to measure the market power of toll motorway gas stations arising from the asymmetry in market entry regulations. This means while toll motorway companies can award gas station concessions, free motorways are characterized by entry-friendly regulations that seek to promote competition. The exercise is conducted for Spanish motorways, which enables us to undertake a good comparison of the different entry barriers in a mixed funding model. Thus, we do not compare gas stations on- and off-motorways, but rather we conduct our comparison of gas stations sited in infrastructure of the

same quality and physical features, the only difference being that some of the motorways are free while others are toll roads.

Our findings, and their associated policy implications, can be extended to other countries that operate similar funding models for their motorways based on private concessions, including France, Italy and Portugal, and to developing countries that have found in private initiative and user payments a source of funding for large necessary infrastructure projects. Moreover, our findings are relevant to other developed economies (for example, the recent concessions awarded in the US) that have recently introduced the user-charging model as a means of funding motorway investment.

The second contribution of this paper is methodological. Within the broad body of literature that has studied the fuel retailing market, only Barron, Taylor and Umbeck (2004) used the geographical distance between gas stations to control for the effective competition affecting price setting. Here, we not only extend this strategy by using a continuum of distances to identify the spatial role of competition (which we consider of great importance for a local market), we also relax their exogeneity assumption regarding the number of rivals, an assumption recognized as being a limitation by Barron, Taylor and Umbeck (2004). Indeed, both the price and the number of sellers in a market are endogenous variables and so we adopt an instrumental variables approach to avoid estimation bias.

The rest of this paper is organized as follows. Section 2 describes the Spanish motorway network in order to understand its mixed funding model and the source of its competitive framework. Next, in section 3, we explain the different regulatory frameworks applied to free and toll motorways so as to highlight the asymmetries affecting their entry barriers. In this same section, we also present information describing the market structure of each motorway type, while in section 4 we briefly review the conclusions of previous reports undertaken by regulatory agencies. Our data and methods are described in sections 5 and 6 respectively, and our results are presented in section 7. Finally, we conclude by reviewing the main contributions of this paper and we discuss the various policy implications and recommendations that can be derived from our study.

1. Spain's mixed funding model for motorways: The source of regulatory asymmetry in gasoline competition

Spain's transportation system presents several distinctive characteristics that make it unique in Europe. Among these features is its mixed funding model for motorways, which means that a significant share of its motorways are toll roads operated by private concessionaires, and a significant proportion are free motorways under public management and funding[3]. This mixed model is not the planned outcome of a particular design for its road system but rather reflects different stages in the country's transport policy[4]. The first motorways were awarded to private firms by the dictatorship in the late 60s and early 70s because of a lack of public resources (given the precarious fiscal system then in operation) to fund the investments. These first projects, undertaken as part of the Program of Spanish National Motorways (PANE)[5], foresaw the building of motorways primarily in the busiest routes, including the Mediterranean corridor and the Ebro River Valley corridor, but also on other routes such as those linking Seville to Cadis (in southern Spain), Villalba to Adanero (in the Madrid area), and Bilbao to San Sebastian (in the Basque Country). This preference for pay-per-use and private operation was suddenly undermined by the economic crisis of the mid-seventies, which saw construction and maintenance costs rise well above private forecasts severely damaging the nascent industry. As a result, by 1975, only 2,042 km of toll motorways from the total of 6,340 initially planned had been completed.

After a period of financial meltdowns, the nationalization of some concessions and the renegotiation of others (a process that affected both the tolls and the length of contracts), the country adopted a publicly funded model, but without compromising the toll motorways already operating. This change was instigated by the Socialist Party, which held power between 1982 and 1996. Given its skepticism regarding private initiative, the new government designed a plan for the construction of a network of free motorways and the nationalization of three toll companies experiencing financial troubles in 1984.[6] This provision of free motorways funded and maintained by the State was financially feasible due to tax system reforms in 1977 and the arrival of European funds for projects in four regional areas (Castile-La Mancha, Andalusia, Castile-Leon and Valencia).

[3] Toll motorways constitute significant share of other European countries' networks, including France, Greece, Portugal and Italy. However, in these countries almost the whole network is tolled, while in Spain the system presents significant shares of both funding models.
[4] See Bel (1999) and Bel and Fageda (2005) for a full description of these stages.
[5] The *Program of Spanish National Motorways* (1967) planned more than 3,000 km of toll motorways. The program was up-dated in 1972 in the *National Plan of Motorways*, increasing the planned length to 6,340 km.
[6] The toll motorway concessionaries nationalized were Audasa, Audenasa and Aucalsa.

The Government's *General Road Plan* (1984-1991) established the public funding model for new motorways and generated a mixed motorway system with some corridors being served by toll motorways and other by free motorways. The outcome of this policy was a clear distribution of motorways reflecting the particular funding method. In 1991, the last year of the Plan, free motorways accounted for 67% (3,844 km) of the total motorway network.

Since that date, a number of specific policies have favored the return to the pay-per-use model. The general renegotiations for extending private concessions in the 1997 *Program of Toll Motorways*, drawn up by Partido Popular (Conservative Party); the privatization of Spain's National Motorway Company in 2003 – owner of the three motorways nationalized in 1984; and the awarding of new toll motorways along several corridors in the late 90s and early years of the last decade have shaped the current mixed model.

2. Entry regulation asymmetry and market structure

This mixed model for funding motorways has a considerable impact on the regulation of gas stations on these roads and on the competition framework of petrol suppliers. While gas stations on toll motorways can be contracted directly by the private concessionaire to retail suppliers (in accordance with the terms of concession), gas stations on free motorways are the responsibility of the State. In the case of toll motorways, Law 8/72 grants the private toll motorway company the right to contract these services. Typically, such companies organize auctions for the operation of all the gas stations on a particular motorway or those in certain geographical sections. This strategy, as well as ensuring gas stations are located at some distance from each other, allows geographical monopolies to be sold and guarantees greater value than a competitive supply. Here, Kay and Thomas (1986), in discussing privatization policies, claim that a seller concerned with maximizing its revenue cannot be expected to support calls for liberalization. Thus, we should not expect toll motorway companies to facilitate a competitive framework when determining their contracting strategy.

A good example of this strategy in operation is provided by the recent concession of three of the four gas stations on the A8 motorway linking Bilbao with Irún to CEPSA, one of the leading petrol providers in Spain. This contract grants the operation of this service free of competition on the sixty-kilometer stretch through the province of Guipuzcoa for a period of 15 years. The fourth gas station is operated by Petronor and is located in the province of Vizcaya, 15 km from Bilbao. In fact, this is also the only operator in a sixty-kilometer stretch and, as such, Petronor and CEPSA operate as geographic monopolies on the Vizcaya and Guipuzcoa sections of the motorway and

are located far enough from each other (44 km) to avoid competition. Additionally, the toll motorway company (Bidegi) has committed itself to prevent any new market entry by ruling out the building of any new gas stations on this motorway. Among others, this contract included the most profitable gas station in Spain at that time (2003)[7]. As a result, Bidegi will obtain annual revenues of 9.5 million euros until 2018.

By contrast, entry regulations on free motorways are considerably more complex and include a variety of norms that favor competition among petrol suppliers. According to Royal Decree 1812/1994, the awarding of new service areas – including gas stations – has to be regulated and executed by public auction. The decision to initiate an auction for a gas station on a free motorway depends on several factors: population density, distribution and characteristics of population, and average daily traffic (Article 4, Royal Decree 15/1999). In order to promote competition, Royal Decree 15/1999 contains a number of liberalization measures favoring new entrants in these auctions. Specifically, it favors a gas station provider that is different from the two nearest gas stations to that particular site. In addition, the Decree promotes public auctions for the awarding of various gas stations in a given service area and the auction of service areas with an existing monopolistic incumbent. As such, it is possible to find more than one gas station provider in the same service area on free motorways.

Additional efforts have been made by the government to prevent market power abuses in this sector and to favor competition on the free motorways for which it has responsibility:

1) The placing of information panels on the motorways displaying details about the location of different gas stations and their prices provide market transparency and reduce drivers' search costs (Royal Decree 15/1999)

2) Public auctions not only consider the variety of operators in the relevant market, as provided for under Royal Decree 15/1999, but also favor entrants committed to avoiding the provision of petrol from the same upstream provider as the immediately previous and following stations on the same side of the motorway.

3) Finally, the government has restricted the entry of gas station companies with a market share greater than 15% (Royal Decree 6/2000). The period established was five years in the case of companies enjoying a market share greater than 30% and three years in the case of those with a market share above 15% but lower than 30%.

[7] See the article "Guipúzcoa abrirá en diciembre con peaje la A-1 con un tramo sin desdoblar" published in El País 30/10/2003.

These attempts to promote liberalization and the differences in entry regulation have obvious consequences for the market structure. **Table 1** summarizes the respective market structures of toll and free motorways. The following points are worth stressing:[8]

a) The average number of rivals for a gas station on a toll motorway is five times lower than that for stations on free motorways.

b) The percentage of gas stations without rivals on a 50-km stretch of motorway is three times higher on the toll motorways than it is on free motorways. In fact, more than 60% of gas stations on tolled motorways have no rivals within this distance.

c) When another gas station does operate within a 50-km stretch, the chances that it is operated by the same brand are very high on a toll motorway. Specifically, only 31.25% of gas stations do not have another own-brand petrol station operating within this distance. By contrast, this share increases to 50.85% on free motorways, which is indicative of the variety of suppliers to be found on these roads.

d) Finally, the average price charged to toll users is more than 1% higher than that charged to free motorway users.

<<Insert Table 1 about here>>

Similarly, **Figure 1** shows the number of rivals a gas station must compete with within a given distance.[9] This shows that operators on free motorways must contend with higher competition due to a larger number of close rivals, while those on toll motorways are protected from such competition by distance, thereby, safeguarding their geographic monopolistic rents. Indeed, the figure stresses how unlikely it is to find competition on toll motorways within a 50-km stretch. By contrast, the number of rivals increases much more steeply over 50 kilometers on free motorways. Likewise, **Figure 2** shows the percentage number of gas stations without competition by type of motorway over a 50-km stretch. It is readily apparent that the share of gas stations without competition on tolled motorways remains largely constant across all distances, while gas stations on free motorways face competition even at short distances. Thus, at the end of this 50-km stretch, we find that 63.9% of gas stations on toll motorways do not face any competition, while this is true of only 14.75% of those on free motorways.

[8] This information is drawn from the specially constructed database that is used in the econometric analysis (see, section 5). The database contains data for all gas stations in Spain's motorway network.
[9] Note, a rival is understood to be a petrol station operated by a different brand.

<<Insert Figure 1 about here >>

<<Insert Figure 2 about here >>

Figures 3 and 4 provide an interesting description of the number and share of own-brand gas stations located on a given motorway by distance in relation to each station. As can be seen, it is difficult to identify any variety on toll motorways, while on free motorways the percentage of own gas stations falls at a much faster rate.

<<Insert Figure 3 about here >>

<<Insert Figure 4 about here >>

In order to illustrate the different market structures generated by the regulatory asymmetry, we compared two substitute motorways.

<<Insert Table 2 about here>>

We take the A2 (free) and AP2 (toll) motorways that serve the corridor linking Barcelona with Lleida – two provincial capitals in the northeastern part of Spain. Note that the distances covered and the journey times are very similar (**Table 2**). However, we find almost twice as many gas stations on the free motorway as on the toll motorway. Moreover, the concentration indexes (HHI, C1, C2, C3) describe a quite distinct competitive structure, so that all the gas stations on the toll motorway are operated by the same brand and so there is no competition along the whole of this stretch of the AP2. The outcome of this is a much higher average price (+3.2%) at the pumps on the tolled motorway than on the free motorway. This difference is more pronounced in the operating margin, calculated as the final price without taxes minus the international wholesale price. **Table 3** extends this analysis by showing the average concentration indices by type of motorway for all motorways on which at least two gas stations are sited. Although we cannot conclude that all gas stations on free motorways operate under a competitive framework, our results identify major differences demonstrating that concentration is much higher on toll motorways than it is on free roads.

<<Insert Table 3 about here>>

In short, entry regulation asymmetries seem to affect the market structure and the competitive framework in which road users and petrol providers interact. The lack of competition derived from the freedom granted to toll companies to award gas stations without any additional competition measures results in fewer gas stations per kilometer stretch of motorway, higher prices and less variety of suppliers. The combined effect of this is to induce market power gains, higher private rents and a reduction in road user welfare.

3. Official reports on gas station competition

Three official reports have been undertaken to date in an attempt at addressing concerns about the high market concentration of gas stations on toll motorways.

The lack of entry regulations and the absence of competition on toll motorways were recognized in a report drawn up by the Catalan Competition Court (2005) (TDC). The report highlighted the fact that concessionaires had the right to permit (or otherwise) the opening of new gas stations on toll motorways, which allowed them, in most instances, to creating monopolies of gas station groups on the different toll motorways.

In a second report, the National Energy Commission (2008)[10] reviewed competition and price setting at gas stations on the toll motorway linking Barcelona with La Jonquera. They concluded that prices were 2.35 and 2.85 €/liter higher for gasoline and diesel respectively than the national mean. This micro-study added that the commercial markup was also 1.12 €/liter higher than the national mean for gasoline and 0.72 €/liter in the case of diesel.

Finally, the most recent reports have been undertaken by the National Competition Commission (2009 and 2011) (CNC)[11]. They analyzed the overall market of gasoline supply in Spain and its regulation. Some of the partial results presented by the 2009 and 2011 reports regarding the competition and market structure on motorways have a direct bearing on our study here. The reports, for example, stress the importance of the body with responsibility for each motorway as the determining factor of market structure in the interurban road network, while finding the degree of market concentration on several toll motorways to be very high. One such instance of this is the toll motorway, the AP-36, which has three station areas along a stretch of 145 kilometers that are served by the same provider (CEPSA). Similarly, on the Tarragona-Valencia (148 km) and

[10] The National Energy Commission (CNE) is the independent regulatory agency for energy markets in Spain.
[11] The National Competition Commission (CNC) is the independent agency in charge of the Competition Policy in Spain.

Málaga-Estepona (82 km) toll motorways there are only three gas stations (in each direction) belonging to the same provider (CEPSA and Repsol, respectively).

The CNC reports recommend that stronger measures be taken to reduce the high degree of concentration in interurban markets by eliminating the possibility of awarding concessions to gas stations from the same supplier. Although the 2009 report does not refer directly to toll motorways – since it is solely concerned with roads under State responsibility, it clearly considers this to be an anticompetitive strategy that must be avoided given the harm it inflicts on consumers. In fact, the CNC (2011) claims that the criteria according to which the same provider should not supply consecutive gas stations is not being adhered to sufficiently, with only between 5 and 10% of the overall weighting in the bidding clauses being given to it.

4. Data

The empirical implementation requires a considerable volume of data. The first step in constructing the database involved identifying each gas station located on any section of motorway (be it tolled or free) in Spain's network. To locate the service stations we used *Google Earth* software and a Spanish Ministry of Industry, Tourism and Trade application that shows the geographical location of all gas stations in Spain. In this way we noted the geographical position (latitude and longitude) for each gas station (n=1,220), the side of the road on which it is located (left or right), the brand operating the station and its opening hours. All these details were available for all gas stations located on both toll and free motorways.

We also noted the retail price of unleaded 95 octane gasoline sold at each station. We collected the retail price of this product since it is, by some way, the most widely consumed in the Spanish market[12]. Unfortunately, not all the gas stations provide price details, which can create a selection bias in our database. However, a simple inspection of the gas stations not reporting prices shows that this lack of information can be considered random, i.e., it does not follow any particular pattern. As such, there would appear to be no problem of sample selection that might bias our results.

The availability of the geographical position of each of the outlets allows us to obtain a range of additional information that is essential for our empirical analysis. First, we calculated the number of rival and same-brand gas stations in a distance ranging from 1 to 50 kilometers. Drawing on the

[12] In 2009, unleaded 95 octane gasoline accounted for 89.2% of total petrol consumption in Spain. This information was obtained from CORES, the public company that controls petroleum product stocks in Spain.

latitude and longitude details for each station we calculated the Euclidean distance from each of the petrol stations to the other 1,219, using MATLAB software. The matrix, containing 1,488,400 distance measurements, allows us to calculate the number of rival and own-brand gas stations located between 1 and 50 kilometers from each station.

We should stress that we considered only those stations located on the same motorway and then those sited on the same side of the road (i.e., serving traffic going in the same direction). This step was taken for two main reasons: first, to avoid counting as rival or as own-brand gas stations those sited directly opposite each other but on different sides of the motorway, and, secondly, to avoid including in the same market area two service stations that while close geographically are located on different motorways, so that consumers in fact have no choice between the two. This step might, however, generate problems in the case of service stations located near the intersection of two motorways. But given that the number of such stations is highly limited, we preferred to maintain the assumption that competition is limited to petrol stations located on the same motorway and serving the traffic going in one particular direction. The information contained in the distance matrix therefore allows us to identify the brand of the nearest rival to each of the 1,220 stations.

Average daily traffic data were obtained from the road map database of the General Directorate of Traffic (DGT), which forms part of the Spanish Ministry of Transportation. This database reports information collected by control stations on traffic volume, speed and safety outcomes. In order to control for potential demand we selected the closest control station (minimum number of kilometers) to each gas station and used the average daily traffic (ADT) recording.

Finally, we also obtained the distances between each of the stations and the gasoline storage facilities that exist in Spain. This variable accounts for the cost of transporting gasoline. To obtain this information we geo-referenced each storage point using its address as listed on the website of the National Energy Commission (CNE).

5. Methods

The regulatory differences between toll motorways and free motorways have a significant impact on the number of petrol stations in their respective networks and on the distribution of these stations among the various brands. In the previous section, we showed that there is a lower density of gas stations and a higher level of market concentration on the toll roads. But how do

these two characteristics affect the prices charged by the service stations? Does less market competition have a negative effect on consumers?

To answer these questions we analyze how the number of rivals located at various distances from a given gas station affects the prices it fixes. This empirical approach has been used by Barron et al. (2004) to determine whether U.S. gas stations set lower prices when the density of competitors in a 1.5-mile radius is higher. However, unlike the aforementioned study, we treat the number of rivals and the number of own-brand gas stations as endogenous variables[13].

Following Barron et al. (2004), to analyze the extent to which the level of competition can affect the prices set by the petrol station and, hence, the consumer surplus, we estimated the following econometric model:

$$P_{AV} = \beta_0 + \beta_1 NoRivals_i + \beta_2 NoOwnBrand_i + \beta_j X_{ij} + \varepsilon_i \qquad (1)$$

where the average price (PAV) set by petrol station "i" depends on the number of rivals within a certain distance ($NoRivals_i$)[14], the number of own-brand petrol stations within the same distance ($NoOwnBrand_i$) and other exogenous factors (Xi_j).

It should be borne in mind that both the number of rivals and the number of own-brand petrol stations located in a particular area are clearly endogenous variables. To solve this problem of endogeneity we use a two-stage estimation procedure employing an instrumental variables method. The instruments used in the first stage of the estimation are the GDP per capita in the province, the nearest traffic density measurement, an index capturing the intensity of tourism in the province in which the gas station is located, and a set of dummy variables used to measure the nearest rival brand[15]. These instruments are used both for the number of rivals and for the number of own-brand gas stations in different markets. These variables are strongly correlated with the number of stations (both rival and own-brand) but are not correlated with the prices set at the pumps.

The remaining exogenous variables introduced into the model are:

[13] Other studies that have used the distance form their rivals as a proxy of the level of competition include Sheppard (1991), Barron et al. (2000), Perdiguero and Borrell (2012) and Jiménez and Perdiguero (2010).
[14] In Spain there is no competition between stations of the same brand. The prices of these petrol stations are set directly or indirectly by the wholesale operator, which ensures perfect coordination between the petrol stations of the same brand located within a certain radius.
[15] We use the tourism intensity index compiled as part of the Annual Municipal Database by “La Caixa” corrected by population.

- D^{toll}: A dummy variable that takes a value of 1 if the station is located on a toll motorway and zero otherwise. If consumers who use toll roads are more willing to pay, they will be equally willing to pay a higher price for gasoline. Similarly, if toll road users have a higher valuation of time, they will not want to spend time looking for a cheaper petrol station and will be equally willing to pay more for gasoline. As a result, we expect a positive relationship between this binary variable and the average price.

- D^{24h}: A dummy variable that takes a value of 1 if the station is open 24 hours a day and zero otherwise. The fact that a gas station is open all day is an element of product differentiation that allows a station to charge higher prices. Moreover, such stations may well incur higher operating costs that are transferred to pump prices. We expect this variable to be positively correlated with the average price.

- D^{Brand}: A set of dummy variables for each brand type. We have different types of brands: those who have refining capacity in Spain (Repsol, Cepsa and BP); those that operate a network of petrol stations but which have no refining capacity in Spain (Galp and Shell), and those that do not own more than two or three service stations, that we named 'independents'. The sign of their impact on average prices is expected to depend on the ability of consumers to make informed assessments of the quality of different brands. If consumers believe that the major brands (who have refining capacity in Spain) offer a higher quality product, they will be willing to pay a higher price.

- $Dist.Storage$: A variable that measures the distance between the point of sale and the nearest gasoline storage center. The stations that are furthest from the storage incur higher transportation costs, which will be transferred to pump prices. However, it should be borne in mind that this cost will be an extremely small percentage of the total product cost. Moreover, it should not be ruled out that the carrier sets uniform prices in large areas, which might mean the variable lacks any statistical significance[16].

We estimate two approximations: the simplest one includes just the number of rivals, the number of own-brand outlets and the dummy variables for the different brands; while the second estimation includes all the above variables.[17]

[16] The Ministry of Industry, Trade and New Technologies of the Canary Islands Government report a uniform price (2004).
[17] Alternative approximations with the progressive introduction of exogenous variables do not give different results.

6. Results

The econometric results are presented in Tables 4a and 4b. We show the results for markets defined by 5, 10, 15, 20 and 25 kilometer stretches of motorway. All other market definitions do not affect our main results[18].

<<Insert Table 4a about here>>

<<Insert Table 4b about here>>

These results show that the number of rivals has a statistically significant negative effect on the average price fixed at the pumps by gas stations. By contrast, the number of own-brand gas stations within a given distance allows a station to set higher prices. These two variables were considered endogenous; however, the Hansen and the Anderson statistics indicate that the instruments used are valid, thus solving the problem of endogeneity and demonstrating the robustness of our estimates.

The fact that the first of these variables (the number of rivals) is negative and statistically significant indicates that the presence of stations operated by other brands has a competitive effect that is reflected in a lower equilibrium price. Thus, spatial competition in local motorway markets matters and improves consumer welfare. This finding is in keeping with that reported by Barron *et al.* (2004), who found that a higher density of gas stations in a 1.5-mile radius resulted in lower market prices. Our results also show how the impact of competitors is diluted and mitigated as rival gas stations are located further apart. By contrast, we find a positive and statistically significant effect of same-brand service stations on average prices due to their ability to coordinate local market power.

These results indicate that low station densities and high concentration indices account for the price differential existing on free and toll motorways. Thus, toll motorways have fewer stations and, therefore, fewer competitors that ensure geographical market power and a higher equilibrium price.

A second important result was obtained for the binary variable, D^{toll}, which is positive but not statistically significant in all cases. This result indicates that service stations sited on toll motorways are not consistently more expensive if they have the same market structure as those

[18] Results for the distance continuum (km) and for longer distances are provided upon request.

located on a free motorway (*ceteris paribus*). Table 5 shows that the toll variable is positive and statistically significant if we estimate the same models without the competition variables.

<< Insert Table 5 about here>>

This finding is important because it suggests that the price differential between toll and free motorways cannot be accounted for by differences in supply and demand factors but rather is attributable to the difference in the levels of competition on both roadways. Thus, were we to ensure the same the levels of competition on free and toll motorways, prices would be equal.

Additionally , we find that petrol stations that operate 24 hours a day charge significantly higher prices (albeit only half a penny). It is reasonable to assume that stations that remain open around the clock incur higher costs and that this is reflected in higher prices. Note, however, that the distance to the storage center was found not to be a statistically significant variable.

To determine the impact rival stations have on the prices charged by a given gas station, we performed a simulation to see what prices would be fixed by a gas station if all its neighboring stations were own-brand outlets. This simulation (transformation of all stations to own-brand outlets) has two effects: on the one hand, it has a positive effect on prices because of the close proximity of stations of the same brand; on the other hand, it has a negative effect on the prices of its closest lying rivals. The results of the simulation are shown in Figure 4.

<<Figure 4 insert here>>

As we can see, prices would rise significantly if a gas station's closest rivals were own-brand petrol stations: prices would climb more than 5 per cent if all rivals in a 20-kilometer stretch were own-brand outlets. If we take this 5 per cent as the 'small but significant and non-transitory increase in prices' (SSNIP TEST) that defines the relevant market, then only 14.6 per cent of the gas stations on toll motorways have rivals, which leaves 85.4 per cent with no competition in the relevant market. In the case of free motorways, the percentage with rivals increases to 74.2 per cent, with just 25.8 per cent of stations operating without competition in the relevant 20-kilometer market.

The small size of relevant markets in the gasoline industry has previously been noted by Barron *et al* (2004), Bromiley *et al* (2002), Jiménez and Perdiguero (2011) and Perdiguero and Borrell (2012)[19]. While the impact of rival stations is limited to an area defined by an 8- to 24-kilometer stretch with a maximum impact within a 14-kilometer stretch, it must be considered doubtful as to

[19] Even in the gasoline wholesale market, the market size has been reported as being very local (see, for example, Spiller and Huang, 1986, or Pinks *et al*, 2002).

whether there is any competition at all on toll roads, since virtually no service station encounters rivals within this range of displacement. Only 11.25 per cent of petrol stations on toll roads have a rival within a 14-kilometer stretch, and this proportion increases only to 20.6 percent if the market is expanded to a 24-kilometer stretch. These results contrast with those obtained for gas stations on free motorways where more than 66 per cent have a rival within a 14-kilometer stretch, increasing to 77 percent in a displacement range of 24 kilometers.

To determine whether gas stations on toll roads act as isolated monopolies, we adopted the following approach.

$$P_{AV} = \alpha_0 + \alpha_1 Before_i + \alpha_2 After_i + \alpha_3 Both_i + \alpha_j X_{ij} + \xi_i$$

where P_{AV} is the average price set by each station and which depends on $Before_i$, a dummy variable that takes a value of 1 if the previous petrol station is operated by another brand, $After_i$, a dummy variable that takes a value of 1 if the following petrol station is operated by another brand, $Both_i$, a dummy variable that takes a value of 1 if both the previous and following petrol stations are operated by another brand, and a set of control variables including dummy variables for the different brands and a dummy variable that takes a value of 1 in the case of diesel fuel and 0 in the case of gasoline. This equation was estimated separately for toll and free motorways. The results are shown in Table 6.

<<Insert Table 6 about here>>

As the above table shows, while stations located on toll motorways do not fix significantly different prices when the nearest petrol stations are operated by different brands, the prices fixed at the pumps by petrol stations on free motorways are lower. This indicates that toll motorway service stations act as isolated monopolies whose prices do not depend on the brand of the nearest petrol station. As such, a change in the ownership of the gas stations would not result in a significant price reduction, yet the entry of new competitors, located at sites close to their rivals, would be an effective way of reducing equilibrium prices.

7. Concluding Remarks

This paper has shown that the prices charged by gas stations on tolled motorways are significantly higher than those charged by stations on free motorways given the prevailing conditions of insufficient competition. This has been illustrated by examining data from Spain, a

country that operates a mixed funding model of motorways of similar quality, which has ensured the reliability of the comparison. The difference reported does not, however, appear to reflect the respective characteristics of demand and sunk costs of the two systems but rather the lack of competition attributable to the asymmetry in Spanish entry regulations governing free and toll motorways.

The right retained by toll motorway concessionaires of awarding concessions for the gas stations sited within their infrastructure allows them to maximize the revenues obtained from this operation by creating local monopolies. They are able to establish this uncompetitive market by locating gas stations at sufficient distances from each other so as to avoid any competition. Moreover, the typical practice has been to award gas station concessions on a given motorway, or at least on given sections of a motorway, to the same brand. By contrast, market entry on free motorways is governed by Ministry of Industry regulations, which have imposed an increasing number of measures to ensure competition in recent years. These differences between toll and free motorways have a critical impact on market structure and, as a consequence, on the price charged to gas station users.

Our results have a number of interesting policy implications. The presence of toll motorways around the world is rising both in developing countries, unable to invest heavily in transport infrastructure, as well as in developed countries, due to their fiscal restrictions and investment needs. Tolls instituted for these reasons are typically associated with private sector involvement and the use of standard Build-Operate-and-Transfer franchise schemes (Engel et al., 2004). In the US, for instance, interest in toll motorways is particularly intense. Indeed, several toll motorway concessions have been awarded over the last decade (the Indiana Toll Road and Chicago Skyway, among others) and others are under discussion, including multi-billion dollar deals involving toll roads in Pennsylvania and Texas.

Our findings and their associated policy implications can be extrapolated to other countries operating similar funding models for motorways based on private concessions, such as France, Italy and Portugal, and where similar franchising models are used, but where the absence of a sizeable free motorway network prevents average price comparisons.

Our results suggest that awarding private companies the right to franchise and design gas stations on toll motorways is tantamount to accepting an uncompetitive market structure and, hence, the charging of higher fuel prices to users already paying a toll. Regulatory measures governing the distances between gas stations and providing restrictions on market concentration need to be introduced to avoid market power abuse in the retailing of fuel on motorways. Such a

policy is even more necessary in countries such as Spain where alternative free interurban motorways in the corridors parallel to the tolled motorway do not always exist.

However, it should be recognized that the introduction of such a competition policy would reduce the extraordinary revenues of toll motorway companies acquired through the contracting of service stations, since they would no longer be able to offer a monopoly. As a result, toll motorway companies might well have to raise their tolls, making it necessary to estimate the welfare impacts associated with a trade-off between high tolls and high fuel prices.

Moreover, this policy would be extremely difficult to implement where concession contracts remain in force, since rights have already been awarded. In addition, the specific characteristics of the service area infrastructure on toll motorways would severely hinder the construction of new service stations. No doubt this would act as a constraint on new market entrants, but once retailing contracts expire, it would be possible to limit market concentration and increase the number of rivals on a given motorway or section of motorway. However, it should be borne in mind that introducing new entrants on toll motorways would imply major investment in infrastructure given the technical characteristics involved.

However, having said this, our policy implications are more readily applicable to experiences in which these rights have yet to be awarded, especially in the case of developing countries in the planning stages of toll motorway projects. The latter are in a position, therefore, to design a regulatory framework that can limit uncompetitive behavior by fixing the number of gas stations and restricting the distance between them. They might also impose rivalry requirements – perhaps prohibiting the location of two gas stations of the same brand in close proximity to each other. The only pitfall to this strategy is that tolls might rise accordingly while governments in developing countries might be more interested in keeping tolls as low as possible rather than in ensuring a competitive fuel retailing market on their motorways.

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TABLES AND FIGURES

Table 1. Market structure, geographic competition by type of motorway

	Toll	Free
Mean rivals < 50 km	0.68	3.80
% gas stations without rivals < 50 km	63.92	14.75
% gas stations without own-brand stations < 50 km	31.25	50.85

Table 2. Comparing two substitute motorways: AP-2 (toll)/A-2 (free)

Section Barcelona-Lleida	AP-2 (toll)	A-2 (free)
Length /Time	178 km/ 1h 49'	163 km / 1h 59'
Nº of gas stations	8	15
HHI concentration index	10,000	4,933
C1 /C2 /C3	1/1/1	0.66/0.86/0.93
Average price €/l	0.70	0.68

Table 3. Level of concentration on the motorways by type

Motorway (Tolled)	Nº of gas stations	C1	C2	C3	HHI
AP-1	**6**	**0.67**	**1**	**1**	**5555.56**
AP-2	**14**	**1**	**1**	**1**	**10000**
AP-4	**4**	**1**	**1**	**1**	**10000**
R-4	**4**	**0.5**	**1**	**1**	**5000**
R-5	**4**	**1**	**1**	**1**	**10000**
AP-6	**4**	**1**	**1**	**1**	**10000**
AP-7	**49**	**0.55**	**0.76**	**0.96**	**3877.55**
AP-8	**8**	**0.75**	**1**	**1**	**6250**
AP-9	**10**	**0.6**	**1**	**1**	**5200**
AP-15	**5**	**1**	**1**	**1**	**10000**
AP-36	**6**	**1**	**1**	**1**	**10000**
AP-66	**4**	**1**	**1**	**1**	**10000**
AP-68	**16**	**1**	**1**	**1**	**10000**
C-16	**5**	**1**	**1**	**1**	**10000**
C-32	**8**	**0.875**	**1**	**1**	**7812.5**
C-58	**4**	**0.5**	**1**	**1**	**5000**
A-1	**57**	**0.46**	**0.63**	**0.74**	**2625.42**
A-2	**80**	**0.53**	**0.73**	**0.83**	**3281.25**
A-3	**53**	**0.47**	**0.66**	**0.77**	**2844.43**
A-4	**110**	**0.39**	**0.57**	**0.72**	**2166.94**
N-IV	**6**	**0.33**	**0.66**	**0.83**	**2777.78**
A-5	**47**	**0.53**	**0.68**	**0.77**	**3209.60**

Table 3. Level of concentration on the motorways (continued)

Motorway (Free)	Nº of gas stations	C1	C2	C3	HHI
A-6	48	0.56	0.69	0.75	3463.54
A-7	73	0.41	0.55	0.66	2204.92
A-8	22	0.55	0.77	0.86	3677.69
A-10	5	0.4	0.6	0.8	2800
A-12	8	0.25	0.38	0.5	1562.5
A-15	4	0.5	0.75	1	3750
A-23	11	0.55	0.91	1	4380.17
A-30	6	0.5	0.83	1	3888.89
A-31	35	0.4	0.54	0.74	2326.53
A-35	5	0.4	0.8	1	3600
A-42	16	0.69	0.88	1	5234.38
A-43	8	0.5	0.63	0.75	3125
A-44	12	0.58	0.83	0.92	4166.67
A-45	6	0.83	1	1	7222.22
A-49	10	0.5	0.7	0.8	3200
A-52	8	0.5	0.75	0.88	3437.5
A-55	6	0.5	0.83	1	3888.89
A-62	32	0.44	0.72	0.84	2929.69
A-66	12	0.5	0.92	1	4305.56
A-67	7	0.43	0.71	0.86	3061.22
A-68	13	0.39	0.62	0.77	2426.04
A-92	64	0.36	0.52	0.66	1928.71
A-92G	6	0.5	0.67	0.83	3333.33
A-92N	9	0.3	0.56	0.78	2345.68
A-376	6	0.33	0.5	0.67	2222.22
A-381	4	0.5	0.75	1	3750
Ma-15	9	0.67	1	1	5555.56
A-231	5	0.4	0.8	1	3600
CL-601	5	0.8	1	1	6800
C-16	5	0.8	1	1	6800
C-17	14	0.36	0.57	0.71	2142.86
C-31	9	0.44	0.67	0.89	3086.42
C-68	4	0.5	0.75	1	3750
M-501	6	0.5	0.83	1	3888.89
M-506	8	0.38	0.75	1	3437.5
M-607	8	0.75	0.88	1	5937.5
RM-12	4	0.5	0.75	1	3750
RM-15	7	0.43	0.57	0.71	2653.06
B-23	6	0.67	0.83	1	5000
A-78	4	0.25	0.5	0.75	2500
LL-11	5	0.6	1	1	5200
M-50	4	1	1	1	10000
MA-21	9	0.44	0.67	0.78	2839.51
SC-20	4	0.75	1	1	6250
SE-30	4	0.5	0.75	1	3750
V-31	6	0.33	0.5	0.67	2222.22
Z-30	6	0.67	1	1	5555.56

Table 4a. Effect of rivals and own-brand stations (instrumental variables)

	5 km	10 km	15 km	20 km	25 km
Constant	1.091***	1.085***	1.087***	1.082***	1.073***
	(0.005)	(0.006)	(0.007)	(0.010)	(0.017)
No rivals	-0.004	-0.014**	-0.013**	-0.011**	-0.008
	(0.008)	(0.005)	(0.006)	(0.005)	(0.006)
No own-brand outlets	0.022	0.040**	0.026**	0.028**	0.028**
	(0.023)	(0.016)	(0.013)	(0.012)	(0.013)
Cepsa	0.003	0.014***	0.015**	0.019**	0.023**
	(0.005)	(0.005)	(0.007)	(0.009)	(0.011)
Shell	-0.004	0.019**	0.023*	0.028**	0.035**
	(0.007)	(0.008)	(0.012)	(0.013)	(0.016)
Galp	0.009**	0.021***	0.028***	0.033***	0.040***
	(0.004)	(0.006)	(0.009)	(0.011)	(0.013)
BP	0.001	0.019**	0.022*	0.029**	0.036**
	(0.006)	(0.008)	(0.011)	(0.012)	(0.014)
Ind	-0.002	0.018*	0.024*	0.033**	0.037**
	(0.007)	(0.010)	(0.013)	(0.014)	(0.017)
No obs.	766	766	766	766	766
R2	0.9996	0.9993	0.9993	0.9991	0.9990
F	3.30***	2.58**	4.34***	2.78**	3.22***
	(0.0043)	(0.0197)	(0.0005)	(0.0130)	(0.0051)
Anderson LR statistic	16.116**	24.338***	28.536***	24.117***	16.769**
	(0.0408)	(0.0020)	(0.0004)	(0.0022)	(0.0112)
Hansen J statistic	10.899	11.363	7.233	6.612	2.894
	(0.1431)	(0.1236)	(0.4050)	(0.4704)	(0.8947)

Table 4b. Effect of rivals and own-brand stations (instrumental variables)

	5 km	10 km	15 km	20 km	25 km
Constant	1.088***	1.084***	1.085***	1.082***	1.077***
	(0.005)	(0.006)	(0.006)	(0.008)	(0.011)
No rivals	-0.001	-0.012**	-0.013**	-0.011**	-0.010
	(0.008)	(0.006)	(0.006)	(0.005)	(0.006)
No own-brand outlets	0.016	0.031***	0.022**	0.024***	0.024***
	(0.018)	(0.012)	(0.010)	(0.010)	(0.009)
Toll	0.010	0.008	0.003	0.004	0.003
	(0.008)	(0.007)	(0.007)	(0.009)	(0.012)
24 hours	0.003	0.004	0.005*	0.004*	0.004
	(0.002)	(0.002)	(0.002)	(0.003)	(0.003)
Cepsa	0.00006	0.009**	0.012**	0.016**	0.018**
	(0.003)	(0.004)	(0.006)	(0.007)	(0.009)
Shell	-0.005	0.014**	0.021*	0.026**	0.032**
	(0.006)	(0.007)	(0.012)	(0.012)	(0.016)
Galp	0.007**	0.017***	0.026***	0.030***	0.037***
	(0.003)	(0.004)	(0.008)	(0.010)	(0.012)
BP	-0.001	0.015**	0.020*	0.027**	0.033**
	(0.005)	(0.006)	(0.010)	(0.011)	(0.013)
Independent	-0.002	0.015	0.023*	0.031**	0.036**
	(0.006)	(0.008)	(0.013)	(0.031)	(0.015)
Dist. Sto.	-6.60e-12	-8.34e-12	1.27e-12	9.52e-13	-3.41e-12
	(8.25e-12)	(1.29e-11)	(1.30e-11)	(1.30e-11)	(1.66e-11)
No obs.	765	765	765	765	765
R2	0.9997	0.9994	0.9994	0.9992	0.9992
F	3.65***	5.69***	4.38***	3.49***	3.86***
	(0.0006)	(0.0075)	(0.0001)	(0.0009)	(0.0003)
Anderson LR statistic	17.667**	24840***	19.951**	15.697**	10.314
	(0.0239)	(0.0017)	(0.0105)	(0.0469)	(0.2437)
Hansen J statistic	10.691	11.641	7.713	6.538	2.913
	(0.1527)	(0.1130)	(0.3586)	(0.4785)	(0.8930)

Table 5. Effect of toll without market structure variables (Least Squares)

Constant	1.092***	1.090***	1.091***
	(0.002)	(0.002)	(0.002)
Toll	**0.009****	**0.009****	**0.009****
	(0.004)	**(0.004)**	**(0.005)**
Cepsa	-0.002	-0.002	-0.002
	(0.002)	(0.002)	(0.002)
Shell	-0.008***	-0.008***	-0.008***
	(0.003)	(0.003)	(0.003)
Galp	0.007***	0.007***	0.007***
	(0.002)	(0.002)	(0.002)
BP	-0.011	-0.012	-0.012
	(0.010)	(0.010)	(0.010)
Independent	-0.010***	-0.010***	-0.010***
	(0.003)	(0.003)	(0.003)
24 hours		0.002	0.002
		(0.002)	(0.002)
Dist. Sto.			-3.41e-12
			(5.63e-12)
No obs.	1173	1170	1170
R2	0.9995	0.9995	0.9995
F	7.44***	7.58***	6.59***
	(0.0000)	(0.0000)	(0.0000)

Table 6. Effect of neighboring rivals (Least Squares)

	Tolled				Free			
Constant	1.096***	1.096***	1.095***	1.097***	1.094***	1.093***	1.096***	1.093***
	(0.007)	(0.007)	(0.007)	(0.006)	(0.002)	(0.002)	(0.002)	(0.002)
Before	**0.007**		**0.006**		**-0.006*****		**-0.005*****	
	(0.005)		**(0.005)**		**(0.001)**		**(0.001)**	
After		**0.007**	**0.006**			**-0.005*****	**-0.004*****	
		(0.004)	**(0.004)**			**(0.002)**	**(0.002)**	
Both				**0.006**				**-0.006*****
				(0.004)				**(0.001)**
Shell	-0.004	-0.004	-0.008	-0.005	-0.004	-0.005	-0.003	-0.003
	(0.005)	(0.005)	(0.005)	(0.004)	(0.003)	(0.003)	(0.003)	(0.003)
Cepsa	0.004	0.004	0.004	0.004	0.001	0.001	0.002	0.002
	(0.007)	(0.007)	(0.007)	(0.007)	(0.002)	(0.002)	(0.002)	(0.002)
Galp	0.012*	0.012*	0.010	0.012*	0.008***	0.008***	0.009***	0.009***
	(0.006)	(0.006)	(0.006)	(0.007)	(0.002)	(0.002)	(0.002)	(0.002)
BP	0.023***	0.023***	0.021***	0.024***	-0.004	-0.004	-0.003	-0.003
	(0.005)	(0.005)	(0.005)	(0.006)	(0.006)	(0.005)	(0.005)	(0.005)
R^2	0.0823	0.0835	0.0981	0.0720	0.0319	0.0290	0.0383	0.0378
N	152	152	152	152	1004	1004	1004	1004

Figure 1. Number of rival gas stations by type of motorway and distance.

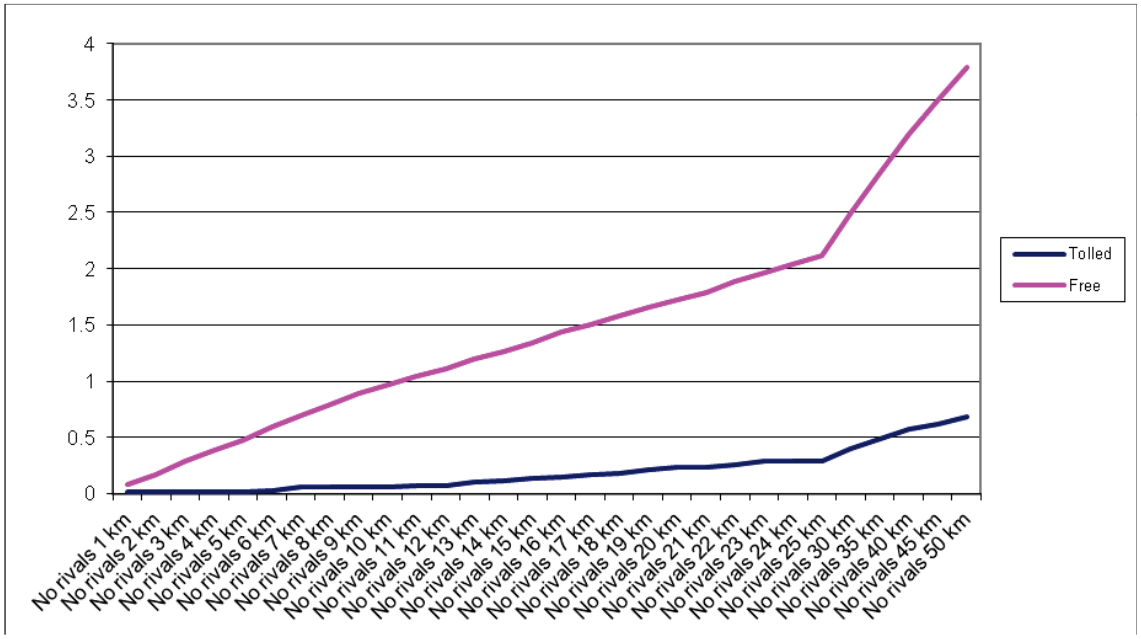


Figure 2. Share of gas stations without competition by type of motorway and distance (%)

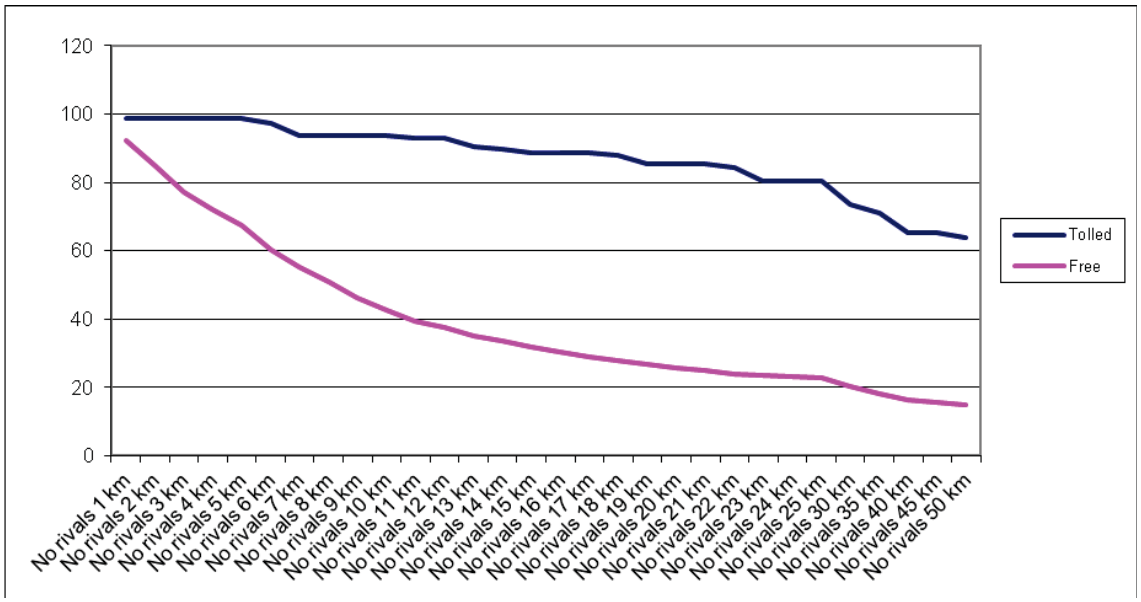


Figure 3. Number of own brand gas stations by type of motorway and distance.

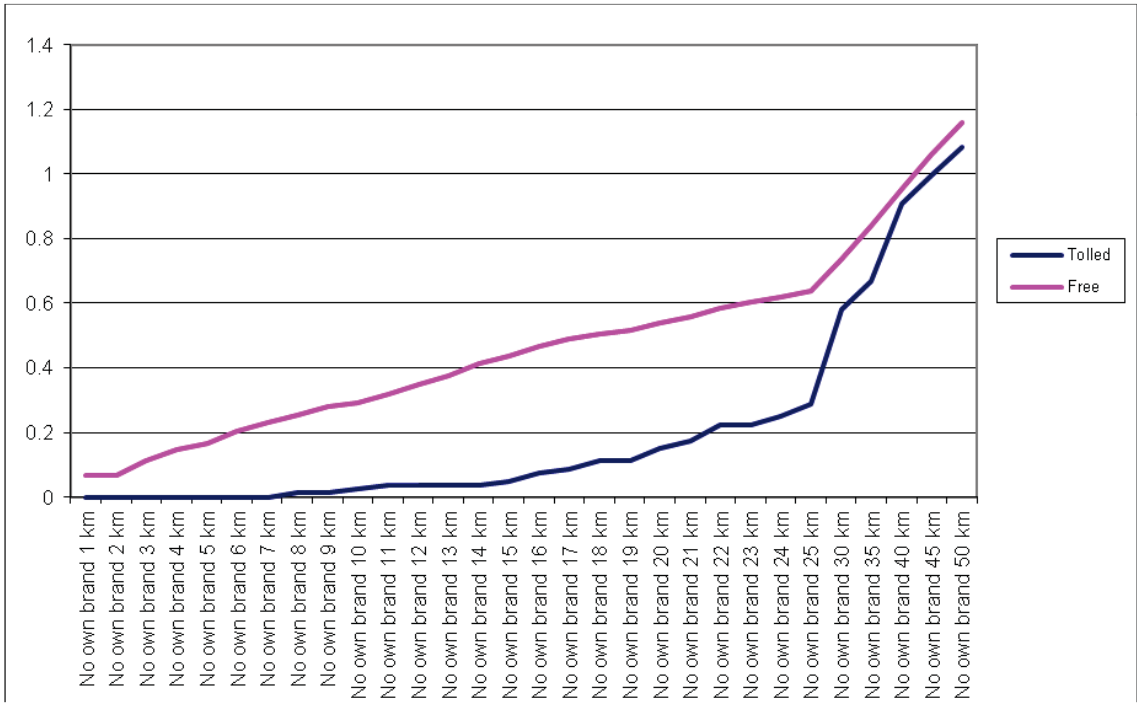


Figure 4. Share of own brand gas stations by type of motorway and distance

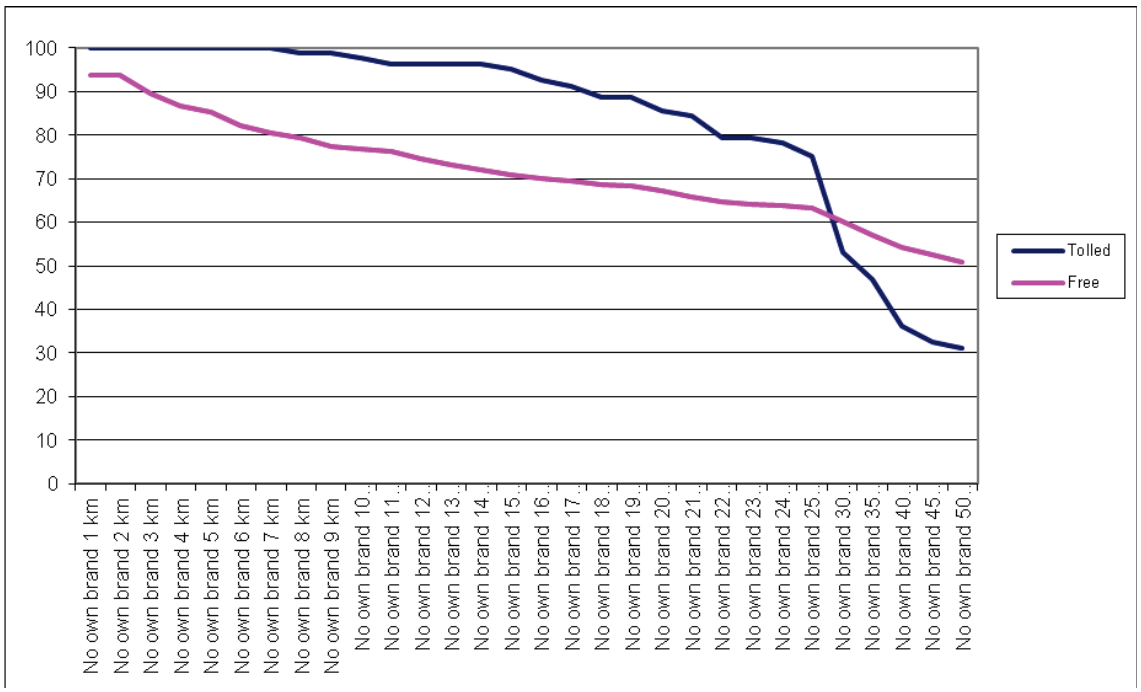
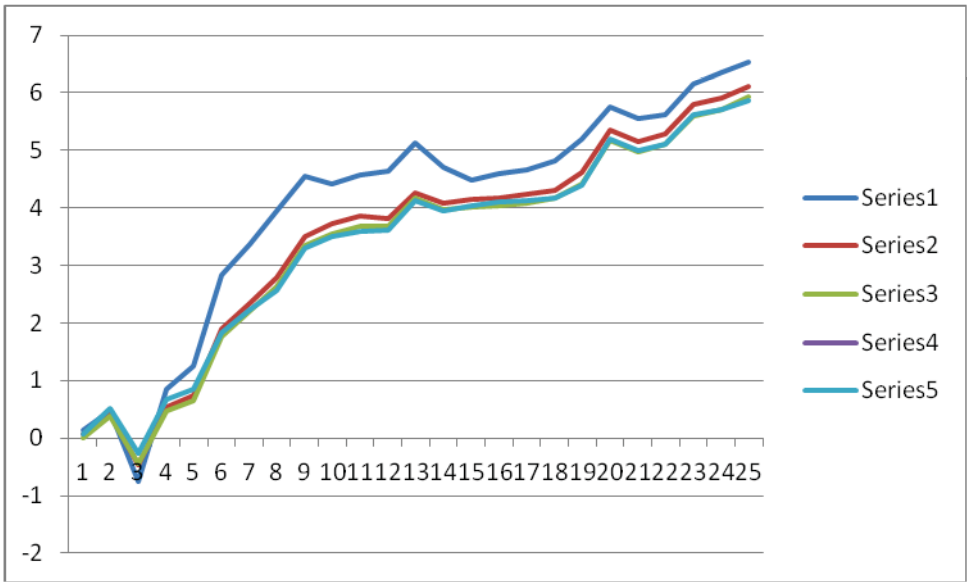


Figure 5. Price simulations



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