REGULATION AS A WAY TO FORCE INNOVATION: THE BIODIESEL CASE

JORDI PERDIGUERO
JUAN LUIS JIMÉNEZ

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Regulation as a way to force innovation: the biodiesel case

Jordi Perdiguero*
Juan Luis Jiménez*

Abstract

The introduction of biofuels is one of the objectives of the European Union. For this reason, measures to promote the production and consumption of this product have been implemented, such as tax exemptions and fixing a minimum amount of mixture. In this paper, we test the level of competition as a factor that can significantly affect the introduction of this new product. The empirical analysis conducted of the biodiesel market in Spain shows a non-linear and inverted U among the level of competition in the market and the introduction of biodiesel by petrol stations. This result justifies the adoption of measures to promote competition in order to improve the commercialization of biofuels.

Keywords: Regulation; Innovation; Competition; Biodiesel

JEL classification: L52; O32; Q42; Q48

* **Corresponding author**: Jordi Perdiguero. Departamento de Política Económica. Grup de Recerca en Polítiques Públiques i Regulació Econòmica (PRE). Institut de Recerca en Economia Aplicada (IREA). Avda. Diagonal 690. 08034. Barcelona. E-mail: jordi.perdiguero@ub.edu

** Departamento de Análisis Económico Aplicado. Grupo de Economía de las Infraestructuras y el Transporte (EIT). Universidad de Las Palmas de Gran Canaria. Facultad de Economía, Empresa y Turismo. Despacho D. 2-12. Campus de Tafira. 35017. Las Palmas. E-mail: jljimenez@daea.ulpgc.es; tlf: +34 928458191.

1. Introduction

The introduction of biofuels to the automotive market is a clear objective within the European Community. In fact, it has established a policy that sets minimum levels of biofuels sold in each member state. The objective of the European Community to replace fossil fuels with biofuels is twofold: firstly, to reduce its reliance on foreign energy (since it has virtually no oil production) and, secondly, to reduce the emission of pollutants to help limit climate change. Therefore, the EU set 2% of all petrol and diesel at 31 December 2005 and 5.75% at 31 December 2010 as targets for biofuels.[1]

Member states can themselves introduce measures to encourage the consumption of biofuels to reach this objective. These measures have focused on tax exception for firms that invest in technology to produce biofuels as well as the charging of a lower consumption tax for biofuels.

In Spain, a fiscal deduction of 10% for renewable energy investments in corporation tax and the removal of the special tax on fuel until 2013 have been introduced as a national policy measure.[2] Besides, the Ministry of Industry, Tourism and Trade is considering the introduction of new measures to encourage the consumption of biofuels, introducing in the draft Law on Energy Efficiency and Renewable Energy the requirement to have a biofuel pump at all those service stations that sell more than 3 million gallons per year.

In this paper, we analyse the role market structure plays in the penetration of biofuels and how the promotion of competition and the use of regulation may be relevant instruments to encourage its implementation. To this, we link the introduction of a new product to the market, such as biodiesel, as an innovation by the company, and therefore it is a decision affected by market structure, among other things.[3]

The literature on industrial organization has analysed the relationship between the level of competition in the market and the level of innovation. The first empirical evidence followed the idea proposed by Schumpeter (1939), which specified a negative relationship between the level of competition and innovation processes. Other authors have found, however, positive relationships between competition and innovation, such as Nickell (1996) and Blundell, Griffith and van Reenen (1999).

[1] Directive 2003/30/EC of the European Parliament and the Council of 8 May 2003.
[2] These measures are included in the Order of the Ministry of Industry, Tourism and Trade ITC/2877/2008.
[3] Schumpeter (1934) defines innovation as: "The introduction of a new good – that is one with which consumers are not yet familiar – or of a new quality of a good".

In both cases, the authors use linear approximations, although Scherer (1967) had already demonstrated that the relationship between these two variables is not linear but presents an inverted U shape: it grows in the presence of relatively few competitors to reach a peak from which, by introducing more firms, the level of innovation is reduced. This empirical evidence has been contrasted by Aghion et al. (2005) for a large panel of firms in the UK. Surprisingly, there is not a large number of empirical articles analysing the existence of this nonlinear relationship between competition and innovation and even fewer in an energy industry such as biofuels. Gilbert (2006) summarizes papers that analyze relationship between competition and innovation. He finds that exclusive rights generally lead to greater innovation incentives in more competitive markets, and viceversa.

Nevertheless, a cornerstone in this case is how to evaluate the innovation. Typically, these measures have involved either some measure of an input into the innovative process, such as R&D (Scherer, 1965), or else a proxy measure of innovative output, such as patented inventions (Acs y Audretsch, 1987). In our case we assume that the introduction of biodiesel in each of the pumps could be understood as a process of innovation. In fact, retail petrol market is a low-innovative sector: biodiesel and next electric cars are the unique product changes in last 50 years.

As already proposed, the objective of this paper is to cover this absence, to analyse the relationship between the level of competition and the introduction of biodiesel to the retail petrol market. We use data from the retail of biodiesel in the four major Spanish cities, analysing how it depends on the decision from service stations to offer biodiesel (or not).[4]

This article makes two main contributions to the economic literature. First, we obtain empirical evidence on the relationship between the market structure and the introduction of a new product to an energy market. Secondly, it shows first empirical evidence of how the level of competition may affect the penetration of biofuels in the market. Thus, we can draw conclusions about whether economic policy affecting the market structure can be an effective mechanism to promote the penetration of biofuels, or, conversely, whether administrative regulation is the only option available.

The empirical results confirm the existence of a nonlinear, inverted U between the introduction of this new product and the level of competition in this market. Therefore,

[4] Keep in mind that a percentage of service stations are vertically integrated and therefore, the decision of this set of stations is made by the same agent, the wholesale operator. However, the fact that the wholesale operator can decide to placing the product of an individual point of sale, the agent makes it relevant to analyze the service station and not the company.

policies to promote competition lead to an increase in the penetration of biodiesel, and other measures would help achieve the objectives of using biofuels.

Although in recent years the effect of biofuel production on economic development has been deeply analysed (Ryan et al., 2006; Frondel and Peters, 2007; Charles et al., 2007; Hahn and Cecot, 2009), regarding the effect of fiscal policy on the development of industry (Wassell and Dittmer, 2006; Vedenov and Wetzstein, 2008) and the effect on countries producing raw materials (Pousa et al., 2007; Peters and Thielmann, 2008; Lamers et al., 2008; Gucciardi and de Souza, 2009; Leite et al., 2009; Bastian-Pinto et al., 2009; Mathews and Goldsztein, 2009)[5], there is no, as far as we know, analysis of what promotes the penetration of biofuels in retail sales, a key element to ensuring the survival of the industry.[6]

After this introduction, the rest of the paper is structured as follows: the main characteristics of the biodiesel market in Spain are explained in section 2; section 3 includes the database used in the econometric specification, which is developed in section 4. The results are shown in section 5. The article ends by presenting the main conclusions and policy recommendations.

2. The biodiesel market in Spain

In the market for biofuels, biodiesel plays a predominant role in the Spanish market, since the production and consumption of bioethanol are much smaller than in the U.S. Most European countries, contrary to what happens in America, share this feature. For this reason, we focus on the biodiesel market.

In this market, as pointed out by the report of the Spanish regulator *Comisión Nacional de la Energía* (CNE) (2005), there are numerous barriers that limit development, both with technical and related characteristics. With respect to the technical aspect, we find the crystallization and solidification of fuel microbial growth during pipeline transport, instability in storage and solvent power and the incompatibility with some plastic components in the retail market.

Papers related to the characteristics of the biofuel market identify some problems: the high costs of raw materials and production; regulatory uncertainties, mainly in agriculture, which

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[5] An example on the environmental effect of the adoption of such fuels is Sartzetakis, S., and Tsigaris, P. (2005).

[6] Articles like those of Rask (1998) and Luchansky and Monks (2009) have analysed the behaviour of supply and demand for bioethanol in the U.S., while focusing on the analysis of its elasticity and not on the diffusion or penetration of the product fuel retail market.

creates uncertainty about the availability of raw materials in the future; the absence of assurances from the producers of vehicles on the proper functioning of the engines; the lack of information for users; and, finally, the poor integration of biofuels into the distribution chain of conventional fuels.

As also indicated by CNE (2005), technical barriers should not be insurmountable for market development, as they can be solved relatively easily in the production, transportation and marketing of biodiesel blended with conventional fuel in percentages of up to 30%, as is the case of Spain.

Concerning the second type of barrier, the high costs of raw materials and production as well as the poor integration of biofuels into the distribution chain of conventional fuels are, without doubt, the most important.[7]

Major steps taken by European countries to compensate for the high costs of raw materials and production, as we noted, have been tax exemption, partial or total. For the specific case of Spain, the main legislative reference is the Order of the Ministry of Industry, Tourism and Commerce ITC/2877/2008 to regulate a mechanism for promoting the use of biofuels and the like for transport, making sense, and the Law 34/1998, which established annual targets for biofuel use in the Spanish territory. Among the tax measures introduced in this Order are the establishment of a zero tax rate on biofuels until 31 December 2012.[8] This exemption seeks to compensate for the higher cost of biofuel production with respect to traditional fuels and it takes into account their lower polluting capacity.

Measures to promote research and development techniques that reduce production costs have been established in the production segment.[9] Also, firms with a turnover level below 5 million are entitled to a deduction in the full quota of 10% of investments in equipment for renewable energy use and to purchase equipment for processing agricultural, forestry or waste oil into biofuels.[10]

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[7] Although there is some uncertainty about the future availability of raw materials, the existence of an international market to some extent helps to overcome that barrier. Similarly, there are already many automobile manufacturers that ensure the smooth operation of their vehicles in the case of using biofuels. Concerning the lack of information, measures to identify suppliers of biofuel and diffusion measures of the environmental benefits of biofuels have been instituted.

[8] Article 6.5 of Law 53/2002 of 30 December.

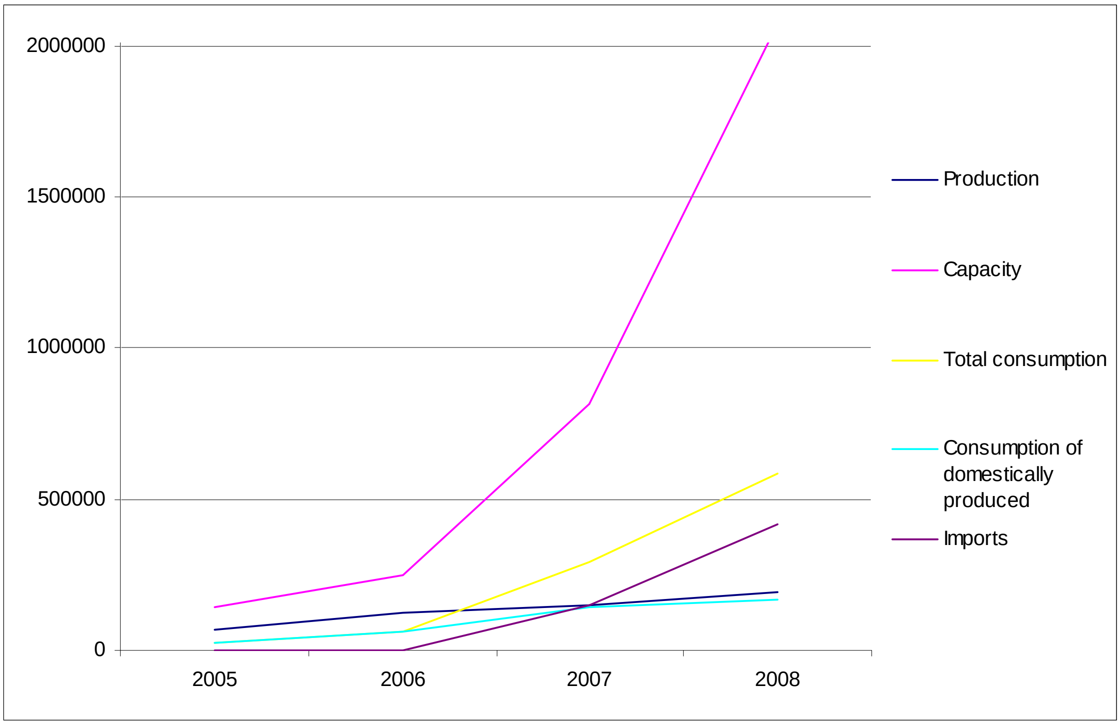
[9] The latter stresses Law 55/1999 of 29 December on fiscal administrative and social order, where amending Articles 33 and 35.4 of Law 43/1995 on corporate income tax look at the tax deductions for activities of research, development and technological innovation and investment in environmental protection.

[10] Law 24/2001 of 27 December on fiscal, administrative and social order amending Article 122 of Law 43/1995.

In addition to these tax measures, a regulation that set the minimum amounts of biofuels that operators must compulsorily consume has been passed. These biofuels are consumed by mixing with conventional fossil fuels.

Due to these measures production capacity shows a remarkable increase in recent years.[11] However, they have not yielded a competitive Spanish market for biodiesel, so it has lost market share in recent years, leading the ratio utilization rates/capacity of producing plants to the lowest levels in history, making it in most cases economically untenable.

Figure I. Capacity, production and biodiesel imports in Spain. Tonnes per year



Source: APPA Biocarburantes

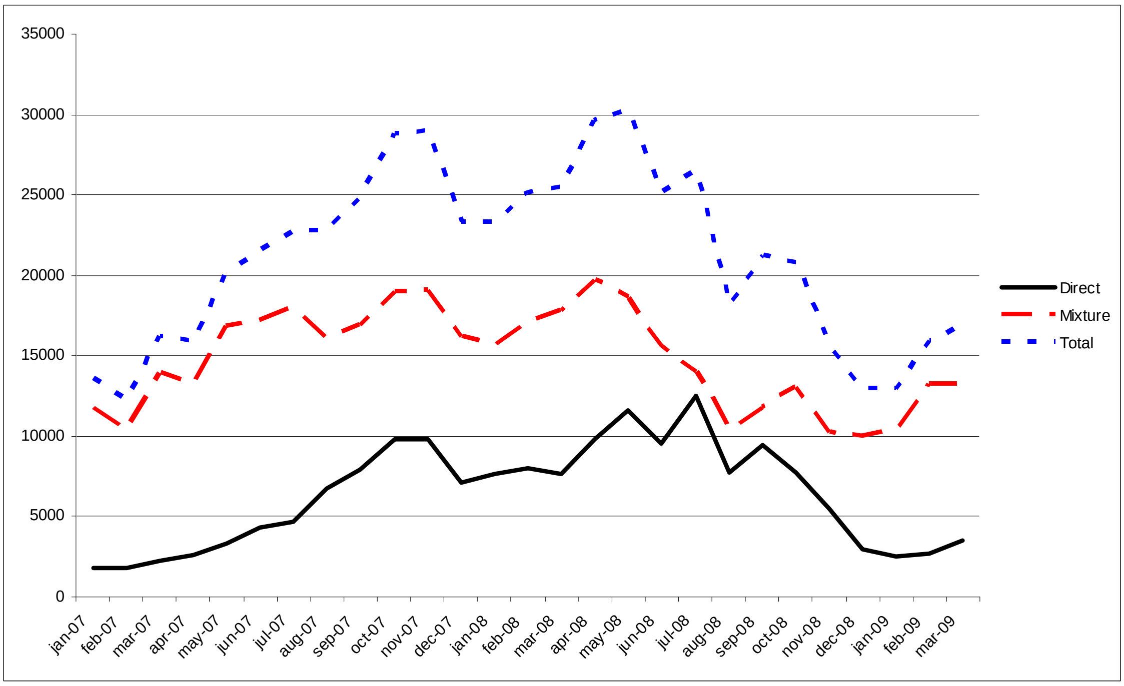
From Figure I and in Annex I, we can discern that only 4 of the 36 plants in 2008 (11%) are at a capacity utilization above 50%. Another 9 plants (25%) produced with a level of capacity between 10 and 50%, while the remaining 64% (23 plants) used between 0 and 10% of their available capacity.

One of the main reasons that consumption does not follow the path of production capacity is its limited inclusion in the distribution chain of conventional fuels. Thus, the percentage of service stations that dispense fuel is very small: only 8.6% of gas stations in our sample.

[11] Annex I includes the list of biodiesel production plants operating in Spain during 2008 and those planned for launch during 2009.

This aspect can also be inferred from the trend in the consumption of biodiesel in the past 2 years.

Figure II. Monthly evolution of the consumption of biodiesel. Spain. 2007–2009



Source: Corporación de Reservas Estratégicas de Productos Petrolíferos (CORES)

As shown in Figure II, the total consumption of this biofuel has fallen since mid 2008 at a monthly negative average rate change of 4.7%, especially in direct sales, although its use for increasing the octane of conventional diesel has also suffered a substantial reduction.

We can summarize that the biodiesel market outlook for Spain is not encouraging. The production segment is oversized, with a production capacity of 2,070,020 tons per year in 2008, 12 times the consumption that occurred in that year. Also, the segment is clearly not competitive with foreign producers, as evidenced by the increase in imports in recent years. These facts result in the economic infeasibility of a large number of existing plants, except if consumption increases further in the coming years, both in Spain and Europe.

In the retail marketing segment, the integration of biodiesel into channels of conventional fuels is almost zero, limiting the consumption of this fuel and decreasing the viability of the productive segment. As we shall see later, an element that may be helping the lack of penetration of biodiesel in the retail segment is the reduced competition in the Spanish gasoline market, as stated by Perdiguero (2010), Perdiguero and Jiménez (2009) and Jiménez and Perdiguero (2009).

3. Data

In order to estimate how the level of competition may affect the adoption of a new product such as biodiesel, we have information on all the service stations operating in the four major Spanish cities: Madrid, Barcelona, Seville and Bilbao.[12]

For the construction of the key variable, the level of competition in the market, we followed the strategy for the sector described by Shepard (1993), and Perdiguero and Borrell (2009), estimating the number of competitors that exist within a distance of half a mile. This calculation required the georeferencing of each of the 245 petrol stations, fixing the longitude and latitude and calculating the Euclidean distance to other stations of different brands, as a proxy for competition in the market.[13] This calculation was performed using the Matlab software.[14] Once we had calculated this distance, we obtained the number of service stations within half a mile.[15]

Similarly, for each of the stations, we have information on whether or not biodiesel is sold and if it provides (or not) the following services: grocery store, open 24 hours, car wash, self-service, workshop repair, the sale of gas canisters and/or bread and if there is a bar/restaurant.

This information has been obtained from the websites of different companies. We contacted those service stations that had no website by telephone and in the case of no response we visited the point of sale for such information, in the cases where it was possible. Despite these efforts we do not have information for all the service stations, which makes the sample slightly reduced in some of the estimates, but it is always above 90% of service stations. The next table shows the descriptive statistics of the variables mentioned above:

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[12] We have information on the ten biggest cities in Spain in terms of population but only in the four mentioned is there any retailer that provides biodiesel.

[13] In the Spanish gasoline market, there is no competition between the stations of the same brand as the company's wholesale fixes the final retail price directly or indirectly. Thus, only the number of stations that are of different brands were calculated.

[14] The Matlab code for the calculation of these distances is available on request from the authors'.

[15] 1/2 mile = 804.672 metres.

Table I. Descriptive statistics

	Obs.	Mean	Std Dev.	Min.	Max.
$No.\ Comp_i$	245	0.8490	1.0777	0	5
$No.\ Comp_i^2$	245	1.8776	3.5921	0	25
No. Serv.	230	3.4652	1.6941	0	7
No. Serv. Comp.	234	3.4188	1.6404	0	7
Shop	234	0.7308	0.4445	0	1
24 Hours	242	0.6612	0.4742	0	1
Wash Machine	234	0.4786	0.5006	0	1
No Self-Service	234	0.6709	0.4709	0	1
Gas	232	0.2586	0.4388	0	1
Bread	231	0.4632	0.4997	0	1
Restaurant	232	0.1681	0.3748	0	1
Shop Comp.	236	0.7288	0.4455	0	1
24 Hours Comp.	243	0.6420	0.4804	0	1
Wash Machine Comp.	236	0.4831	0.5008	0	1
No Self-Service Comp.	236	0.7542	0.4315	0	1
Gas Comp.	234	0.2564	0.4376	0	1
Bread Comp.	234	0.3632	0.4820	0	1
Restaurant Comp.	236	0.1568	0.3644	0	1
Madrid	245	0.5429	0.4992	0	1
Barcelona	245	0.2490	0.4333	0	1
Sevilla	245	0.1796	0.3846	0	1
Bilbao	245	0.0286	0.1669	0	1

Source: Own elaboration

Of the total of 245 service stations in the 4 cities considered, an average of 1 competitor in half a mile (0.849) is not achieved. The minimum number of competitors in that distance is 0 and the maximum is 5. The stations have more than 3 of the 7 characteristics analysed, being shop the feature more present. Regarding the distribution by city, Madrid has more than half the stations, followed by Barcelona, Seville and Bilbao.

4. Hypothesis and empirical approximation

As described above, the introduction of biodiesel have been a product innovation in this market and also for retailers. According to our hypothesis, it is influenced by the number of competitors that each outlet has in a predetermined radius that the literature determines as effective competition. To approximate this we estimate a logit model explaining the probability of selling biodiesel from the following expression:

$$Y_i = \beta_0 + \beta_1 No.Comp_i + \beta_2 No.Comp_i^2 + \beta_j X_{ij} + \varepsilon$$

where Y_i is a dummy variable that takes the value 1 if the service station *i* sells biodiesel and 0 otherwise. This decision depends on the number of rivals who have a service station within half a mile ($No.Comp_i$) and its square ($No.Comp_i^2$) and a set of control variables (X_{ij}). To satisfy the inverted U relationship described in the literature, we should observe a positive sign in the coefficient of the number of rivals in half a mile ($\beta_1 > 0$) and a negative coefficient for its square ($\beta_2 < 0$). These are the two hypotheses that we test empirically.

Among the control variables (X_{ij}), we include dummies for the different cities, the different services offered by each retail outlet and the services offered by the nearest competitor. The variables in the different cities take the value 1 if the station is located in the city and 0 otherwise. These variables should pick up possible differences in local legislation or in the sensitivity of consumers faced by the innovation of introducing this new product.

Regarding services offered by the petrol station, the possibility that these variables are considered as strategic for the competition should be set out, so that each station could include other services to compete with their rivals, rather than offering the new product. However, the service stations that have introduced other services in the past and therefore do not have many more services to add may have a greater predisposition to introduce this new product at the point of sale. As already indicated by Grabowski (1968), companies that succeed in introducing innovations to the market have a greater willingness to innovate. Therefore, the relationship between other services offered by the service station and the probability of selling biodiesel is a matter to be determined empirically. To the services described above we introduce both the grouped shape (the number of services offered by the station or the nearest rival) and an individual one (a dummy variable for each service, which takes the value 1 if the petrol station offers the service and 0 otherwise).

We must note that, in addition to the institutional differences that may exist between regions and that would be reflected in the dummy variables for the cities, there may be heterogeneity among the service stations in the regions. To solve this problem of heteroskedasticity and to obtain a robust variance–covariance matrix, we introduce a cluster in a city that takes into account this feature of the data.

Finally, we note that the sample is a small number of positive cases. In fact, 8.6% of the total number of service stations in these 4 cities offers biodiesel (21 outlets). This low level of values can lead to the logit estimator reaching results that might not be efficient. To solve this problem, we estimate the model described by a "complementary log-log model". This type of logistic model takes into account that the database can be unbalanced, because there is either a low probability of occurrence or a high probability. Thus, the estimate would be efficient. The results obtained are shown in the following section.

5. Results

Table II contains the estimation using the "complementary log-log model",[16] in five different specifications depending on the number of variables included: the first only includes the number of rivals, the second includes the number of available services in aggregate, the third adds the number of services of the rivals, the fourth estimation includes the number of rivals and the services of the petrol stations in disaggregate and, finally, the fifth also adds the services of rival stations. These different specifications will help us verify the robustness of our analysis and show that there are problems of omission of relevant variables that might bias our results.

[16] Annex 2 presents the empirical results of applying a logit estimator. We can see that the results did not change significantly.

Table II. Complementary log-log models, robust					
	Est. 1	Est. 2	Est. 3	Est. 4	Est. 5
Constant	-1.487***	-1.911***	-2.361***	-3.439***	-2.540*
	(0.149)	(0.684)	(0.307)	(1.333)	(1.320)
No.Comp$_i$	0.338*	0.433**	0.474*	0.528**	0.609***
	(0.196)	(0.209)	(0.296	(0.224)	(0.165)
No.Comp$_i^2$	-0.090*	-0.105*	-0.100***	-0.119**	-0.160*
	(0.055)	(0.057)	(0.037)	(0.055)	(0.089)
No. Serv.		0.055	0.109		
		(0.251)	(0.220)		
No. Serv. Comp.			0.029		
			(0.073)		
Shop				2.894**	2.702**
				(1.460)	(1.241)
24 Hours				-1.001	-1.154
				(1.076)	(1.137)
Wash Machine				0.341	0.751***
				(0.643)	(0.282)
No Self-Service				0.013	0.504
				(0.464)	(0.545)
Gas				-1.837**	-1.021
				(0.744)	(1.136)
Bread				-0.693	-0.964
				(0.789)	(0.812)
Restaurant				-0.204	-0.251
				(0.270)	(0.529)
Shop Comp.					-0.103
					(0.264)
24 Hours Comp.					-0.879
					(0.735)
Wash Machine Comp.					0.293
					(1.068)
No Self-Service Comp.					-1.815***
					(0.493)
Gas Comp.					-1.450
					(1.184)
Bread Comp.					0.442
					(0.945)
Restaurant Comp.					1.298***
					(0.289)
No. Obs.	245	230	221	230	221

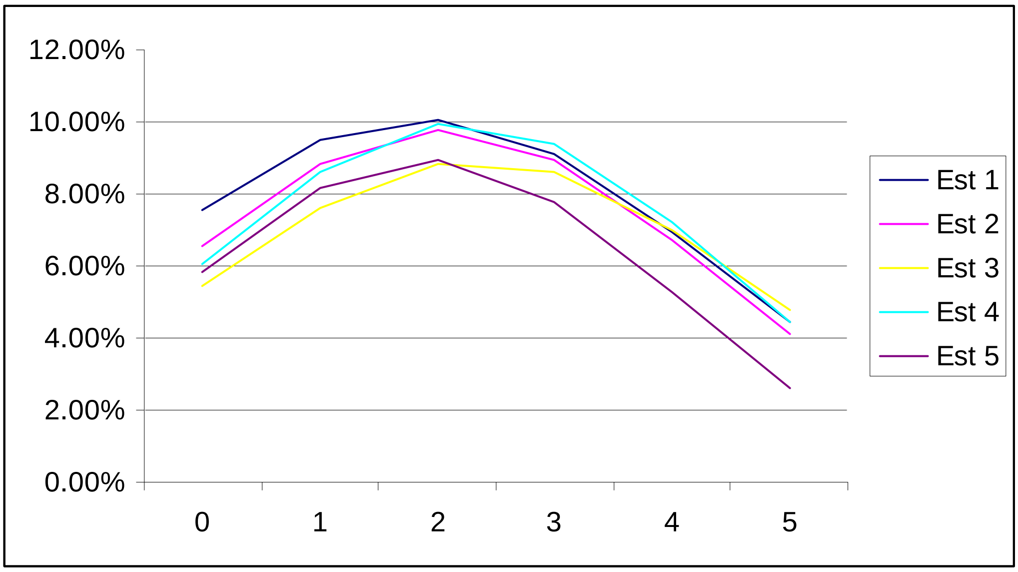
Note: Fixed effects of cities are not included in the table. (*** 1%, ** 5%, *10%)

The estimations show that the coefficient of the number of rivals who are half a mile away is positive and significant in all cases as well as its square being negative and significant. This empirical evidence indicates that there seems to be an inverted U-shaped relationship between competition and opportunities to innovate in the market, as indicated by Aghion et al (2005).

Also, they show that the services offered by the outlet do not have a significant effect on the possibility of selling biodiesel, as well as the services offered by the nearest rival. Most of the services variables are not significant, and those that are show both positive and negative signs. Only in specification five can we observe that two services offered by the gas station are significant and positive (shop and car wash). This result would support the idea that service stations that have introduced other goods or services before are more likely to introduce biodiesel.

To show more clearly the inverted U relationship between the incorporation of biodiesel and the number of competitors in half a mile, we perform a series of simulations to determine the likelihood of its existence, as summarized in the figure below.

Figure III. Evolution of the probability of selling biodiesel depending on the number of competitors in half a mile



Source: Own elaboration

As seen in Figure III, in all the specifications, the maximum probability is reached in a market structure with 2 opponents in less than half mile. Considering that the average rivals in our sample do not reach 0.9, we conclude that there is indeed potential for increasing the marketing of biodiesel incident to market structure, i.e. increasing the level of competition that exists today. We should note that Spain has one of the lowest densities of petrol per thousand inhabitants in all of Europe, which we estimate would explain, at least in part, the low level of commercialization of biodiesel.

It should be noted, however, that the chances of introducing the new product are low in all cases. Even with the number of rivals that maximizes the probability of introducing innovation (2 competitors), this probability barely reaches 10%. Therefore, the increased competition would be a measure that helps increase the penetration of biodiesel in Spain, and thus complements fiscal and regulatory measures put in place today.

6. Concluding remarks

The introduction of renewable energy to help reduce CO_2 emissions and therefore to comply with environmental commitments is a primary objective in Europe. Both in Europe and in Spain several incentives have been introduced for the development of the biofuel industry and more specifically biodiesel. As a result of these measures, there has been a steady increase in production capacity in Spain, which contrasts with the moderate growth in demand and the strong increase in the percentage of imports. This fact causes many plants to operate below 10% of their capacity, a threshold that make the continuity in the market unviable.

To explain the low penetration of biodiesel consumption in Spain, we have discussed how service stations make the decision to offer this new product. Following the industrial economics literature, where empirical evidence exists on the effect of the market structure on innovation, we based the study on the existence of a nonlinear effect in an inverted U-shaped form: the greater the number of competitors in a market increases the probability of innovation, but beyond a certain level, this probability decreases.

The application of this approach to the four major Spanish cities shows that for biodiesel this functional form actually exists. The presence of one or two competitors within half a mile increases the probability of introducing the new fuel while having greater competitive pressure reduces the chance of having it.

Considering that Spain has one of the lowest densities of petrol stations in Europe, and that the transition from public monopoly to the free market cannot yet generate effective competition in the market, Spain can provide consumption levels of biofuels that are too low, at least in part, in relation to its market structure. Promoting the consumption of this type of fuel is key to maintaining a recently established bloated generation industry and the current levels of consumption are completely unsustainable.

Given the empirical results obtained in this study, a way to promote the consumption of such fuel would be to introduce more competition into the market, either through new entrants or by facilitating a change of brand of the retailers established in the market, which would mean that there are traders of different brands in each market. However, these measures would probably have a limited effect, since even with the optimal level of competitors the probability of selling biodiesel only reaches 10%. Therefore, measures to promote competition can help increase the penetration of biodiesel in Spain, but there should be accompanying measures, fiscal and regulatory measures already introduced in the market, if we are to achieve the objectives proposed by the European Union.

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Annex I. Production and projections of biodiesel production in Spain

Table A.I.1. Biodiesel plants in Spain on 31 December 2008

Firm	Locality	Province	Capacity (t)
Infinita Renovables	Castellón	Castellón	300000
Bioenergética Extremeña 2020	Valdetorres	Badajoz	250000
Bio-Oils Huelva I	Palos de la Frontera	Huelva	250000
Combustibles Ecológicos Biotel	Barajas de Melo	Cuenca	150000
Biocarburantes CLM	Ocaña	Toledo	105000
Biodiesel Aragón	Altorricón	Huesca	100000
Linares Biodiesel Technology	Linares	Jaén	100000
Biocom Energía	Algemesí	Valencia	75000
Biodiesel Caparroso	Caparroso	Navarra	70000
Biocombustible de Cuenca	Cuenca	Cuenca	50000
Ecoproductos Cast. La Mancha	Montalbo	Cuenca	50000
Bionet Europa	Reus	Tarragona	50000
Entabán Biocomb. Guadalquiv.	Sevilla	Sevilla	50000
Biodiesel Castilla la Mancha	Santa Olalla	Toledo	45000
Biodiesel de Andalucía 2004	Fuentes de Andalucía	Sevilla	40700
Combunet	Monzón	Huesca	40000
Energía Gallega Alternativa	Cerceda	A Coruña	40000
Bionor Berantevilla	Berantevilla	Álava	35320
Biocarburantes de Galicia	Begonte	Lugo	35000
Grupo Ecológico Natural	Llucmajor	Baleares	33000
Stocks del Vallés	Montmeló	Barcelona	31000
Hispanergy Puertollano	Puertollano	Ciudad Real	25000
Entabán Biocomb. Del Pirineo	Alcalá de Gurrea	Huesca	25000
Biocarburante Almadén	Almadén	Ciudad Real	21000
Biocarburante de Castilla	Valdescorriel	Zamora	20000
Diesol	Alcalá de Henares	Madrid	15000
Bioteruel	Albalate del Arzobispo	Teruel	10000
Comb. Ecol. Mediterráneo	Elda	Alicante	10000
Albabío Andalucía	Níjar	Almería	6000
Biocarburos de Almanzora	Cuevas de Almanzora	Almería	6000
Biodiesel Carburantes	Carranque	Toledo	6000
Bercam	Los Yébenes	Toledo	6000
Bionorte	San Martín del Rei	Asturias	5000
Biocomb. De Castilla y León	San Cristóbal de Entrevías	Zamora	6000
Transportes Ceferino Martínez	Vilafant	Girona	5000
Asthor Biodiesel	Gijón	Asturias	4000
TOTAL			**2070020**

Source: APPA Biocarburantes

Table A.I.2. New biodiesel production capacity in Spain. Year 2009

Firm	Locality	Province	Capacity increase (t)
Infinita Renovables	Castellón	Castellón	+300000
Infinita Renovables	Ferrol	A Coruña	300000
Iniciativas Bioenergéticas	Calahorra	La Rioja	250000
Abengoa San Roque	San Roque	Cádiz	200000
Biodiesel Bilbao	Ziérbana	Vizcaya	200000
Saras Energía	Cartagena	Murcia	200000
Cogeneración de Andújar	Andújar	Jaén	200000
Biocombustibles de Ziérbana	Ziérbana	Vizcaya	200000
Entabán Biocomb. de Galicia	Ferrol	A Coruña	200000
Biocarburantes Peninsulares	Narón	A Coruña	120000
Greenfuel Extremadura	Los Santos de Maimona	Badajoz	110000
Sdad. Coop. Gral. Agrop. Acor.	Olmedo	Valladolid	100000
Aceites del Sur – Coosur	Tarancón	Cuenca	50000
Dipesa Gestión	Madrid	Madrid	50000
Augas Mansas	As Pontes	A Coruña	34000
Solartia	Los Arcos	Navarra	28500
Hispanergy del Cerrato	Herrera de Valdecañas	Palencia	25000
Biocom Pisuerga	Castrojeriz	Burgos	6000
TOTAL			**2273500**

Source: APPA Biocarburantes

Table A.I.3. New biodiesel production capacity in Spain projected to 2010

Firm	Locality	Province	Capacity increase (t)
Bio-Oils Huelva II	Palos	Huelva	250000
Greenfuel Aragón	Andorra	Teruel	110000
Biodiesel de la Ribera	Milagro	Navarra	16100
TOTAL			**376100**

Source: APPA Biocarburantes

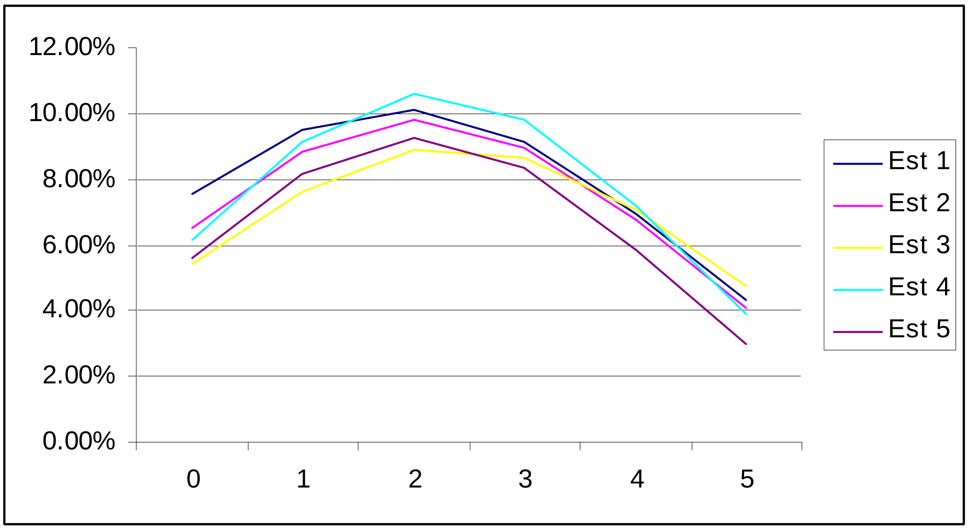
Annex II. Estimated logit model

Table A.II.1. Econometric estimation. Logit model, robust

	Est. 1	**Est. 2**	**Est. 3**	**Est. 4**	**Est. 5**
Constant	-1.371***	-1.804**	-2.340***	-3.335***	-2.786**
	(0.161)	(0.756)	(0.371)	(1.224)	(1.400)
$Nriv_i$	**0.380***	**0.472****	**0.529****	**0.630****	**0.725*****
	(0.225)	**(0.231)**	**(0.270)**	**(0.263)**	**(0.142)**
$Nriv_i^2$	**-0.101**	**-0.114***	**-0.111*****	**-0.147****	**-0.193*****
	(0.068)	**(0.069)**	**(0.032)**	**(0.059)**	**(0.056)**
N° Serv.		0.050	0.115		
		(0.270)	(0.236)		
N° Serv.Riv.			0.038		
			(0.068)		
Shop				3.365**	3.189**
				(1.533)	(1.532)
24 Hours				-1.307	-1.359
				(1.241)	(1.340)
Wash Machine				0.354	0.741**
				(0.601)	(0.357)
No Self-Service				-0.055	0.520
				(0.382)	(0.386)
Gas				-2.082**	-1.219
				(1.000)	(1.218)
Bread				-0.950	-1.132
				(0.869)	(0.982)
Restaurant				0.012	0.229
				(0.307)	(0.709)
Shop Riv.					-0.023
					(0.296)
24 Hours Riv.					-1.047
					(0.469)
Wash Machine Riv.					0.252
					(1.209)
No Self-Service Riv.					-1.816
					(0.530)
Gas Riv.					-1.792
					(1.205)
Bread Riv.					0.819
					(1.376)
Restaurant Riv.					1.219***
					(0.453)
Pseudo R^2	0.1412	0.1187	0.1233	0.2695	0.3749
Chi^2	27.39***	60.28***	69.68***	23.77***	7.90**
	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0481)
No. Obs.	245	230	221	230	221

Note: Fixed effects of cities are not reported. (*** 1%, ** 5%, *10%)

Figure A.II.1. Simulation of the effect of rivals on the probability of introducing biodiesel



Source: Own elaboration

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