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"Vertical relations and local competition: an empirical approach"

Jordi Perdiguero García

Institut de Recerca en Economia Aplicada | *Research Institute of Applied Economics*

IREA
Institut de Recerca en Economia Aplicada Regional i Pública
Research Institute of Applied Economics
Universitat de Barcelona
Av. Diagonal, 690 • 08034 Barcelona

WEBSITE: www.ub.edu/irea/ • CONTACT: irea@ub.edu

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Abstract

The analysis of vertical industry relations forms an essential element in the field of industrial organization. This paper tests hypotheses derived from transaction cost theory and the principal-agent problem in Chile's petrol market. It shows that local competition plays an important role in the choice of a "disintegrated" vertical structure, and that low levels of service investment have the same effect. Conversely, the number of own-brand outlets and a high level of investment in services reduce the probability of disintegration. The paper demonstrates that vertical disintegration has a null effect on wholesale petrol prices and a positive effect on retail petrol prices of between 1.6 and 7 per cent, depending on fuel type.

JEL classification: L11, L22, L42
Keywords**:** Vertical structure, local competition, petrol market, services and prices

Jordi García Perdiguero. GiM Research Group-IREA. Department of Economic Policy and World Economic Structure. University of Barcelona, Av. Diagonal 690, 08034 Barcelona, Spain. E-mail: jordi.perdiguero@ub.edu

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1. Introduction

Why companies decide to buy or to produce certain products and services is a key question in industrial organization, especially as regards retailing. It is essential to know a firm's limits and why it chooses to increase or reduce the number of activities in which it engages[1]. One traditional explanation as to why small firms might produce or purchase activities, such as retailing, is that they are responding to the financial problems they face as they seek rapid market expansion (Caves and Murphy, 1976). Small firms have limited access to capital markets, and franchising represents a cheaper source of financing. The theory holds, therefore, that small firms will disintegrate some of their stores so as to monitor their profitability, while internalizing the more profitable ones. In such instances, disintegration is not a rational decision taken by a firm to achieve its most efficient vertical structure, but rather a financial necessity.

However, not only small companies franchise outlets. Large companies also opt to franchise all or part of their retailing, which casts some doubt on the validity of the above theory. Indeed a number of scholars, including Rubin (1978), criticize this theory on the grounds that the risk of investing in a single retail outlet is greater than that involved in investing in the shares of different stores. Risk-averse agents seek a greater return than investing in a single retail outlet, as this can be more expensive than offering a share of the investment to the franchisee. Thus, problems accessing capital markets are not the only factor influencing the decision to disintegrate part of the product chain.

In contrast to this theory, authors such as Sklivas (1987) present the vertical relationship as the rational outcome of the desire to create the most efficient business format. The most popular of the theories here are transaction cost analysis and positive economic theory, which analyze vertical relationships as a response to the principal-agent problem[2]. According to transaction cost theory, an efficient vertical structure seeks to minimize transaction costs, i.e., the cost when a good or service is transferred across a technologically separable interface. The principal-agent problem increases this transaction cost, as it generates price and effort control costs for the retailer. Herein lies the link between the two theories[3].

[1] See Lafontaine and Slade (2007) for an extensive summary of vertical relations in different industries.
[2] See Katz (1989) for an extensive summary of the positive theory of vertical restraints and Williamson (1981) or Lafontaine and Slade (1996) for transaction cost analysis.
[3] For theoretical and empirical comparisons of the financial restriction problem and transaction costs, see Brickley and Dark (1987), Carney and Gedajlovic (1991) and Kehoe (1996).

These theoretical models, therefore, seek to establish a relationship between a firm's characteristics and the probability of its disintegration. Yet, generally, they reveal how integrated vertical relationships serve to limit the incentives operating for retailers to make much effort. In the case of the integrated system, retailers receive a fixed wage and, hence, obtain some incentive to make an effort. However, in a disintegrated system, these incentives are increased further. But, at the same time, the system serves to exacerbate other principal-agent problems, including the double marginalization of prices, and the establishment of levels of service and effort below those of the efficient firm level.

Local competition plays an important role in this trade-off. Firstly, competition at this level eliminates the problem of double marginalization, which is a key variable in the principal-agent problem. Secondly, it may moderate or eliminate the costs of effort and those of undertaking service quality controls in a disintegrated channel. The competitive environment means that private managers offer both price and quality of services at the levels established by the market equilibrium. Private managers are unable to take advantage of transaction costs or incomplete contracts, because the market imposes the prices and quality. The effect of local competition was first discussed by Williamson (1979), who showed theoretically that, in the presence of competition, vertical disintegration is dominant at the expense of vertical integration. However, the empirical literature has not tested in deep this theoretical relationship.

The main innovation of this paper, therefore, is its introduction of local competition into the empirical specification as an essential element in accounting for the choice of the vertical relationship between firms and retailers, in contrasts with other authors that have analyzed this same issue, including John and Weitz (1988), Levy (1985), Minkler (1990) and Baker and Hubbard (2003, 2004). A further innovation is that in this paper I test the effect of two different vertical relationships on wholesale and retail prices, taking into account the endogenous character of vertical type relationships.

I have found very little empirical evidence for the effects of local competition on the vertical structure of firms, and there is even less evidence for the effects of these different structures on wholesale and retail prices. If the companies choose these structures efficiently, and we can control all the factors that might affect the price, then probably the type of vertical structure does not affect price levels. If the disintegrated outlets are located in more competitive markets, then the prices in them will be low. However, if local competition is not a perfect instrument to control price and effort, then the disintegrated structured will probably incur higher costs and, consequently, charge higher prices than is the case in vertically integrated stores. Here, the empirical

specifications seek to estimate the effects of the different vertical price control structures for all factors that might have a bearing on price levels.

The empirical implications are tested in the Chilean petrol market. Petrol markets have traditionally been used for testing different vertical relationships because there are clear and identifiable stages in the product channel, different vertical relationships and a great number of different market characteristics on which the various empirical implications can be tested; for example, services, level of competition, investment necessities, etc.

The paper is organized as follows. The next section describes the main characteristics of the Chilean petrol market, which is my reference market for testing the empirical hypothesis. Section 3 presents the empirical hypothesis in the light of the transaction costs and principal-agent problem models. Section 4 describes the data used to test the hypothesis, and Section 5 includes the empirical specifications and results. My conclusions are presented in Section 6.

2. Chilean petrol market

The Chilean petrol market comprises three segments: the refinery, the wholesale and the retail markets. The first of these, the refinery market, is characterized by public intervention. As such, the Government owns all the refineries, and prices are regulated by a formula that is fixed in accordance with the international price for refined petrol. In Chile the *Empresa Nacional del Petróleo* (ENAP or the Chilean National Petroleum Company) is responsible for setting petrol prices and all companies pay the same price to ENAP.

The wholesale market is made up of the companies - COPEC, ESSO, SHELL and YPF - that buy refined petrol from ENAP. They then sell it on to the petrol stations, which are normally stations belonging to their same brand. While the price that companies pay ENAP is regulated and equal for all, the wholesale prices charged to the petrol stations are free of all restrictions. As such, the companies can charge a different wholesale price, not only in function of different costs (including transport and labor costs), but also in function of strategic variables such as different vertical relationships.

Finally, the retail segment is constituted by the same companies as in the wholesale market plus a number of independent retailers. The various operators are free to fix both the wholesale and retail prices. However, the fixing of the final price is not entirely free as it depends on the vertical relationship between the company and the retail operator. Some petrol stations are free to fix their

own retail prices, while others are set by the firms. Below, I define the different vertical relationships and outline how they affect the freedom to fix the final price.

The vertical relationship between the companies and the retailers in the Chilean petrol market depends on whether the company owns the petrol, and whether the final price is fixed by the company or by the retail operator. If the company owns the petrol until the fuel is sold onto the consumer, then the retailer simply works for the company and earns a commission. As such the retailer operates as a commission agent and can be considered a company employee. On the other hand, if the company sells the petrol to the station, who in turn sells it on to the consumer, then the station operates as a reseller. Thus, we can distinguish between:

> *Resellers*: Retailers purchase from the wholesalers and sell the fuel to the consumers. As the retailer is free to fix the final price, the volume they sell and their margins determine the final profit. I refer to this as a disintegrated vertical relationship.
>
> *Commission Agent:* The company retains ownership of the petrol until it is sold to the consumers. The commission agents act as company employees by selling the petrol to the consumers, for which they receive a commission. Their profits depend on the volume of petrol sold and on the rate of commission fixed between the agent and the company. Traditionally, the commission comprises a fixed component, similar to a wage, and a variable component that depends on the quantity sold, which increases the incentive to sell. I refer to this as an integrated vertical relationship.

In the Chilean petrol market it is the companies that build the petrol stations and who determine the type of vertical relationship they wish to enter into with the retailer; or, alternatively, an individual may build a petrol station and sign a contract with a wholesale company. This eventuality needs to be considered here as the retailers in this market have, on occasion, to fix the level of investment and assume the risk. In this respect the market differs from that operating in the United States, where the companies build the stations and then choose the type of vertical relationship they wish to establish with the retailers.

Thus, the Chilean petrol market is characterized by a public refinery sector that sells the refined petrol at the same price to the four companies that operate in the wholesale market. These four companies are free to fix the wholesale price for their retail operators and the independent retailers.

This wholesale price can differ, not only in accordance with the different costs incurred, but also with other strategic variables such as the type of vertical relationships[4].

3. The role of local competition in vertical relationships

As we have seen in Section One, local competition can play an important role in determining the vertical structure. Local competition can positively affect disintegration for at least two reasons:

- The probability of double marginalization is eliminated. If competition exists, then the private manager cannot fix a price level above the market equilibrium price. Then, the company can disintegrate the service without the threat of the private manager fixing a price higher than the efficient company level.

- Similarly, competitors make the private manager offer an efficient level of service, both in terms of number and quality. If competition exists then the private manager has to offer the number and the quality of services that the market fixes. Thus, competition eliminates the threat of underinvestment in services and of a lower quality service than the efficient company level.

If competition in the local market is strong, then a disintegrated vertical structure represents the most efficient structure for the company. As Williamson (1971, 1979) and Anderson (1985) show, disintegrated vertical relationships are more efficient than integrated systems and benefit competition. So Hypothesis 1 is:

H1: The level of competition in the local market positively affects the probability of disintegrating the services.

Nonetheless, there are other characteristics that can affect the vertical structure, which may or may not make vertical disintegration an efficient structure for the firm.

Concentration of Outlets

The concentration of own-brand outlets plays an essential role in the decision as to whether or not to disintegrate. One reason for disintegrating the services is when private managers have a greater

[4] For further details of the Chilean petrol market see Gómez-Lobo and Córdova (2006).

incentive to promote sales compared to that of employees that receive a fixed salary. If the company wishes to ensure its employees make the right amount of effort, does monitoring employee behavior and this control represent a cost for the firm? The fact that the stations are spatially concentrated reduces this cost of monitoring, and increases the probability of integrating the services - see, for example, Anderson and Schmittlein (1984), Anderson (1985) and Brickley et al. (1991).

So the second hypothesis that needs to be tested empirically is:

> *H2: The concentration of outlets of the same brand has a negative effect on the probability of disintegrating the service.*

Level of Investment

The level of investment necessary for opening a new station negatively affects the disintegration of the services, since private managers face greater difficulties in obtaining the necessary financial resources. So, if the investment needed to open the station is high, then it is less probable that the station operates under a disintegrated structure.

> *H3: If the investment necessary to open a new store is substantial, then it is less probable that the company operates under a disintegrated structure.*

Level of Services

The level of services that a petrol station offers has a positive effect on the probability of disintegration because employees in the integrated system have less incentive to make an effort. So, if the number of services over which the firm has to control the level of effort increases, then the probability of disintegrating this petrol station increases. Authors such as Shepard (1993) have established that the level of services is the main characteristic accounting for the choice of a vertical structure.

> *H4: As the number of services that the petrol station offers increases, the probability of disintegrating the structure increases.*

It should be borne in mind that the level of services offered and the level of investment required in supplying it are usually closely related. If the petrol station offers a service that needs sizeable investment, such as a vehicle repair shop or a pharmacy, then this service will have two conflicting

effects on the vertical structure. A disintegrated system is the likely outcome as it can offer more services; yet, conversely, a more integrated service can be expected because of the greater level of investment required. Thus, we need to verify empirically the net effect of the different services as regards the probability of disintegration.

A further two hypotheses are traditionally tested in the literature that are not tested in this paper. The first is the effect of transacting specific assets within the vertical relationship. If the store has to invest in expensive specific assets, it would need a long term contract to recover the investment. Sometimes the duration of the contracts are limited by law, as in the European petrol market, and this means that a disintegrated system leads to underinvestment. So, investment in specific assets reduces the probability of disintegration - see Williamson (1979), and the empirical results reported by Anderson and Schmittlein (1984). Here, I do not test this hypothesis as the petrol market has no obvious brand specific assets.

The second hypothesis (not tested here) is the effect of non-repeat consumers. Retailers that have non-repeat customers have little or no incentive to make any effort or to provide quality services. As such, they tend to reduce the brand value. For these reasons, retailers situated in places with non-repeat customers are more likely to be vertically integrated. For the petrol market this hypothesis can be tested on motorway petrol stations. However, in Santiago, the Chilean capital and the area considered in this paper, there are no petrol stations on the motorways in the metropolitan area.

While it might be important to test the effect of the different characteristics within the vertical structure, it is perhaps more pressing to verify the effects of the two different vertical structures on the wholesale and final prices. In the case of the wholesale price, it is not easy to predict the possible effects of disintegration primarily because in integrated firms the wholesale price acts like an internal price, since the same firm is both the seller and the buyer, and as such the real price might not be reflected.

As discussed in the previous section, the effect of the vertical structures upon the retail price can be ambiguous. If the disintegrated retailers are trading in a more competitive environment they will probably fix lower prices. However, if local competition is an imperfect instrument to solve the principal-agent problems, then probably the disintegrated petrol stations will fix higher prices. Theoretically, the vertical structure can ambiguously affect the final prices, but there is strong empirical evidence demonstrating a positive effect between disintegration and prices. By using different techniques, authors such as Barron and Umbeck (1984), Shepard (1993), Blass and

Carlton (1999) and Vita (2000) provide empirical evidence for a positive relationship between disintegration and prices, although none of them take the endogenous nature of the vertical structure into account.

The hypotheses presented in this chapter, and the effects of two different vertical relationships on prices, are tested in Section 5 using data from the Chilean petrol market. In the next section I present the data used in the empirical specification.

4. Data

I seek to test these hypotheses in Chile's petrol market drawing on a survey conducted by the Chilean Government's National Economic Prosecutor's Office (*Fiscalia Nacional Economica*). The survey supplies information regarding the addresses of the petrol stations, contract types, prices, quantities sold, services and brands. It consists of individual daily data for 208 of the 470 petrol stations in Santiago's metropolitan area. Table 1 provides a statistical description of this survey. The data covers January to September 2006.

Table 1. Survey statistics

	Nº observations	Mean	SD
Retail price 93	208	604.29	7.92
Wholesale price 93	109	587.96	14.89
Quantity sold 93	207	2290.69	1823.80
Retail price 95	170	611.48	15.11
Wholesale price 95	74	595.30	17.74
Quantity sold 95	163	4787.18	2781.41
Retail price 97	207	624.20	10.58
Wholesale price 97	106	605.96	13.49
Quantity sold 97	206	1455.53	1564.42
Retail price Diesel	206	455.48	9.58
Wholesale price Diesel	107	445.28	13.56
Quantity sold Diesel	205	2267.30	2063.74
ENAP Price 93	208	542.40	----
ENAP Price 95	208	561.55	----
ENAP Price 97	208	580.62	----
ENAP Price Diesel	208	413.58	----
Number of rivals 0.5 miles	208	2.01	1.87
Number of rivals 1 mile	208	6.16	4.41
Number of rivals 2 miles	208	24.34	14.56
Own-brand outlets 0.5 miles	208	0.75	0.98
Own-brand outlets 1 mile	208	2.01	1.93
Own-brand outlets 2 miles	208	8.48	6.87

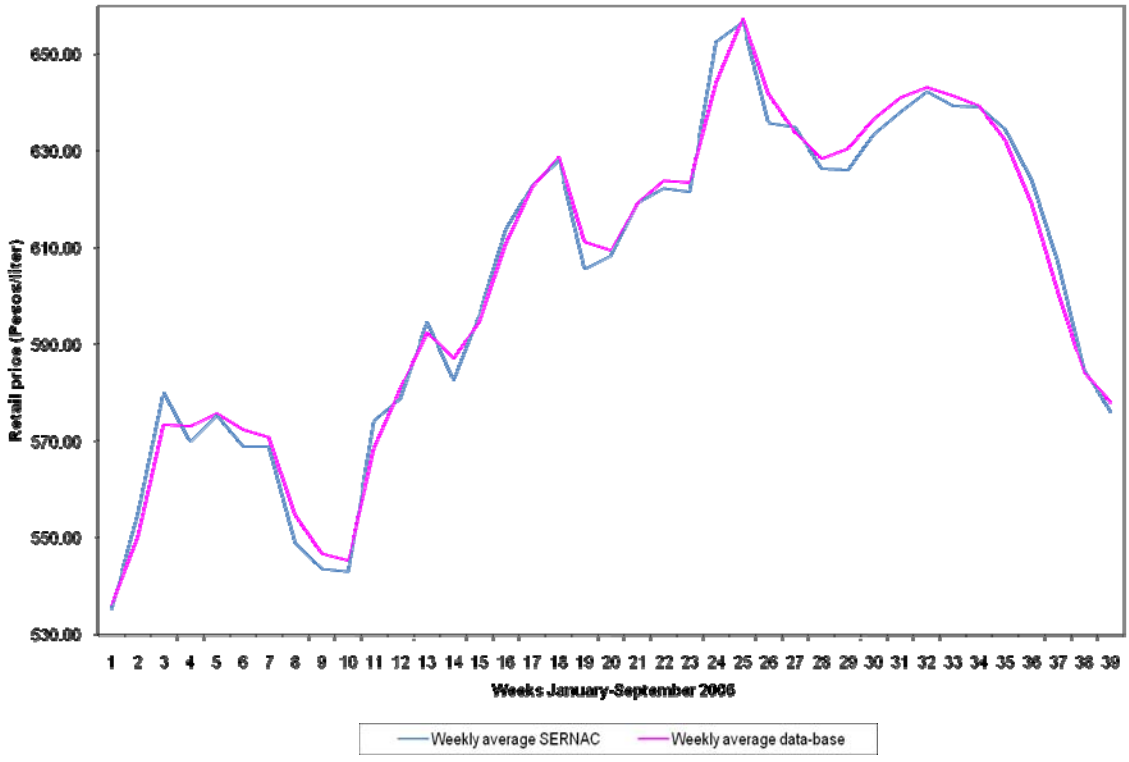
Table 1 shows that the wholesale prices and the retail prices follow a logical progression: thus, the price of unleaded petrol 97 is more expensive than unleaded petrol 95, and this in turn is more expensive than unleaded petrol 93. The ENAP pricing follows the same pattern. This progression is

logical, reflecting the increased costs incurred in obtaining higher quality fuels. The number of rivals and the number of own-brand outlets are also rational, increasing with the size of the market. A further characteristic that becomes apparent is that for all market sizes the number of rivals is greater than the number of own-brand outlets. More specific statistical relationships between prices, number of rivals, number of own-brand outlets and the type of vertical relationship are presented at the end of this section.

Although the general statistical descriptions do not present any irrationalities, a further two features are needed to validate this database: first, the possible presence of self-selection problems in the data and, second, the method used to compute the number of rivals and own-brand outlets.

The fact that less than fifty per cent of the petrol stations completed the survey may have introduced self-selection problems into the data. The possibility that only the petrol stations with certain characteristics (for example, low price, high level of services, etc.) or those owned by certain companies answered the survey introduces a possible bias into the empirical specification. To test whether our sample is representative of the regional petrol market, we compared our average weekly price with the price reported by National Consumer Service (*Servicio Nacional del Consumidor*, SERNAC), which is a representative survey published by the state-owned company affiliated to the Ministry of Economy. The following graph shows the two time series.

Graphic 1. Comparative evolution of prices: Data base vs. SERNAC. (Unleaded gasoline 93)



It is apparent that the two series of data are very similar, showing a correlation of 0.99 for unleaded petrol 93[5].

Likewise, the respective percentages of vertical relationship types in the whole market and in the data studied here are similar. The proportion of resellers in Chile's petrol market is 40.9 per cent, while here the share stands at 40.5 per cent. Thus, in general, the percentage of petrol stations operating according to the two types of vertical relationship is representative of the whole petrol market.

In conclusion, given that the pricing and the two types of vertical relationship are representative of the market, the data can be considered representative of the petrol market in Santiago's metropolitan area.

The second concern regards the method used to compute the number of rivals and the number of own-brand outlets in the various geographical markets (i.e., half a mile, one mile and two miles). To do this, the points of longitude and latitude were determined using "*Google Earth*" software. Given that we have the addresses for the 470 petrol stations, the geographical coordinates of all the petrol stations could be fixed in the market. Clearly, here it was necessary to obtain full market information, so as to take into account all possible rivals and own-brand outlets. Using the geographical coordinates we computed a 470 x 470 matrix with 220,900 distances indicating the location of each petrol station with respect to the other 469 pumps. These distances were computed using "*Matlab*" software. With the same software, a further two programs were designed to compute the number of rivals and the number of own-brand petrol stations lying within a half-mile, one-mile and two-mile radius.

The descriptive statistics presented below help shed further light on the outcomes of our hypotheses.

[5] This result is largely the same for the other petrol types, i.e., unleaded petrol 95, unleaded petrol 97 and diesel.

Table 2. Number of rivals and own-brand outlets according to the type of vertical relationship

	Resellers	Commission Agent
Rivals 0.5 miles	2.24	1.93
Rivals 1 mile	6.26	6.25
Rivals 2 miles	24.99	24.35
Own-brand outlets 0.5 mile	0.63	0.84
Own-brand outlets 1 mile	1.75	2.29
Own-brand outlets 2 miles	7.10	9.83

We can see that on average, the vertical relationship typified by the presence of a reseller has on average more rivals than that typified by the presence of a commission agent for all market distances. By contrast, we can see that commission agents operate in markets with a greater average number of own-brand outlets than do the resellers. These results are compatible with hypotheses H1 and H2, i.e., a greater number of rivals increases competition, which in turn increases the probability of a disintegrated vertical relationship. Likewise, a greater number of own-brand outlets reduces control costs and increases the probability of an integrated vertical relationship.

Table 3. Level of services according to the type of vertical relationship

	Resellers	Commission Agent
Car wash	61%	71%
Lubrication	60%	68%
Food Shop	51%	39%
Pharmacy	1%	2%
Toilets	48%	32%
Cash machine	50%	35%

Table 3 shows that resellers operate a greater percentage of outlets with food shops, public toilets and cash dispensers, which are the services requiring the lowest investment levels. By contrast, the commission agents operate a higher percentage of outlets offering lubrication services, pharmacies and automatic car washes. These services require greater levels of investment and it might be that resellers encounter financial problems when trying to offer them. According to the third hypothesis (H3), we would expect to find a negative relationship between disintegration, the reseller- type of vertical relationship, and the existence of services requiring high levels of investment (namely, lubrication, pharmacies and automatic car washes). The presence of services requiring low levels of investment is related to a greater probability of disintegration, since the commission agents have low incentives to make an effort, and controlling a greater number of services implies higher control costs. Thus, a positive relationship (see hypothesis four – H4) is expected between low-level investment services, such as food shops, toilets and cash dispensers, and the probability of vertical disintegration.

Table 4. Retail price according to the type of vertical relationship

	Resellers	Commission Agent
Retail price 93	604.67	604.04
	(7.40)	(8.27)
Wholesale price 93	586.46	590.87
	(9.89)	(21.42)
Margin 93	18.21	13.17
Retail price 95	614.56	608.73
	(7.84)	(19.05)
Wholesale price 95	594.42	598.76
	(9.95)	(34.85)
Margin 95	20.14	9.97
Retail price 97	624.22	624.20
	(8.64)	(11.73)
Wholesale price 97	604.60	608.60
	(10.16)	(18.22)
Margin 97	19.62	15.60
Retail price Diesel	455.89	455.20
	(8.58)	(10.22)
Wholesale price Diesel	444.21	447.32
	(10.09)	(18.44)
Margin Diesel	11.68	7.88

*Standard deviations in brackets

It can be seen that the retail prices charged by the resellers are higher than those charged by the commission agents for all petrol types. In the previous section, the two factors that affect retail prices were discussed, but these data show that local competition can be an imperfect instrument for eliminating the principal-agent problem. It is necessary, therefore, to verify the econometric specification to determine if the type of vertical relationship accounts for these price differences, or whether they are due to other factors. Notice that the wholesale price charged to the reseller is lower than that charged to the commission agent. The reason for this is that for the commission agent it represents an internal transfer not a real price. As such, the wholesale prices declared in the survey may be below the real price.

Given the higher retail prices and the lower wholesale prices, the reseller enjoys higher margins than those enjoyed by the commission agents. In fact the margin of the resellers is 1.3 times higher than that of the commission agents for unleaded petrol 93 and 97, 1.5 times higher for diesel, and two times higher for unleaded petrol 95. Nevertheless, it should be borne in mind that the commission agent's margin is not a real retail margin for the same reason that the wholesale price does not reflect a real value. This possible bias needs to be taken into consideration when estimating the effect of the vertical relationship on the wholesale price.

5. Empirical specification and results

This section provides a definition of the empirical specification and the main econometric results. In the first part, the determination of the specific vertical relationship is defined. In the second part, the effect of this vertical relationship on the wholesale and retail prices is shown.

To determine which vertical relationship to select, the following logit specification was estimated, where the dependent variable takes the value one for the disintegrated structure and zero for the integrated structure:

$$tvr = \beta_0 + \beta_1 nrivals_i + \beta_2 nownbrand_i + \beta_3 cashmach_i + \beta_4 toilets_i + \beta_5 food_i + \beta_6 pharmacy_i + \beta_7 \text{lub}rication_i + \beta_8 washmach_i + \upsilon_i$$

The vertical relationship selected depends on the number of rival petrol stations that competes with the petrol station *i*, the number of own-brand outlets, and a set of dummy variables that take the value one if the station offers a particular service and zero if not. The specification is estimated with the half-mile, one-mile and two-mile definitions of the variables, the number of rivals and the number of own-brand outlets. In this way I am able to contrast the sensitivity of results according to the definition of these variables. The signs expected for the variables in the specification are shown in the following table:

Table 5. Expected signs in the equation of vertical relationships

	Expected sign
Number of rivals	+
Number of own-brand outlets	-
Cash machine	+
Toilets	+
Food shop	+
Pharmacy	-
Lubrication	-
Car wash	-

To estimate the logit specification, we reduce the database to the average of the 208 petrol stations, since the characteristics that determine the vertical relationship do not change over the period of reference. The econometric results obtained for the logit specification are presented in Table 6:

Table 6. Econometric results of logit specification determining vertical relationships.

	0.5 miles	1 mile	2 miles
Nº rivals	0.139*	0.031	0.019*
	(0.080)	(0.035)	(0.011)
Nº own-brand outlets	-0.268*	-0.126	-0.063**
	(0.167)	(0.089)	(0.026)
Cash machine	0.277	0.243	0.178
	(0.456)	(0.459)	(0.462)
Toilets	0.457	0.501	0.396
	(0.331)	(0.333)	(0.339)
Food	0.052	0.038	0.140
	(0.462)	(0.460)	(0.460)
Pharmacy	-0.036	-0.170	-0.142
	(1.183)	(1.222)	(1.275)
Lubrication	-0.061	-0.064	-0.030
	(0.395)	(0.381)	(0.380)
Car wash	-0.433	-0.385	-0.339
	(0.396)	(0.386)	(0.390)
Nº observations	208	208	208
Wald Chi^2	11.77	10.17	13.55*
	(0.1619)	(0.2536)	(0.0943)
Pseudo R^2	0.0473	0.0392	0.0532

Robust standard deviation in brackets. P-value: ***(1%), **(5%), *(10%)

Table 6 shows that for all three geographical market definitions, the logit estimation coefficients present the expected signs for all the variables. The signs of these coefficients confirm the four hypotheses; however, only the coefficients of rivals and own-brand outlets are significantly different from zero at the five and ten per cent confidence level.

The logit specification shows that the level of competition positively affects the probability of disintegration, and confirms our first hypothesis. The coefficient of the number of own-brand outlets is negative, which confirms our second hypothesis, i.e., that a reduction in the control cost reduces the probability of disintegration. Two markedly different effects were recorded for the services offered by petrol stations. The services requiring a high level of investment, namely, lubrication, automatic car washes and pharmacies, have a negative effect on the probability of disintegration.

The fact that individual retailers face financial constraints that do not permit this level of investment accounts for this relationship, and confirms our third hypothesis. By contrast, the services that do not require such a high level of investment, namely food shops, toilets and cash dispensers, have a positive effect on the probability of disintegration. These results confirm our fourth hypothesis, i.e., that as the level of service increases so does the probability of disintegration. This occurs because the services increase the control costs in an integrated vertical structure.

After analyzing the choice of vertical structure, it is interesting to examine the effect of these vertical structures on wholesale and final prices. To estimate the effect of the various types of vertical relationship on the wholesale price, the following specification is proposed:

$$wholesaleprice_i = \alpha_0 + \alpha_1 refineprice_i + \alpha_2 trv_i + \alpha_3 quantity_i + \zeta_i$$

$$tvr = \beta_0 + \beta_1 nrivals_i + \beta_2 nownbrand_i + \beta_3 washmach_i + \beta_4 pharmacy_i + \\ + \beta_5 \text{lub}\, brication_i + \beta_6\, food_i + \beta_7 toilets_i + \beta_8 cashmach_i + \upsilon_i$$

The wholesale price for petrol station *i* depends on the refined price (which is fixed by the public firm ENAP) and is equal for all companies, the different vertical relationship types, and the quantity of fuel sold at the pump, as the quantity bought might attract a discount. The fact that the refinery prices fixed by ENAP are equal for all companies means that these variables are constant when we reduce the database. For this reason, we eliminate the constant term in the regression. We assume this type of vertical relationship to be endogenous, so we use the same logit specification variables as instruments[6].

The results using a two-stage least square estimator with instrumental variables are shown in the following tables:

Table 7a. Effect of vertical relations on the wholesale prices - unleaded gasoline 93 (two-stage least squares)

	0.5 miles	1 mile	2 miles
Type of vertical relationship	16.080*	13.709	10.955
	(9.301)	(9.630)	(9.459)
Quantity sold	0.004**	0.003**	0.003**
	(0.002)	(0.002)	(0.002)
Refined price	0.943***	0.947***	0.951***
	(0.016)	(0.017)	(0.017)
Nº observations	109	109	109
Hansen J Statistic	8.446	7.435	8.237
	(0.2949)	(0.3850)	(0.3121)
F-Statistic	58925.83***	56803.26***	62532.17***
	(0.0000)	(0.0000)	(0.0000)

Robust standard deviation in brackets. P-value: ***(1%), **(5%), *(10%)

[6] The same specifications were estimated using the quantity sold as an endogenous variable but the results did not vary significantly. The population and the number of vehicles in the administrative regions were used as instruments.

Table 7b. Effect of vertical relations on the wholesale prices - unleaded gasoline 95 (two-stage least squares)

	0.5 miles	1 mile	2 miles
Type of vertical relationship	21.396*	22.608	24.816
	(12.694)	(18.367)	(23.284)
Quantity sell	0.002**	0.002*	0.002*
	(0.001)	(0.001)	(0.001)
Refined price	0.926***	0.925***	0.921***
	(0.022)	(0.031)	(0.038)
Nº observations	72	72	72
Hansen J Statistic	4.856	4.205	4.210
	(0.5624)	(0.6489)	(0.6483)
F-Statistic	51830.53***	32951.90***	30957.60***
	(0.0000)	(0.0000)	(0.0000)

Robust standard deviation in brackets. P-value: ***(1%), **(5%), *(10%)

Table7c. Effect of vertical relations on the wholesale prices - unleaded gasoline 97 (two-stage least squares)

	0.5 miles	1 mile	2 miles
Type of vertical relationship	7.659	4.604	3.115
	(6.736)	(7.330)	(7.918)
Quantity sell	0.004***	0.004***	0.004***
	(0.001)	(0.001)	(0.001)
Refined price	0.957***	0.961***	0.963***
	(0.010)	(0.011)	(0.011)
Nº observations	106	106	106
Hansen J Statistic	12.209*	7.997	6.249
	(0.0939)	(0.3329)	(0.5110)
F-Statistic	84510.38***	81748.74***	83100.50***
	(0.0000)	(0.0000)	(0.0000)

Robust standard deviation in brackets. P-value: ***(1%), **(5%), *(10%)

Table 7d. Effect of vertical relations on the wholesale prices - diesel gasoline (two-stage least squares)

	0.5 miles	1 mile	2 miles
Type of vertical relationship	14.404**	13.850*	11.921
	(6.982)	(7.973)	(8.480)
Quantity sell	0.001	0.001	0.001
	(0.001)	(0.001)	(0.001)
Refined price	0.958***	0.959***	0.962***
	(0.015)	(0.017)	(0.018)
Nº observations	107	107	107
Hansen J Statistic	8.469	8.373	9.222
	(0.2931)	(0.3008)	(0.2371)
F-Statistic	33018.55***	30486.40***	33975.97***
	(0.0000)	(0.0000)	(0.0000)

Robust standard deviation in brackets. P-value: ***(1%), **(5%), *(10%)

In all the specifications the F-statistic shows that we can reject the possibility that all the variables are equal to zero. The Hansen J statistic shows that the vertical relationship variable instruments are valid. However, notice that the instruments are not strong, and may be biased towards zero in the variable coefficient for the vertical relationship, i.e., presenting attenuation bias.

From the above tables it is evident that disintegration positively affects the wholesale price, although the coefficient does not differ very significantly from zero. In fact, in most of the specifications it is not possible to reject the fact that the coefficient is equal to zero. Thus, we can conclude that vertical relations do not significantly affect the wholesale price. The attenuation bias mentioned in the previous paragraph might be partly responsible for this result.

The results show that the principal variable affecting wholesale price is the refinery price, and the value of the coefficient is very close to one[7]. Thus, changes in the refinery price are passed on to the wholesale price. The last empirical implication presented by the results is the positive relationship between the quantity sold at the petrol pumps and the wholesale price. This variable presents the opposite sign to the one expected, indicating that the stations with the greatest sales volumes do not receive any reductions in wholesale prices. A possible explanation for this might lie in price discrimination: i.e., the company knows which petrol stations have the largest sales volumes and which consumers have the greatest disposition to pay high prices and, subsequently, set higher prices at these stations. Thus, there is a positive relationship between disintegration and wholesale prices, although the relationship is not strong. It would appear that the results are affected by the fact that the integrated vertical structure of the wholesale price is only transferred within the same company.

To identify the effect of the different vertical relationships on the final retail price, the following specification is proposed:

$$retailprice_i = \alpha_0 + \alpha_1 wholesaleprice_i + \alpha_2 trv_i + \alpha_3 quantity_i + \alpha_4 nrivals_i +$$
$$+\alpha_5 nownbrand_i + \alpha_j \sum_{j=1}^{4} brand_i + \upsilon_i$$
$$tvr_i = \beta_0 + \beta_1 washmach_i + \beta_2 pharmacy_i + \beta_3 \text{lub}\, rication_i + \beta_4 food_i +$$
$$+\beta_5 toilets_i + \beta_6 cashmach_i + \mu_i$$
$$quantity_i = \gamma_0 + \gamma_1 vehicles_h + \gamma_2 population_h + \gamma_h \sum_{h=1}^{25} region_i$$

[7] In all cases we can reject statistically (at least at the 5% per cent confidence level) that the coefficients are equal to one.

The retail price at petrol station *i* depends on the wholesale price, the type of vertical relationship, the quantity of fuel sold, the number of rivals in the predefined market, the number of own-brand outlets in the same markets, and the dummy variables that capture the brand effect on price. The instruments for this type of vertical relationship are the dummy variables of the various services offered by the petrol station, the number of vehicles and the population of the region.

Table 8a. Effect of vertical relations on the retail prices - unleaded gasoline 93

	0.5 miles	1 mile	2 miles
Type of vertical	10.846***	9.708***	10.324***
relation	(3.309)	(3.023)	(3.094)
Quantity sold	-0.003***	-0.003***	-0.003***
	(0.001)	(0.001)	(0.001)
Wholesale	0.198***	0.203***	0.202***
price	(0.070)	(0.071)	(0.069)
Nº of rivals	-0.513*	-0.514***	-0.163***
	(0.273)	(0.126)	(0.041)
Nº own-brand	-0.069	0.203	0.161
outlets	(0.589)	(0.388)	(0.115)
Esso	-14.382***	-14.530***	-15.854***
	(4.446)	(4.004)	(4.507)
Shell	-13.276***	-12.429***	-13.275***
	(2.833)	(2.696)	(2.696)
YPF	-12.254***	-11.181***	-11.550***
	(3.160)	(2.918)	(2.885)
Constant	494.679***	494.172***	494.838***
	(40.356)	(40.381)	(39.298)
Nº obs.	109	109	109
Centered R^2	0.20	0.25	0.25
Hansen J	44.658	46.550	47.375
Statistic	(0.1810)	(0.1350)	(0.1181)
F(8,100)	4.62***	6.13***	6.00***
	(0.0001)	(0.0000)	(0.0000)

Robust standard deviation in brackets. P-value: ***(1%), **(5%), *(10%)

Table 8b. Effect of vertical relations on the retail prices - unleaded gasoline 95

	0.5 miles	1 mile	2 miles
Type of vertical	42.298*	38.809**	47.712**
relation	(22.574)	(18.458)	(21.428)
Quantity sold	-0.002*	-0.001*	-0.002**
	(0.001)	(0.001)	(0.001)
Wholesale price	0.323**	0.307**	0.337**
	(0.160)	(0.153)	(0.145)
Nº of rivals	-0.262	-0.710**	-0.256***
	(0.404)	(0.305)	(0.082)
Nº own-brand	0.486	0.281	0.462
outlets	(1.630)	(1.140)	(0.318)
Esso	-29.155	-26.672	-37.417*
	(21.579)	(17.994)	(21.511)
Shell	-30.048	-25.864	-35.133*
	(20.840)	(16.973)	(20.071)
YPF	-27.039	-23.175	-30.685
	(20.879)	(16.706)	(19.856)
Constant	415.403***	426.712***	410.407***
	(95.253)	(90.442)	(86.167)
Nº obs.	72	72	72
Centered R^2	0.23	0.31	0.26
Hansen J	35.462	37.263	35.156
Statistic	(0.3992)	(0.3213)	(0.4132)
F(8,63)	1.38	2.18**	2.58**
	(0.2233)	(0.0411)	(0.0168)

Robust standard deviation in brackets. P-value: ***(1%), **(5%), *(10%)

Table 8c. Effect of vertical relations on the retail prices - unleaded gasoline 97

	0.5 miles	1 mile	2 miles
Type of vertical	9.933**	9.133**	9.363**
relation	(4.778)	(4.530)	(4.659)
Quantity sold	-0.003***	-0.003***	-0.003***
	(0.001)	(0.001)	(0.001)
Wholesale price	0.305***	0.299***	0.294***
	(0.112)	(0.113)	(0.110)
Nº of rivals	-0.845**	-0.529***	-0.166***
	(0.351)	(0.162)	(0.048)
Nº own-brand	0.297	-0.208	0.057
outlets	(0.770)	(0.507)	(0.166)
Esso	-10.007*	-9.739*	-10.511*
	(6.003)	(5.629)	(6.535)
Shell	-11.314***	-10.854**	-11.186**
	(4.400)	(4.374)	(4.598)
YPF	-8.800*	-8.336*	-8.218*
	(4.948)	(4.683)	(4.836)
Constant	443.571***	449.156***	452.106***
	(66.876)	(67.281)	(65.022)
Nº obs.	106	106	106
Centered R^2	0.15	0.19	0.20
Hansen J	42.632	40.064	42.546
Statistic	(0.2417)	(0.3358)	(0.2445)
F(8,97)	2.60**	3.38***	3.92***
	(0.0129)	(0.0018)	(0.0005)

Robust standard deviation in brackets. P-value: ***(1%), **(5%), *(10%)

Table 8d. Effect of vertical relations on the retail prices - diesel gasoline

	0.5 miles	1 mile	2 miles
Type of vertical	10.218***	10.317***	10.389***
relation	(3.153)	(2.872)	(3.138)
Quantity sold	-0.002***	-0.002***	-0.002***
	(0.001)	(0.001)	(0.001)
Wholesale price	0.186*	0.181*	0.190*
	(0.108)	(0.108)	(0.106)
Nº of rivals	-0.489*	-0.396***	-0.106**
	(0.303)	(0.151)	(0.053)
Nº own-brand	-0.889	-0.728	-0.116
outlets	(0.863)	(0.551)	(0.160)
Esso	-6.251*	-6.980**	-6.960*
	(3.797)	(3.346)	(4.283)
Shell	-7.127**	-7.299**	-7.306**
	(2.931)	(2.907)	(3.004)
YPF	-6.741**	-7.265**	-7.087**
	(3.228)	(3.049)	(3.193)
Constant	374.394***	379.420***	374.612***
	(48.460)	(47.711)	(47.185)
Nº obs.	107	107	107
Centered R^2	0.23	0.26	0.25
Hansen J	40.144	37.923	42.367
Statistic	(0.3326)	(0.4271)	(0.2506)
F(8,98)	4.92***	5.51***	4.94***
	(0.0000)	(0.0000)	(0.0000)

Robust standard deviation in brackets. P-value: ***(1%), **(5%), *(10%)

In common with the wholesale price specifications for retail prices, the F-statistic shows that we can reject the possibility that all variables are equal to zero. The Hansen J statistic shows that the instruments used are valid, but that the same attenuation bias is present as in the case of the wholesale price. Thus, it should be borne in mind that the coefficient of the type of vertical relationship may be biased towards zero.

In all cases the empirical results show a positive and significant relationship between disintegration and retail prices. The magnitude of this coefficient is between 1.6 and 2 per cent, or around 10 pesos, except for unleaded petrol 95 where it stands at 7 per cent. This result is the effect of this type of vertical relationship, at least as far as the retail price is concerned. If we take the attenuation bias into consideration, however, this effect may be greater. This result is in line with the findings of Barron and Umbeck (1984), Shepard (1993), Blass and Carlton (1999) and Vita (2000).

The other variables in the specification present the expected sign and, in most instances, are statistically significant. The quantity of fuel sold at the pumps presents a negative coefficient indicating the possibility of small economies of scale in petrol retailing. Similar results are presented by Jiménez and Perdiguero (2010) in the case of the Canary Islands petrol market. The wholesale price is positive and statistically significant as expected.

The number of rivals in the predefined markets has a negative effect on the retail price. This variable reaches the level of competition in the market, so we would expect a negative relationship between competition and price levels. Similarly, the number of own-brand outlets is a proxy for market concentration, and increases the possibility of market power; we would expect a positive relationship between number of own-brand outlets and the level of prices.

Finally, the brand dummy variables show that all brands fix their prices below those of COPEC, the biggest company in the market. As the company with the greatest market share fixes the highest retail price, it can be deduced that there is imperfect competition in the Chilean petrol market.

To summarize the above empirical results obtained when applying the various specifications, it can be seen that:

- Vertical disintegration is more probable in markets with high competition and a lower level of service investment. By contrast, integration is more likely in the case of a market with a high level of service investment and a high concentration of own-brand outlets.

- Vertical disintegration has a null effect on the wholesale price and a positive effect on the retail price, although we should take into account the attenuation bias present in our estimations.

6. Conclusions

Analyzing the vertical relations within industries has been the concern of the industrial organization literature for some time. Here, drawing on the hypothesis derived from transaction cost theory, and on the principal-agent problem, I have undertaken an empirical test of Chile's petrol market. The main hypothesis advanced is that local competition plays an significant role in the choice of vertical relations: first, because it eliminates (or reduces) the effects of double marginalization, which are one of the main principal-agent problems; and, second, because it reduces the probability of

underinvestment (quantity and quality) of services that the retailer offers, to a level that might be below firm-level efficiency. Thus, local competition should have a positive effect on disintegration decisions. Further empirical hypotheses, including the reduction of employee cost controls with outlet concentration and the effect of different services, are also tested.

The empirical results show that local competition positively affects the disintegration decision. Likewise, the results confirm the hypotheses derived from this decision: i.e., the concentration of own-brand outlets increases the probability of outlet integration; high-level investment services mean that firms decide to integrate; and, conversely low-level investment services increase the likelihood of disintegration.

However, the study has not only sought to verify the variables that affect vertical relationship decisions, it has also tested the effect of different vertical relations on wholesale and retail prices. In the case of the wholesale market a null effect is recorded; however, in the retail market the effect between the disintegrated vertical structure and prices is positive. This same result was previously reported by Barron and Umbeck (1984) and Shepard (1993), among others, using different approaches. The increase in retail prices associated with the different vertical structures ranges between 1.6 and 7 per cent. Thus, local competition is an imperfect instrument for eliminating the transaction cost and the principal-agent problems.

These results suggest that a firm's choice of vertical relationships is a rational decision taken in order to ensure the most efficient vertical structure, which in turn will minimize the transaction cost and principal-agent problems. Although local competition is not a perfect instrument, the divorcement policies applied in the past in the United States tend, as Blass and Carlton (1999) and Vita (2000) show, to introduce greater inefficiency into vertical structures and increase the final price.

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Institut de Recerca en Economia Aplicada Regional i Pública
Research Institute of Applied Economics
Universitat de Barcelona
Av. Diagonal, 690 • 08034 Barcelona

WEBSITE: www.ub.edu/irea/ • **CONTACT:** irea@ub.edu