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INTERNATIONAL JOURNAL OF TRANSPORT ECONOMICS
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PRICES AND COSTS STRUCTURE IN THE SPANISH TRANSPORT OF PERISHABLE IN GROUPAGE LOADS

SILVIA ANDRÉS GONZÁLEZ-MORALEJO*

ABSTRACT: This paper analyze the pricing system in force of refrigerated logistics operators in the transport of perishable goods in groupage loads, responding to how prices are determined in this transport, what influences them and how much. Using Spanish data for 2008, obtained directly from a sample of haulage firms, we formulate a model that allows the identification of the ordinary tariffs, final prices and the main components involved, and distinguishing what extent these prices reflect the cost of production resulting from the activity. Based on the estimated equations, it can state that distribution companies are pricing according to their total mean cost by using final prices expressly calculated for each customer from an ordinary tariff, reflecting the cost structure of the company, which is applied bonus depending on the requested service and the commercial policy of the company. Results represent a contribution to the transport economics literature, as they refer an economic phenomenon unexplored due to the difficulties in the measurement of prices and costs, as well as decision makers in company, which are provided with relevant information to achieve a reduction in costs.

KEYWORDS: Road transport, prices, discount, mean cost.
JEL Classification: L92, R41.

1. INTRODUCTION

FREIGHT transport by road is a tremendously complex sector due to these two fundamental reasons: its high degree of atomization that causes the existence of constant returns of scale or small economies of scale (Blauwens *et alii*, 2007), and the high levels of competition on which it is based (Quinet and Vickerman, 2004; De Rus *et alii*, 2003).[1] Is an opaque market with competition

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[1] Due to the heterogeneous group of companies that offer road transport services (autonomous, transport agencies...), this paper focuses on the most consolidated figure of last years in perishable food products sector, the refrigerated logistic operator, who is an specialized company in a wide range of activities in relation with logistics at low-temperature: transport and transport management, supply chain management, warehouse, information systems management services…

practices that in certain cases are unfair (characterized by prices below the marginal costs of journeys). The uncertainty of the behaviour of energy costs and the total disappearance of barriers to market access in Spain and the rest of the EU countries, which has made possible the entry of new firms with significantly lower costs, have caused the final price of the service to become the key factor of choice for Refrigerated Logistics Operators (RLOs), who are the professionals specialized in the provision of refrigerated transport in groupage loads. This article introduces a new form of empirical analysis which aims to answer the following questions: how are prices determined by RLOs in the transport of perishable in groupage loads? What factors influence prices, and to what extent? In this context, the first aim of this study focuses on the analysis of the pricing system method in force of RLOs in groupage (transport of part loads) of perishable goods by road, formulating a model which allows the identification of the principal components making up the final price in this type of transport. Secondly, as there are some available real information about production costs of RLOs, it will detail whether the prices of such transport reflect accurately the cost[1] of production derived from the activity.

After this introduction, section 2 establishes a framework for the literature research. In section 3 we formulate the model of pricing in the provision of refrigerated groupage transport. Section 4 describes the basic features of the gathering of information, on the basis of which a descriptive statistical analysis is applied which is developed in section 5. Section 6 integrates all the results. Finally, in section 7 the principal conclusions of the study are discussed.

2. Literature research

The concern to clarify how transport services are priced has stimulated, at the academic level, the development of different lines of research[2]. Originating with the contributions by Newbery, numerous studies have analyzed pricing, for any type of user, for the use of infrastructures. Newbery's first studies (1988, 1989, 1991) developed the analysis of specific pricing of roads, and subsequently studies have been published determining the advantages and disadvantages of any change of prices in the road transport system (Greene *et alii*,

[1] We refer to private costs, which are those borne by the carrier firm that carries out the transport activity.

[2] In the EU there has been an intense debate on the principles of pricing in transport, very particularly in road transport. In this sense, the efforts of the Commission have been set out in the publication of important documents, outstanding among which are the Green Book *Towards fair and efficient pricing in transport* (1995) and the White Book *European Transport Policy for 2010* (2001).

1997; Ahlstrand, 2001). Though it is true that most of these studies refer to the analysis of urban transport, there are also some that have analyzed this question at the interurban level (Sansom *et alii*, 2001; Vermeulen *et alii*, 2004). In the Spanish case there is a notable contribution by Álvarez *et alii* (2007), which estimates the structure of optimum prices for interurban road transport, differentiating by type of vehicle, type of road, and moment in time.

Especially extensive is the academic literature that studies urban passenger transport, where a public body controls the provision of collective transport services in cities and metropolitan areas. This line of research has generated results of notable economic interest. We can remark the efforts to estimate cost functions, which offer valuable information on the type of economies of scale that characterize the industry (Williams and Hall, 1981; Williams and Dalal, 1981; Berechman and Guliano, 1984; Berechman, 1987), the existence of economies of scope (Talley and Anderson, 1986) and of economies of density (Caves and Christensen, 1988). Also the studies to determine the cost reductions that would be achieved by the introduction of competition in the industry, which have empirical application in countries such as the USA, the United Kingdom, Sweden, Australia and Spain (for example, see Hensher, 1987). In Spain, the maximum exponent of the analysis of this industry is to be found in De Rus (1987, 1989, 1991), who has studied *inter alia* the behaviour of its costs, price discrimination, the system of cross-subsidy and the determination of optimum values for the most significant variables (prices, frequency, size of vehicle and financial result).

Rather less plentiful, especially in Spain, is the economic literature of an academic character that studies the principles of pricing in freight traffic,[1] because its empirical analysis suffers from serious practical difficulties. The relevant international studies have focussed basically on aspects relating to the regulation of the sector and the estimation of cost functions. More specifically, Bayliss (1998) analyzed for the EU as a whole the causes and effects of the deregulation begun in the 1980s, as well as the evolution since then of the economic policies (market structure, externalities, transparency) and public policies (employment, structure of industry, regional diversity) applied in the sector, and the regulations developing them. Nor can we fail to cite the existence of some empirical studies that have considered the need

[1] Within the perishable foods sector we can highlight the empirical contributions by Rebollo *et alii* (2006), who study the evolution of commercial margins in Spain for fresh food products, and by Mir and Borrás (2008), who calculate the costs of the distribution chain of fresh horticultural and fruit products. In both cases the price of transport is considered, but its composition is not specified, nor the variables that influence it, as we do in the present study.

to regulate prices (Hurley, 1995) or the economic implications that the introduction of a special (tonne-kilometre) tax on transport of goods by road would have on the European economy (Barker and Köhler, 2000). The studies by Harmatuck (1991) laid the bases for estimating cost functions (based on a translog model of costs) for logistics operators, on the basis of which the nature of the economies of scale and of scope in the provision of freight transport services in the USA are examined. Authors like Daughety *et alii* (1985) obtained similar developments for the case of Europe.

The limitations and problems inherent in the measurement of the costs of transport and its pricing have been dealt with in the literature dedicated to the analysis of trade flows; among the most recent references, Anderson and Van Wincoop (2004) review the different elements that configure the costs of trade, among them those linked to the transport of goods. Fundamentally, they find two obstacles. Firstly, the empirical evidence on freight transport is limited by the non-existence of data bases that would make its investigation possible, with very few exceptions, among which are the *US Waterborne Database* of the Maritime Administration of the USA, the bases of PIERS *Global Trade Intelligence* and the *International Transport Database ITD* of the CEPAL (United Nations). With the aim of filling this gap, in Spain the TRADE TRANS database is being developed.[1] García and Pérez (2007) make a review of the methodology followed for the construction of TRADE TRANS, as well as of the principal biases and problems inherent in its utilization. Secondly, much of the information required for the analysis of a pricing system, especially that of a quantitative nature (prices, direct costs, indirect costs), belongs to the confidential area of the firm. This is private and protected information that firms are very reluctant to reveal.

In this context, our paper proposes a research design that integrates the qualitative and quantitative approaches. Through in-depth interviews it makes possible the access to solid and truthful information which, combined subsequently with observation and descriptive statistical analysis, would enrich and enable understanding of the phenomenon studied in its target dimension.

3. Materials and methods

3. 1. *Generation of primary information: case studies and recorded variables*

As the information required to achieve the objective of this study is not to be found gathered in statistical sources or data bases, it must be collected

[1] TRADE TRANS represents an innovation given the non-existence of this type of statistics in Europe, both in the academic field and in specialist consultancy.

directly from firms, where it is generated. In this way, as well as endowing the research with an empirical base, we have available reliable and up-to-date information that could not be found otherwise. Consequently, the research carried out is based on a *case study*:[1] a sample of 10 RLOs that work in part loads or groupage was selected and their pricing systems analyzed in depth. The information corresponding to each firm[2] was obtained through the technique of in-depth interview by open questions, since these are better for the RLO to reveal its authentic experience. This method has been used successfully in other research in transport economics. For example, Jonkeren *et alii* (2012, 2011) have used panel data from shipping companies.

In choosing the RLOs that make up the sample we followed a procedure consisting of various stages: gathering information on the existing RLOs, refining the information and selecting the firms to be interviewed. It has been considered that case studies will be illustrative in terms of the research objectives provided that the selection is done adequately. Therefore, in designating the RLOs to be analyzed priority was given to all of them being included in the top 30 firms in the sector by volume of sales in refrigerated services,[3] as shown in Table 1. A second criterion of selection was that at least seven of the RLOs interviewed should be within the top 10 of this ranking. The RLOs considered in this study thus represent 60 per cent of the total turnover of the sector. All the RLOs interviewed have branches in the Valencia Region, the geographical area to which the field work is restricted. This geographical restriction is essential, as otherwise the gathering of data would have been much more difficult. Obviously, all the RLOs interviewed have also branches in other Spanish regions. Regarding the type of markets, the RLOs interviewed supply, as a minimum, the local and national markets.

A single information-gathering procedure was followed. After talking by telephone to the managers of the firms to be interviewed, to explain the purposes of the research and to request their collaboration, all those who showed themselves willing to collaborate were asked for an appointment. The field work was done over a target group of 30 RLOs (see Table 1). The reject rate to participate on the study is approximately the reliability rate that

[1] See in Yin (1994) an analysis of the nature of case method and of their field of application.

[2] The interviews were carried out between the months of January and April 2008.

[3] The turnover for refrigerated services of the 30 firms in the ranking is spread between 5 and 120 million euros per year.

was established previously at the White Book of the Logistics Operators in Spain (2005). All the information was obtained by the author of the study from personal interviews with the managers of the 10 firms[1] selected. At this point we need to clarify that the job profile of the managers interviewed were the commercial responsible, operation responsible and/or branch manager.

With respect to the quantitative variables, observations were recorded at three different levels. The first level corresponds to the *general ordinary tariff per pallet (GOTpallet)* of each RLO. Each first level observation includes a value per pallet depending on the number of pallets and on the journey; in this way, there is a *GOTpallet* for loads of 1 pallet, 2-3 pallets, 4-6 pallets and 7-10 pallets,[2] from the principal sending points of goods (Madrid, Barcelona, Valencia, Sevilla and Bilbao) and to 49 Spanish provincial capitals. 980 first level observations were recorded per RLO interviewed. The second level corresponds to the *final price per pallet (FPpallet)* offered to each customer. Each second level observation includes a value per pallet depending on the number of pallets and on the destination; thus, for each customer (300 customers) there is a *FPpallet* for loads of 1 pallet, 2-3 pallets, 4-6 pallets and 7-10 pallets, for journeys starting in Valencia and destination in 49 provincial capitals in Spain.[3] 196 second level observations were recorded per customer. The third level corresponds to the *producer mean cost per pallet (MCpallet)* of each RLO. Each third level observation includes a value per pallet depending on the number of pallets and on the journey; in this way, there is a *MCpallet* for loads of 1 pallet, 2-3 pallets, 4-6 pallets and 7-10 pallets, for journeys starting in Valencia and destination in 49 provincial capitals in Spain. 196 third level observations were recorded per RLO interviewed. All the observations recorded refer to the year 2008, as this is the year when a greater volume of information is available for temperature-controlled transport services with goods palletized on EUR Pallets (0,80 x 1,20 m), to a maximum height of 1,80 m. and maximum weight of 800 Kg.

[1] They are not named in this study at the suggestion of some of them, who prefer to remain anonymous.

[2] From 10 pallets onwards it is more profitable to hire a complete truck (full load), though some space remains unused.

[3] It should be noted that some observations are incomplete, depending on the customer's own specifications, since they may lack the value corresponding to a destination or to a number of pallets.

TABLE 1. Refrigerated logistics and groupage firms. Ranking by turnover

Nº	FIRM
1	SDF IBÉRICA, S.A.
2	SALVESEN LOGISTICA, S.A.
3	GRUPO INTEGRA2 (LOGISTA)
4	EXEL IBERIA GRUPO, S.L.*
5	DHL IBERIA
6	LOGIFRIO GESTION FRIGORIFICA, S.L.
7	GRUPO LOGISTICO SANTOS, S.A.
8	CONWAY THE CONVENIENCE COMP. ESPAÑA, S.L.
9	HERMES LOGISTICA, S.A.
10	DISFRIMUR, S.L. (GRUPO)
11	GRUPO LINSER LOGISTIC & TRADE, S.L.
12	CRONOFRIO-NORESTRANS
13	ACR LOGISTICS IBERIA, S.L.
14	LOGISTICA REFRIGERADA, S.A.
15	TRANSPORTES BADOSA, S.A.
16	TRANSPORTES AGUSTIN FUENTES E HIJOS, S.L.
17	TRANSPORTES TRESSERRAS, S.A.
18	INTERLOGISTICA DEL FRIO, S.A. (INTERFRISA)
19	TRANSPORTES J. CARBO, S.A.
20	OLANO Y MUÑOZ, S.A. (TOMSA)
21	TUDEFRIGO, S.L. (GRUPO)
22	MONTFRISA, S.A.
23	GRUP-OIL, S.A.
24	LOGISTICA ALICANTINA DEL FRIO, S.L.
25	SEUR, S.A. (SEUR FRIO)
26	LOGISTICA SANCHEZ BREA, S.L.
27	TRANSFRIO, S.C.L.
28	CEFRUSA SERVICIOS FRIGORIFICOS, S.A.
29	TRANSPORTES FRIGORIFICOS BUIL, S.A.
30	TRAIGLEFER, S.L.

Source: Vivó, 2007.

3. 2. Design of the pricing model

The pricing system proposed in this work derives directly from the information extracted from the case studies (described in detail in the previous section) and the specific pricing procedure of the RLOs, whose business reality

is analyzed. In this sense, Mun and Nakagawa (2010) have developed a pricing model for international trade which analyzes the cost of transport between countries. Other modeling based on the case study is the application to groupage transports (Boone and Quisbrock, 2010) and to road transport in the wood industry (Hammar *et alii*, 2008).

The RLO pricing system, more common in Spanish refrigerated transport, is composed of a fundamental element called *transport cost* and additional insurance cost. The first derives from the main service by the RLO; therefore, it is the most important invoice item, which justifies its existence. Additional insurance cost is an auxiliary cost that depends on the transport cost and is senseless without it. The transport cost is built in unitary terms from the *general ordinary tariff per pallet* (*GOTpallet),* estimated according to destination of the good, plus a *discount* per customer;[1] it is then multiplied by the pallets number. The *GOTpallet* is composed through an *internal tariff* that reflects the structure of the RLO's direct and indirect costs plus a *gross commercial margin*. The discount[2] per customer is applied according to the production cost of the service and the commercial policies of the company, which include the following factors:

- Synergies with the destination (probability of the vehicle making its return journey with a new load).
- Degree of occupation of the vehicle or load factor (high or low).
- Volume of business implied by the service contracted, and its frequency (single or periodical journey).
- Importance of the customer requesting the service (as percentage of RLOs total annual income).
- RLOs current turnover (need to sell).

In consequence, the unit transport cost is, in most cases, personalized, as it is calculated *ad hoc* for each customer as a result of a negotiation influenced by such diverse factors as the destination of the goods, the time of year when the service is requested[3] or the macroeconomic situation. It will therefore take a different value for each customer and journey. This gives an idea of the difficulties of achieving an in-depth understanding of the transport cost

[1] For some customers the system of pricing is rather more complex, as the discount could be of negative sign, i.e. an economic penalty, normally because of an excessively complicated service.

[2] Another analysis of the discounts in the price of goods can be found in Tsao and Sheen (2012). The authors suggest that offering discounts on freight transport is positively related to the weight of the load. The impact of synergies with destiny has been studied previously by Jonkeren *et alii* (2011); his work relates the price developments in freight transport with demand destination and the probability that the vehicle returns unloaded.

[3] In Spain, the perishable food sector is affected by a high degree of seasonality.

because of the numerous variables that have to be considered in its calculation, the individual influence of which it is not always possible to verify (even for the RLOs themselves). In the following epigraphs we will detail that the unit transport cost subject to a high degree of variability is the result of differences in production costs or also the differentiation of prices between customers. In this paper, we call *final price per pallet (FPpallet*) to each transport service the unit transport cost, this is, the *GOTpallet* plus the discount (without multiplying by the pallets number).[1]

As mentioned earlier, the *GOTpallet* is built up on the basis of an internal tariff plus a gross commercial margin. The internal tariff, in turn, can be disaggregated into four different types of costs of production for the RLO: *business cost, pick-up cost, transfer cost and distribution cost*. Those cost components are privileged information private to the firm which the RLOs have only revealed exclusively for this research. This is the reason why we have assumed the compromise of not publishing, at least, the monetary value of the most sensitive items to their competition. Following the notation used in Álvarez *et alii* (2007), we call *mean cost per pallet (MCpallet)* to the internal tariff, this is, the sum of the four components of the cost of production, which are described below. We should remark that although quantitative information is not published, the real breakdown of *MCpallet* in the mentioned components is used for the calculations of this work.

The business cost is taken from the allocation of the structure of direct and indirect costs. Direct costs are those associated with the running of the refrigerated vehicle.[2] To the direct cost are added the indirect costs of management, personnel, commercialization, etc… borne by the RLO, which are sometimes difficult to quantify as they are not directly related to the volume of transport carried out by the firm. They are valued as a percentage by the RLOs,[3] either as a percentage of the direct cost per kilometre travelled, or as

[1] The last component of the invoice, insurance, given its optional character, is excluded from our empirical analysis.

[2] Given our compromise of not publishing their monetary value due to the strategic importance for the firms of the sample, we refer the analysis carried out by the "Observatory of Costs for Road Transport of Goods", of the Ministry of Public Works, updated to 31st October 2008, that illustrates the structure of average direct costs that running an articulated refrigerated vehicle generated for a typical goods transport firm. This direct cost corresponds to the national average, obtained by weighting the costs of each province by its share in the transport of goods by road. Thus, the direct cost can be estimated at 1,092 €/Kilometre travelled (or 1,050 €/Kilometre in the case of a two axles refrigerated truck).

[3] Indirect costs assignment is affected by subjectivity (De Rus, 2003). There are different methods to calculate the part of the indirect cost which belongs to each service; in the case of perishable goods, the method is based on direct costs, which are known for each service. This facilitates estimation of indirect costs.

a percentage of the sum of the values of the other cost items (pick-up, transfer and distribution). The use of percentages of the direct cost per kilometre travelled is usual in the calculation of tariffs for fully loaded trucks, while the application of a percentage of the sum of the value of the other cost items is common in the calculation of prices for part loads, as concerns us in this study.

The pick-up cost represents the cost of picking up the goods from the customer's premises. The distribution cost refers to local distribution to the point of delivery, also known as capillary distribution. Given their strategic importance for the firms of the sample, especially in the case of capillary distribution, we invite the readers to look up the examples included in the note number two.

RLOs have pre-established routes with a starting point and a destination. It may therefore occur that the goods make a stopover, passing from one of the company's logistical platforms to another, until they reach the destination. At each platform the goods are unloaded from the truck to group them in another, together with other goods from various starting points also destined for the next platform. This causes the cost of the service to rise, as each stopover incurs a handling cost, which is passed on, called transfer cost. If no stopovers are made, there is no transfer. When they are made, one fixed amount is added to each haulage at an average value of 15,75 €/pallet, which corresponds to the data from the RLOs interviews, with a mean down load price of 14,50 €/pallet, and a mean load price of 1,25 €/pallet.

The gross commercial margin *(GCM)* applied by the RLO is valued as a percentage of the sum of the value of the foregoing cost items (business cost, pick-up, transfer and distribution).

The algebraic expression giving the calculation of the *GOTpallet* for each journey would be:

$$GOT_{pallet} = MC_{pallet} + GCM_{pallet} \quad [1]$$

$$GOT_{pallet} = (C^{Pick\text{-}up} + C^{Transfer} + C^{Distribution} + C^{Business}) + GCM_{pallet} \quad [2]$$

$$GOT_{pallet} = m(C_1 + C_2 + C_3 + 1{,}092K_3/n_3 + p\sum_{i=1}^{3} C_i) \quad [3]$$

$$GOT_{pallet} = m(1{,}050K_1/n_1 + C_2 + 1{,}050K_2/n_2 + 1{,}092K_3/n_3 + p\sum_{i=1}^{3} C_i) \quad [4]$$

where m is the percentage applied as gross commercial margin (m>1), C_1 is the *pick-up cost* or $1{,}050K_1/n_1$ (where K_1 is the number of kilometres of the pick-up way and n_1 is the pallet number capacity of a two axles refrigerated truck), C_2 the transfer cost *(C_2=0* if there is no transfer), C_3 the distribution cost or $1{,}050K_2/n_2$ (where K_2 is the number of kilometres of the distribution way and n_2 is the pallet number capacity of a distribution refrigerated truck), $1{,}092K_3/n_3$ is the business direct cost (where K_3 is the number of kilometres

of the transport way and n_3 is the pallet number capacity of a articulated refrigerated truck) and p is the percentage applied as business indirect cost (p<1). If we include in [4] the discount *(Dpallet)* we obtain the *FPpallet*:

$$FP_{pallet} = GOT_{pallet} \pm D_{pallet} \quad [5]$$

$$FP_{pallet} = t[m(1{,}050K_1/n_1 + C_2 + 1{,}050K_2/n_2 + 1{,}092K_3/n_3 + p\sum_{i=1}^{3} C_i)] \quad [6]$$

where t is the percentage applied as discount (t<1 if the discount is bigger than cero).

3. 3. *Statistical treatment of data*

Following the notation used in De Rus (1989), the provision of temperature-controlled freight transport services is a multi-product activity, as there are as many products as possible points of origin-destinations in the network, distinguishing by number of pallets. The data supplied by the RLOs regarding their system of pricing provides us, for each journey, with the *GOTpallet* of the RLO and, for each customer and journey, with the *FPpallet*. On the basis of these we have defined the variables to be estimated in this study for each journey: the *MEAN GENERAL ORDINARY TARIFF per pallet (MGOTpallet)*, the *MEAN FINAL PRICE per pallet (MFPpallet)* and the *MEAN TOTAL COST per pallet (MTCpallet)*. Let us see the model that has been constructed to make their calculation possible.

To obtain the *MGOTpallet* the average *GOTpallet* of the 10 RLOs was calculated, weighting each *GOTpallet* by the percentage of total turnover represented by the annual turnover of each RLO. Thus, the *MGOTpallet* can be expressed as follows:

$$MGOT_{pallet} = \frac{\sum_{i=1}^{10}(GOTipallet \cdot Fi)}{\sum_{i=1}^{10} Fi} \quad [7]$$

On the basis of [7], and using the programme Microsoft Office Excel 2007, we constructed an automatic calculator of mean general tariffs that permits immediate calculation of the *MGOTpallet* for journeys starting from the principal points of origin of goods (Madrid, Barcelona, Valencia, Sevilla and Bilbao) and destination in any provincial capital in Spain. Given the breakdown available of *GOTpallet* into internal tariff plus gross commercial margin, the calculator was constructed in such a way as to offer the user the possibility of applying to each internal tariff any commercial margin, thus increasing its potential. We thus have available a dynamic data base on internal tariffs and general tariffs, permitting us to make multiple simulations.

To obtain the *MFPpallet* for journeys starting in Valencia we averaged the second level observations of *FPpallet* available, one per customer, and to find the mean percentage discount applied by RLOs, it was approximated on the basis of the standard deviation, which considers the arithmetic mean of deviations from *MFPpallet*, calculating the percentage of *MFPpallet* represented by said standard deviation, or in other words, the *coefficient of variation* (which is insensitive to the magnitude of the data). Thus we have defined:

$$MFP_{pallet} = \frac{\sum_{i=1}^{x} FPipallet}{x} \quad [8]$$

$$\%D_{pallet} = CV = 100(\frac{s}{MFPpallet}) \quad [9]$$

where x is the number of second level observations (x≤300) and s the standard deviation for each journey.

For journeys starting in Valencia the variable *MTCpallet* was also calculated as the average of the *MCpallet* of the RLOs of the sample, weighting by the percentage of the total turnover represented by the annual turnover of each RLO.

$$MTCpallet = \frac{\sum_{j=1}^{10} \langle 1{,}050K_1/n_1 + C_2 + 1{,}050K_2/n_2 + 1{,}092K_3/n_3 + p\sum_{i=1}^{3} C_i\rangle \cdot F_j}{\sum_{j=1}^{10} F_j} \quad [10]$$

The specification of a statistical model that will correctly describe the reality that we aim to describe is a delicate and difficult task, especially in a scenario where, as already noted, the availability of information stands out as the most important bias. To discover to what extent the *MTCpallet* contributes to the explanation of the differences in the variables *MGOTpallet* and *MFPpallet* we developed a classical regression model, using the minimum square analysis method. The aim of constructing this model is to discover a formulation that is simple, but with sufficient precision to contribute useful ideas, to reflect correctly how *MGOTpallet* and *MFPpallet* vary when *MTCpallet* varies, and how the latter varies with the kilometres travelled on each journey, with the existence of transfers and with the complexity of the capillary distribution. The existence of divergences between the model and reality will lead us to determine whether there exist other sufficiently influential variables that have been omitted from the model.

Thus we initially rehearsed the estimation of linear models, although a testing of hypothesis verified that logarithmic models offer an improved fit. In

addition, the discreet percentage variability of *MTCpallet* explained (R^2=0.56) depending on the distance travelled (measured in Km) by our model led us to think of the need to test the inclusion of additional variables. In *MTCpallet* the distance travelled is duly reflected in the business cost. However, in general the item of greatest value is the distribution cost, representing the complication faced by the RLO in capillary distribution. Likewise, though of less importance in the *MTCpallet*, transit of the goods through another platform of the RLO before reaching its destination, included in the transfer cost, is another known factor to be considered. Consequently, we experimented with the incorporation into the *MTCpallet* function of two fictitious variables in order to also quantify the effect on average costs of the existence of transfers and the greater or lesser complexity of the capillary distribution. The coefficients estimated have statistical significance and are presented following.

Log *MGOTpallet*= 0,999 + 0,525 Log *MTCpallet* [11]

R^2=0,56			
Coefficient	*Standard Error*	*Statistic- t*	*P-value (α=0,005)*
bo (0,999)	0,131	7,602	0,000
b1 (0,525)	0,068	7,682	0,000

Log *MFPpallet*= 0,761 + 0,655 Log *MTCpallet* [12]

R^2=0,93			
Coefficient	*Standard Error*	*Statistic- t*	*P-value (α=0,005)*
bo (0,761)	0,049	15,411	0,000
b1 (0,655)	0,026	25,523	0,000

Log *MTCpallet*= 0,551 + 0,515 Log *Km* [13]

R^2=0,56			
Coefficient	*Standard Error*	*Statistic- t*	*P-value (α=0,005)*
bo (0,551)	0,178	3,093	0,003
b1 (0,515)	0,067	7,694	0,000

MTCpallet=40,389 + 0,041*Km* + 18,008*DV1* + 45,858*DV2* [14]

R^2=0,85			
Coefficient	*Standard Error*	*Statistic- t*	*P-value (α=0,005)*
bo (40,389)	5,695	7,092	0,000
b1 (0,041)	0,011	3,794	0,000
b2 (18,008)	5,28	3,411	0,001
b3 (45,858)	5,927	7,737	0,000

Where *DV1* and *DV2* are the dummy variables built to illustrate the transfer cost and the distribution cost respectively.

The equations presented are only useful for prediction in the range of the observed values of the independent variables on which we have information (i.e. within Spain), as outside that range we do not know the relationship; the interpretation of this fact implies that our models [11], [12], [13] and [14] can not be extrapolated to international transport, as the latter suffers from different problems.[1]

4. Results

Table 2 shows a simulation of the values of the variable *MGOTpallet*, starting from Barcelona and Madrid and for all destinations, with the application of a commercial margin of 15 and 25 per cent respectively. The calculation was done with the automatic calculator constructed in this study, which makes possible any other simulation. Note that the variability in *MGOTpallet-s* from the same starting point seems to be due to differences in the number of kilometres travelled, but also to the existence or otherwise of transfers and to the greater or lesser complexity of the capillary distribution; we shall see to what extent this is confirmed by the statistical analysis.

Table 3 offers the main results of the variable *MFPpallet* starting from Valencia and for all destinations. In it we can observe the *MFPpallet* depending on the number of pallets, as well as the *coefficient of variation,* which is used as a proxy for the average percentage *discount* on each journey. The variability in the *MFPpallet-s* seems to originate, as they depend on the general tariffs, in differences in the number of kilometres travelled, in the existence or otherwise of transfers, and in the greater or lesser complexity of the capillary distribution, but also on the percentage of *discount*. In this sense, some interesting conclusions can be drawn from the reading of Table 3:

• As noted earlier, the limits between which the percentage of *discount* is bounded are zero (in which case the *final price* coincides with the *general tariff*) and the *gross commercial margin*. Observe that the maximum average *discount* per journey that we have found is close to 22 per cent, causing the RLOs *net profitability margins*, especially in the journeys with greatest demand, to become established between 3 and 5 per cent.[2] Our results corroborate, in this sense, the tight profitability that affects the freight transport sector.

[1] See in Andrés (2012) an analysis applied to the case of European transport.

[2] These values are more typical of a margin that adds value to the product than of a speculative margin.

TABLE 2. Mean general tariffs per pallet in 2008 (euros/pallet).

From Barcelona, margin 15%					From Madrid, margin 25%				
To	1 pallet	2/3 pallets	4/6 pallets	7/10 pallets	To	1 pallet	2/3 pallets	4/6 pallets	7/10 pallets
ALAVA	80,53	68,07	60,41	48,33	ALAVA	82,86	70,03	62,14	49,72
ALBACETE	110,82	93,66	83,14	66,52	ALBACETE	61,74	52,19	46,32	37,07
ALGECIRAS	138,01	116,65	103,53	82,84	ALGECIRAS	99,16	83,81	74,38	59,51
ALICANTE	85,92	72,62	64,46	51,57	ALICANTE	93,87	79,34	70,42	56,34
ALMERIA	105,95	89,54	79,47	63,58	ALMERIA	92,01	77,77	69,02	55,23
ANDORRA	154,78	130,82	116,10	92,89	ANDORRA	197,35	166,80	148,04	118,45
ASTURIAS	128,70	108,78	96,54	77,24	ASTURIAS	78,04	65,97	58,54	46,84
AVILA	86,79	73,36	65,11	52,09	AVILA	42,68	36,08	32,02	25,62
BADAJOZ	123,67	104,52	92,77	74,22	BADAJOZ	72,43	61,22	54,34	43,48
BARCELONA	31,82	26,90	23,87	19,10	BARCELONA	84,53	71,44	63,41	50,73
BURGOS	88,97	75,20	66,75	53,41	BURGOS	50,82	42,96	38,13	30,51
CACERES	123,67	104,52	92,77	74,22	CACERES	72,43	61,22	54,34	43,48
CADIZ	115,32	97,48	86,52	69,22	CADIZ	86,23	72,88	64,68	51,75
CANTABRIA	83,81	70,83	62,86	50,30	CANTABRIA	93,87	79,34	70,42	56,34
CASTELLON	71,45	60,38	53,59	42,88	CASTELLON	78,04	65,97	58,54	46,84
CIUDAD REAL	98,31	83,09	73,75	59,01	CIUDAD REAL	57,86	48,91	43,40	34,73
CORDOBA	138,01	116,65	103,53	82,84	CORDOBA	86,23	72,88	64,68	51,75
CUENCA	114,18	96,50	85,65	68,53	CUENCA	66,54	56,23	49,91	39,94
GERONA	39,27	33,19	29,46	23,57	GERONA	91,55	77,37	68,68	54,94
GIBRALTAR	175,33	148,19	131,52	105,23	GIBRALTAR	116,90	98,80	87,69	70,16
GRANADA	175,33	148,19	131,52	105,23	GRANADA	86,23	72,88	64,68	51,75
GUADALAJARA	86,79	73,36	65,11	52,09	GUADALAJARA	42,68	36,08	32,02	25,62
GUIPUZCOA	69,68	58,89	52,27	41,82	GUIPUZCOA	79,22	66,96	59,42	47,55
HUELVA	115,32	97,48	86,52	69,22	HUELVA	86,23	72,88	64,68	51,75
HUESCA	84,65	71,55	63,50	50,81	HUESCA	90,64	76,61	68,00	54,40
IBIZA	164,00	157,96	156,43	156,43	IBIZA	199,44	199,44	199,44	199,44
JAEN	175,33	148,19	131,52	105,23	JAEN	116,90	98,80	87,69	70,16
LA CORUÑA	122,44	103,49	91,85	73,50	LA CORUÑA	92,47	78,15	69,37	55,50
LEON	107,55	90,90	80,68	64,55	LEON	63,93	54,03	47,95	38,37
LERIDA	46,76	39,52	35,08	28,07	LERIDA	97,19	82,15	72,91	58,33
LOGROÑO	83,81	70,83	62,86	50,30	LOGROÑO	93,87	79,34	70,42	56,34
LUGO	138,01	116,65	103,53	82,84	LUGO	98,17	82,98	73,65	58,93
MADRID	80,13	67,72	60,11	48,09	MADRID	34,59	29,24	25,94	20,76
MALAGA	177,10	149,69	132,85	106,30	MALAGA	86,23	72,88	64,68	51,75
MENORCA	164,00	157,96	156,43	156,43	MENORCA	199,44	199,44	199,44	199,44
MERIDA	177,10	149,69	132,85	106,30	MERIDA	72,43	61,22	54,34	43,48
MURCIA	85,49	72,25	64,13	51,31	MURCIA	72,78	61,51	54,60	43,69
NAVARRA	80,53	68,07	60,41	48,33	NAVARRA	82,86	70,03	62,14	49,72
ORENSE	122,44	103,49	91,85	73,50	ORENSE	92,47	78,15	69,37	55,50
PALENCIA	108,09	91,35	81,08	64,87	PALENCIA	76,12	64,35	57,11	45,69
PALMA DE MALLORCA	164,00	157,96	156,43	156,43	PALMA DE MALLORCA	199,44	199,44	199,44	199,44
PIRINEO CATALAN	72,53	61,30	54,41	43,53	PIRINEO CATALAN	114,02	96,37	85,53	68,43
PIRINEO ARAGONES	93,06	78,65	69,81	55,85	PIRINEO ARAGONES	99,66	84,23	74,75	59,81
PONTEVEDRA	110,82	93,66	83,14	66,52	PONTEVEDRA	80,02	67,64	60,03	48,03
SALAMANCA	98,31	83,09	73,75	59,01	SALAMANCA	57,86	48,91	43,40	34,73
SEGOVIA	86,79	73,36	65,11	52,09	SEGOVIA	42,68	36,08	32,02	25,62
SEVILLA	111,36	94,12	83,53	66,84	SEVILLA	80,81	68,31	60,62	48,50
SORIA	93,06	78,65	69,81	55,85	SORIA	99,66	84,23	74,75	59,81
TARRAGONA	39,27	33,19	29,46	23,57	TARRAGONA	91,55	77,37	68,68	54,94
TERUEL	93,06	78,65	69,81	55,85	TERUEL	99,66	84,23	74,75	59,81
TOLEDO	86,79	73,36	65,11	52,09	TOLEDO	42,68	36,08	32,02	25,62
VALENCIA	67,97	57,46	50,99	40,79	VALENCIA	74,24	62,75	55,70	44,56
VALLADOLID	92,14	77,88	69,12	55,31	VALLADOLID	52,11	44,04	39,10	31,28
VIZCAYA	81,34	68,75	61,02	48,82	VIZCAYA	76,51	64,67	57,39	45,92
ZAMORA	111,92	94,60	83,96	67,17	ZAMORA	63,30	53,50	47,48	37,99
ZARAGOZA	66,96	56,59	50,23	40,19	ZARAGOZA	71,70	60,60	53,78	43,03

Source: Own preparation.

• The average percentages of *discount* vary between 3 and 22 per cent. The lowest values, up to 5 per cent, correspond to journeys with very little goods traffic, especially distant such as Andorra, Mérida, Algeciras and Gibraltar, or complicated such as the Balearic Islands (which require sea

TABLE 3. Mean final prices per pallet originating in Valencia in 2008 (euros/pallet).

	1 pallet		2/3 pallets		4/6 pallets		7/10 pallets	
To	MFP pallet	CV	MFP pallet	CV	MFP pallet	CV	MFP pallet	CV
ALAVA	94,84	18,36	88,42	19,61	83,74	20,53	77,74	15,21
ALBACETE	79,95	13,43	74,37	14,44	69,88	15,19	64,96	13,72
ALGECIRAS	120,69	3,93	112,33	3,94	106,72	3,87	99,97	4,43
ALICANTE	50,37	20,59	47,60	19,73	45,18	20,04	43,25	19,86
ALMERIA	87,84	13,32	82,26	13,71	76,92	12,75	72,58	16,16
ANDORRA	196,35	3,12	166,19	3,64	147,55	3,79	117,68	2,75
ASTURIAS	140,31	8,53	127,60	9,04	113,04	9,11	106,30	9,94
AVILA	101,06	13,63	95,10	14,81	83,22	15,37	78,14	12,28
BADAJOZ	132,72	10,86	120,19	11,21	109,83	11,19	103,21	10,92
BARCELONA	70,89	12,16	65,94	14,11	62,30	16,67	59,13	13,69
BURGOS	123,69	14,15	112,60	14,07	103,16	14,84	97,74	13,43
CACERES	132,405	9,50	120,08	9,93	109,72	9,89	103,26	10,79
CADIZ	104,12	11,95	97,08	12,31	90,41	12,57	84,30	11,38
CANTABRIA	151,34	12,60	137,85	14,45	116,80	14,94	109,60	12,10
CASTELLON	40,83	18,62	38,37	20,28	35,92	20,89	34,07	23,47
CIUDAD REAL	111,91	11,64	105,33	12,61	93,34	12,89	87,66	11,37
CORDOBA	110,99	7,86	102,29	9,49	95,33	9,50	88,51	7,89
CUENCA	126,08	19,09	115,17	19,67	103,11	19,56	97,94	19,20
GERONA	88,55	11,16	83,13	11,36	78,98	11,11	74,56	10,55
GIBRALTAR	158,41	3,57	133,89	3,57	118,83	3,56	95,10	3,43
GRANADA	114,44	7,34	105,46	6,88	97,55	6,84	89,59	7,53
GUADALAJARA	85,38	13,23	79,69	13,97	75,13	14,49	70,14	12,28
GUIPUZCOA	92,25	16,29	86,12	16,77	81,64	17,08	76,46	16,47
HUELVA	107,32	13,12	100,20	13,55	93,52	13,74	87,48	13,22
HUESCA	155,98	13,62	141,74	15,47	117,11	15,93	110,24	13,74
IBIZA	138,57	3,50	138,57	3,50	138,32	3,09	138,70	2,82
JAEN	121,86	7,45	112,58	7,12	100,58	7,04	92,89	7,19
LA CORUÑA	148,07	12,26	134,35	14,08	116,21	14,81	109,15	12,69
LEON	127,93	13,54	116,45	14,48	105,32	14,42	99,47	11,74
LERIDA	91,59	13,83	85,71	14,57	81,25	14,50	76,15	11,23
LOGROÑO	101,23	10,20	93,84	11,45	88,42	11,73	81,70	12,54
LUGO	157,29	11,70	142,99	13,55	119,57	14,10	112,10	11,48
MADRID	71,55	13,95	66,62	15,73	62,66	17,99	59,59	16,22
MALAGA	113,56	7,05	104,51	6,67	97,22	6,69	89,30	7,21
MENORCA	144,39	5,41	144,33	5,42	144,33	5,42	143,77	7,06
MERIDA	144,94	3,09	130,67	2,96	117,94	2,96	109,97	2,77
MURCIA	57,00	21,74	53,22	23,20	51,06	21,92	48,27	24,91
NAVARRA	94,94	12,57	88,42	13,46	83,65	14,11	77,88	14,62
ORENSE	148,22	12,70	134,36	14,35	116,23	15,08	109,03	12,54
PALENCIA	130,44	13,59	119,00	14,57	106,12	17,90	100,62	11,93
PALMA DE MALLORCA	138,34	3,91	138,28	3,76	138,28	3,76	138,36	3,20
PIRINEO CATALAN	123,15	12,07	101,64	10,43	85,14	6,45	72,38	10,13
PIRINEO ARAGONES	141,58	4,89	125,15	7,49	103,95	4,00	88,01	6,37
PONTEVEDRA	133,56	14,44	121,97	16,10	107,85	17,16	101,93	14,14
SALAMANCA	118,61	11,48	108,62	12,25	100,29	12,50	94,66	11,37
SEGOVIA	88,84	11,10	83,15	11,52	79,60	11,74	74,85	12,40
SEVILLA	95,99	20,19	91,07	18,45	87,26	16,16	83,21	11,73
SORIA	161,24	11,06	146,37	12,43	120,04	12,83	112,75	11,59
TARRAGONA	87,58	11,07	82,20	11,01	75,53	10,92	71,16	10,05
TERUEL	104,77	12,36	96,89	13,81	91,19	14,23	83,75	11,59
TOLEDO	98,62	12,91	89,30	13,69	79,74	14,22	74,81	12,28
VALENCIA	36,08	17,51	33,90	18,90	31,61	19,66	30,07	21,10
VALLADOLID	116,55	11,60	106,51	12,66	98,40	12,82	93,19	13,37
VIZCAYA	94,58	15,09	88,07	15,35	83,39	15,49	77,80	14,25
ZAMORA	129,14	13,93	117,53	14,56	107,25	14,39	101,27	13,19
ZARAGOZA	90,23	11,74	84,26	12,85	78,38	13,59	73,28	13,47

Source: Own preparation.

transport). From Valencia, the lack of synergies with these destinations and very low rates of occupation of the trucks make it impossible for the RLOs to grant greater *discounts*. Something very similar occurs with destinations like Asturias, Extremadura or the provincial capitals of Andalusia the further away they are from Sevilla, which do not reach 10 per cent. At the other extreme are the highest *discounts*, exceeding 15 per cent, that characterize the journeys in most demand or closest to the starting point (through which most goods are channelled), such as the Valencia region itself, Murcia, Cuenca, Sevilla and the Basque Country. Our results corroborate the hypothesis that the final price of transport depends not only on the mileage cost, which increases with the distance to be travelled, but also on the volume of business handled by the RLO to that destination, which acts to determine the existence of synergies and the degree of occupation of each vehicle. It seems reasonable to suppose that routes with more goods traffic will concentrate loads of greater volume and frequency, which leads us to think that the importance of the customer who requests the service, or the RLO's need to sell, lose importance as variables explaining the percentage of *discount*.

The results obtained from the model developed, whose estimated coefficients for the proposed equations were presented in the previous epigraph, permit us to uphold some hypotheses of undoubted interest with regard to the system of pricing that concerns us:

• The increase of the *MGOTpallet* grows smaller as the *MTCpallet* increases, though the squares model tried does not offer a good fit with the data observed, as only 56 per cent of the total variability is explained by the model (R^2=0.56). This suggests that the establishment of *ordinary general tariffs* by RLOs is influenced, as well as by *MTCpallet*, by other factors whose inclusion in this model is complicated by the difficulty of measuring them. Specifically, two significant factors have been identified that generate such divergences: first, the effective percentage of *gross commercial margin* applied by the RLO in calculating its *ordinary general tariffs* is not the same for all journeys; second, the RLO offers in some situations *ordinary general tariffs* lower than the *mean total cost* calculated for the journey.

• Economic theory suggests that there is a causal relationship between *MFPpallet* and *MTCpallet,* and our results support this theory. Thus, our model explains 93 per cent of the variability of the *final prices* (R^2=0.93). This result suggests that the *final prices* charged by RLOs are indeed a faithful reflection of the *MTCpallet*, such that the *discount*, as the only difference between *GOTpallet* and *FPpallet*, acts to reduce the divergences found between the *general tariff* and the *mean total cost* for one pallet. Expressed in other words,

RLOs are pricing according to the *mean total cost*. The elasticity of *final prices* relative to the *mean cost per pallet* has an approximate value of 0.655.

• The high percentage of variability of *MTCpallet* explained by the multiple regression (R^2=0.85), which has improved substantially from that offered by a logarithmic model where the mean costs depend only on the distance (R^2=0.56), shows that the existence of transfers and the difficulty of the capillary distribution, together with the kilometres travelled, are the most important production costs for RLOs. However, their marginal variation is more difficult to estimate, as these independent variables are in turn correlated with each other (correlation coefficients: r=0.47; r=0.23; r=0.64, respectively), so the coefficient of each one of them does not show the effect produced by that variable in all conditions but the effect when it is combined with the others (conditioned coefficients). The rate of variation of the *mean costs per pallet* in relation to the distance travelled has an approximate value of 0.041, the *mean cost* rising by about 33 per cent when a transfer is involved, and up to 80 per cent when affected by a complicated capillary distribution. The error of the model reflects the importance of other production costs which it was not possible to include in this modelling because their value is not known for certain (the indirect running costs captured in the *business cost*).

• The results obtained in the estimation of the *mean costs per pallet* function, though implicitly, permit us to sustain the hypothesis of the existence of economies of density in the provision of refrigerated transport, i.e. the mean cost of transporting a pallet decreases with the number of pallets transported. In this case it is possible to know how the *mean cost per pallet* behaves relative to variations in the total flow of pallets transported per consignment: the empirical evidence contributed by our study reveals that an increase of 1 pallet in the number of pallets included in the consignment reduces the *mean cost per pallet*, on average, by 3 per cent. The presence of economies of density is of great importance as this is a relevant concept when the price policy is being negotiated, with an effect on the *final prices per pallet*, depending on the number of pallets, that has been duly illustrated in Table 3 of this study.

5. Conclusions

This study has investigated the formation of prices in groupage freight transport, with emphasis on the case of perishable products, analyzing some of the most important questions posed in determining the prices that will be charged: what are the components making up the final price and what value do they take and how are they related to the cost of production derived from the activity.

The generalized system of pricing uses final prices calculated expressly for each customer, since there are demands of differing intensity throughout the year and journeys with notable differences in the costs of production. Thus the *discount* applied to the *GOTpallet* incorporates into the tariff structure the most notable differences in the costs of production, avoiding the discriminatory component of the single general tariff per journey. The estimations obtained in this study, reinforced by the tests performed, permit us to uphold the hypothesis that RLOs are pricing according to the *mean total cost*, and not in terms of the competition or of the market.

The results of this work show several consequences for the business activity, from which we would like to highlight some fundamental questions for the strategy of the firm using this service and the RLO:

1. The *FPpallet* offered by the RLO suffers from a certain complexity in its calculation and is very variable. Two sources of variability have been characterized. On the one hand, the *GOTpallet* used as reference to obtain the *final prices* is based on the RLO's structure of direct and indirect running costs; consequently, it will take a different value depending on the RLO engaged. On the other hand, a *discount is* applied to the *GOTpallet*, depending basically on the structural network of the RLO (which explains the existence of synergies and the degree of occupation of the vehicle for each journey); consequently, the *FPpallet* will change not only depending on the RLO considered, but also for the same RLO depending on the time of year when the service is engaged.

2. The above evidence favours industries of a markedly competitive character, like the ones formed by food producers, which minimize their costs of production. If they give due consideration to the suitability of working jointly with two or more RLOs as providers, they will obtain an excellent opportunity of achieving a substantial reduction of their transport costs.

3. The knowledge of the main elements that affect the mean cost per pallet involves an added value for the RLOs, who will be able to work in their analyses and improvement while other cost elements have smaller acting margins.

We can conclude by proposing future researching lines that will be able to increase the application of the results of this study. There is a wide range of differences in the turnover of the RLOs and the load companies (large, medium and small size), and also in the subcontracting agreements that relate them (formal long-term contracts, "collaboration contracts", verbal agreements, strategic alliances…). These agreements would let a segmentation of the cases with the aim of analysing the behaviour differences depending on these variables. In this way, it would be interesting to know the pricing poli-

tics of large and small size RLOs respect to large, medium and small size load companies with formal long-term contracts or informal ones. In addition it would be also useful to know what are the *pick-up costs*, *transfer costs*, *business costs* and *distribution costs* per pallet generated by a large size RLO and confront them with a medium or small size RLO, discussing if there is any difference and in which elements they are. In other context, another improvement that is going to be deeper analyzed consists on comparing production costs between different types of road transport and quantifying later its impact on the final prices.

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