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# Transport as a limiting factor for the growth of Spanish agri-food exports [1]

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**Abstract**

The location of the main Spanish fruit and vegetable production areas in the southern Mediterranean region and their dependence on road transport hinder the exporting activity in this area. The growth of transport costs and future scenarios with constrictions, for example green taxes and land transit limitations, oblige exporters to seek out alternatives, such as sea transport within an intermodal framework. The present study aims to provide a quantitative analysis for strategic decisions to promote this adaptation. The results support the change to intermodal transport and highlight the negative effects of transport cost increases on exports. They also reveal the benefits of a consolidated business nucleus at origin to avoid certain logistical problems caused by the modal switch.

**Keywords**: transport cost; fruit and vegetables exports; intermodal transport; gravity equation

**JEL codes:** F18, Q17

## 1. INTRODUCTION

Spain is the main European exporter of fruits and vegetables (F&V). In 2018, Spain exported a total value of vegetables worth 5.29 billion euros and fruits worth 7.542 billion euros (FEPEX, 2018). Nearly all these exports are transported in refrigerated trucks, making this sector extremely dependent on road transport. However, there are a number of potential risks that threaten this means of transport, for example, future eco-taxes and the trend towards increasing costs (Galati et al., 2016). Such a context makes it necessary to search for other logistics alternatives. Intermodality (trucks + ships) could be the easiest to implement.

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Approached from a medium and long-term perspective, the option of using trains as an alternative means could be viable with the full completion of the so-called "Mediterranean Corridor" – a railway line that would link Algeciras (southeast Spain) with Perpignan (southeast France), running along the entire Spanish coast. This project requires the installation of twin-track freight-passenger rails with international track width, in addition to tripling the size of the current high-speed rail network and unifying railway standards with the rest of Europe. Currently, there is no project under way to unite this Corridor; there is simply a series of lines with double rails, third tracks or independent tracks with completely different projects and deadlines (AVE, 2018). Furthermore, the railway option continues to prove deficient in terms of the transportation of perishable goods (Woroniuk et al., 2013); it requires large-scale cargo groupage, which slows down journeys, and it lacks suitable cold storage infrastructures. As for sea transport, although it also displays some of the same drawbacks as rail, it would be possible to take advantage of sea transport within an intermodal framework (truck + ship). The present study presents arguments that support the strategic decision to opt for said change.

The relationship between transport costs and international trade has been investigated by several researchers (Baier and Bergstrand, 2001; Bensassi et al., 2014; Chi, 2016; Limao and Venables, 2001; Martínez-Zarzoso et al., 2008; Tiller and Thill, 2017; Xu et al., 2013). Most of them have found evidence that transport costs have a significant negative impact on trade, although this influence varies at industry and commodity levels (Chi, 2016; Martínez-Zarzoso et al., 2008; Wilmsmeier and Sanchez, 2009). However, no study has focused on perishable goods, such as F&V. Only Martínez-Zarzoso et al. (2008) showed that, in the case of Spain, some sectors with high value-added are more sensitive to a transport cost change than others. Nevertheless, they did not include F&V in the analysis.

The present research will analyze F&V exports from Spain to the main import areas in the European Union in order to investigate the structural importance of transport costs. The contribution of the paper is that it provides evidence on the impact of transport costs on the volume of F&V exports in Spain using a gravity model and considering the effects of both land and intermodal transportation. Moreover, it includes environmental externalities and calculates elasticities to determine the increase in demand as a result of savings in transport costs according to the export destination. The rest of the paper is organized as follows: a literature review is presented in Section 2; then, the F&V sector in Spain is described in Section 3; the methodology, data and variables are explained in Section 4; the results are shown in Section 5; finally, discussions and conclusions are displayed in Section 6.

## 2. LITERATURE REVIEW

This section presents a brief overview about road and maritime transport and the role of transport costs as a key factor of exports.

### 2.1. Sea and road transport

Increasing congestion on the roads is attracting special attention and leading to the promotion of intermodality (Sakalys and Palsaitis, 2006). Said system consists of combining the transport of goods by both sea and land, which also includes shipping by rail. Such a plan requires increasing Short Sea Shipping (SSS) and developing the so-called motorways of the sea (MoS).

Efforts have been made to promote the SSS, but its weight within a logistics network is still well below that of road transport (European Commission, 2016; Paixao and Marlow, 2007). Thus, several studies have shown that operators have a clear preference for land transport (European Commission, 2003, 2004; Musso and Marchese, 2002; Napier University, 2002). There are several reasons behind this preference: the service provided by SSS tends to be slow and infrequent and increases the lead times (Çekyay et al., 2017); it has a poor reputation in the door to door transport chain; shipping procedures require documentation which is not standardised among different ports and/or countries; port infrastructure is sometimes not adequate (Wilmsmeier and Sanchez, 2009); and there is a lack of information and monitoring of the cargo during transit (Paixao and Marlow, 2001). In short, sea transport is clearly less flexible as it does not easily allow changes in the final destination of the product once it has left. In addition, due to the lack of competitiveness of many port facilities, landing costs at ports must also be taken into account.

Nevertheless, SSS also has less external costs and many positive points (Galati et al., 2016; Kotowska, 2014; Lupi et al., 2017; Morales-Fusco et al., 2012; Paixao and Marlow, 2005), which are the following:

- It is more eco-friendly because it consumes less energy, is less noisy and generates lower $CO_2$ emissions per ton transported;
- It has geographic advantages, such as less traffic congestion and accidents.
- It has economic advantages, such as no toll payments, transporting larger volumes of product and less infrastructure deterioration.
- It has lower costs and externalities than land transport.

- It offers the opportunity for expansion by taking advantage of an underused network.
- It has the potential to exploit auxiliary activities that can create both employment and economic growth.

### 2.2. The impact of transport costs on exports

The influence of transportation costs on bilateral flows depends on different factors, such as the type of product and the agreements between exporters and importers.

On the one hand, regarding the type of product, Emlinger et al. (2008) showed that the degree of product perishability determines transport costs and their impact on trade. Thus, in perishable products, transport costs tend to be higher as they require special conditions such as special protective packaging for better conservation, refrigerated or modified atmosphere packing trucks or cargo ships. Consequently, transport costs certainly have greater impact on F&V exports.

On the other hand, with respect to agreements between exporters and customers, the latter usually bear the cost of transporting products, and, accordingly, any reduction in transport costs will mean that they are willing to acquire greater quantities (Hummels, 2001). In the case of perishable products, this is confirmed more strongly, since any deterioration in the quality of the produce during transport represents a loss for the purchaser. In this way, when transport costs go down, the importer will be prepared to purchase more and take greater risk. If no previous deal has been reached with the customer, exporters may dispatch their produce to a wholesale market for sale on commission, in which case they run the risk of not being able to cover transport costs (De Pablo et al., 2007). Therefore, reduction of transport costs will result in exporters being able to dispatch greater amounts of produce and/or in importers wanting to increase their demand.

Many researchers have found evidence on the negative relationship between transport costs and exports (Baier and Bergstrand, 2001; Bensassi et al., 2014; Chi, 2016; Limao and Venables, 2001; Martínez-Zarzoso et al., 2008; Xu et al., 2013). For example, Baier and Bergstrans (2001) determined that about 8 percent of world trade growth can be explained by transport cost reductions, while Limao and Venables (2001) showed that the elasticity of trade with regard to transport costs was -2.5. Additionally, this impact of transport costs on bilateral flows has been found to vary at industry and commodity levels (Chi, 2016; Martínez-Zarzoso et al., 2008;

Wilmsmeier and Sanchez, 2009). However, the previous literature lacks empirical evidence on transport cost elasticity in the agri-food sector. Only Crescimanno et al. (2013) and Emlinger et al. (2008) explored this sector at a disaggregated level, but they used the variable distance as a proxy for transport costs. The present study focuses on agri-food exports and the direct impact of transport costs.

## 3. DESCRIPTION OF SPANISH F&V EXPORTS

Spanish agriculture is one of the leading industries in the European Union (EU). In addition, Spain is the main European exporter of F&V, exporting to almost all European countries (Figure 1). Specifically, the Southeast region (Almeria and Murcia provinces) accounts for 64 percent of all Spanish F&V exports. Also, this figure summarizes the mean transit times by both land and intermodal transport from southeast Spain to the most important destinations in Europe, including optimized calls to different ports on both Atlantic and Mediterranean routes. It can be seen that although intermodal transport is usually cheaper than by road, transit times are higher. On average, land transport saves 55% in terms of time compared to intermodal transport.

[Insert Figure 1 about here]

In order to simplify the analysis, EU destinations have been grouped into seven areas according to their proximity, imports preferences and their habitual presence on distribution routes, as follows:

1. Germany and Austria, which represent 31% of all Spanish F&V exports[2].
2. France, which accounts for 17% of Spanish exports.
3. United Kingdom (England and Ireland), 12% of Spanish exports.
4. Central Europe (Holland, Belgium and Luxemburg), 13% of exports.
5. Eastern Europe (Czech Republic and Poland), 6% of exports.
6. Scandinavia (Finland, Sweden and Denmark), 6% of exports.

[2] The F&V produce from this area is mainly tomato, pepper, cucumber, aubergine, green bean, courgette, lettuce, melon and watermelon.

7. Italy, 5% of exports.

Other countries represent an additional 10% of Spanish exports.

In international transactions, transport cost is the second most relevant factor after labor costs, as it may account for 20-25 percent of the total cost. Figure 2 displays the cost of transport in relation to import prices (cost, insurance and freight, Cif) in the studied areas. The highest transport costs correspond to Eastern and Northern European destinations.

[Insert Figure 2 about here]

The cost per kilometer of using a refrigerated truck has increased well above the general price index over the last 24 years, if we consider depreciation (Figure 3). This means that F&V production has become less competitive.

[Insert Figure 3 about here]

Furthermore, transport costs have increased despite the fact that petrol prices have declined in recent years. This is because fuel only represents 24 percent of the costs directly attributed to a truck (Ministry of Public Works and Transport, 2017), as Figure 4 shows.

[Insert Figure 4 about here]

## 4. RESEARCH METHOD

The method and methodology used in the present study are described in this section, along with the data and variables utilized.

### 4.1. Gravity model

In its most frequently used version, the gravity model attempts to explain commercial fluxes between different areas based on characteristics of the source of produce and its destination (population, income, distance, etc.). In the present study, a gravity model is used as the theoretical framework in order to determine the impact of transport costs on the volume of exports.

In the economic literature there are many studies that have used this model to explain the determinants of bilateral trade, combined with the widely accepted belief that gravity equations soundly describe trade patterns (Tinbergen, 1962; Baier and Bergstrand, 2007; Da Silva and D'Agosto, 2013; or Head and Mayer, 2014). Such models vary greatly in both their specifications (Chen and Wall, 1999; Egger, 2000; Song et al., 2003; or Çekyay et al., 2017) and in their incorporation of new variables (price, exchange rate, dummies including some characteristics of the countries, etc.) or indices (Anderson and van Wincoop, 2003; Bougheas et al., 1999; Clark et al., 2004; or Limão and Venables, 2001).

Most studies take distance as a proxy of transport costs and other obstacles to commerce (Bensassi et al., 2015; Crescimanno et al., 2013; Emlinger et al., 2008; Gangnes et al., 2011; Ozer and Koksal, 2016). However, other studies have found that distance is imperfectly correlated with transport costs and is, therefore, a poor proxy (Martínez-Zarzoso and Nowak-Lehmann, 2007), since it could include other factors such as differences in tastes, history or culture. Thus, some works specifically incorporate data on transport costs in the gravity equation, either previously estimated or obtained from secondary sources such as international databases (Bensassi et al, 2014; Martínez-Zarzoso, 2003; Marquez-Ramos, 2007; Xu et al., 2013).

In the case of the agri-food sector, Emlinger et al. (2008) focus on tariffs for non-EU Mediterranean countries; Crescimanno et al. (2013) assess the determinants of Italian F&V exports; and Ozer and Koksal (2016) apply a similar analysis in the case of Turkey´s citrus exports. All of these studies estimate gravity equations with variable distance as a proxy of transport costs. In this regard, no research has been found in the case of Spanish F&V exports, despite the importance of this sector in the country's economy. Moreover, transport costs are considered higher and more important than in non-perishable produce. For this reason, they are explicitly incorporated into the gravity equation, including externalities.

To begin an assessment of the Spanish sector, we start with the generalisation of the function proposed by Baier and Bergstrand (2001), with the explicit inclusion of transport costs to adapt it to the needs of perishable produce. We also estimate a demand model for Spanish agri-food exports based on a log-linear form of a gravity equation. Similar applications can be found in Márquez-Ramos (2007), Martínez-Zarzoso et al. (2003, 2008), and Özer and Koksal (2016).

### 4.2. Data and variables

The analysis incorporates annual data in the period 1995 to 2017 (23 years / data used) for Spain and the seven export areas (Germany and Austria, France, United Kingdom, Central

Europe, Eastern Europe, Scandinavia, and Italy). We use the Spanish Ministry of Public Works and Transport databases (Spanish Ministry of Public Works and Transport, 2017) for data on transport costs, along with data from the Association of Fruit and Vegetable Growers of Almería (COEXPHAL) to calculate the concentration index and the Eurostat databases for data on the rest of variables. In a time period *t*, the variables used are:

— Exports ($\frac{Y_{it}}{n_{it}}$): $y_i$ denotes the Spanish F&V exports[3] to area *i* (in tonnes[4]); $n_i$ is the total population of the destination area *i*. Thus, $\frac{y_{it}}{n_{it}}$ stands for Spanish agri-food exports per capita to area *i*.

— Prices ($p_i$, $p^c$): $p_i$ is the F&V import price (Fob[5]) to area *i*; $p^c$ is the mean F&V import price (Fob) of the rest of the areas. The latter variable is included to determine whether there is any variation of exports according to profit obtained in each area. In other terms, it shows if exports are diverted to other destinations based on whether prices are better or worse at specific locations. Similar index prices have been used by Emlinger et al. (2008) for agri-food exports also.

— Income ($\frac{r_{it}}{n_{it}}$): $r_i$ is the value of total imports of F&V to destination area *i*, and it is considered as a proxy of income. Then, $\frac{r_{it}}{n_{it}}$ means agri-food purchases (in euros) per capita in area *i*. Traditionally, many studies use GDP and GDP per capita as a proxy of income. These variables are sound income proxies when the study is performed at a higher level of aggregation. At a disaggregated level, they do not take into account the specific characteristics of the sector and consistency could prove to be a problem (Emlinger et al., 2008). For this reason, as this study is focused on the agri-food sector, the F&V purchases per capita in destination areas are considered a better income proxy variable. In addition, in this study the gravity equation only includes a proxy of income and population in the destination area since the analysis involves Spanish exports to 7 market destinations, so the income and population of the exporter country (Spain) does not vary.

— Transport costs ($T_{it}$): They represent the transport costs in euros of dispatching an articulated refrigerated truck to area *i*. To obtain them, we multiplied a unit cost in euros

[3] They include tomato, pepper, cucumber, courgette, aubergine, green bean, lettuce, melon and watermelon.

[4] As we explain below, this variable was proved in value and tonnage, but the previous one was chosen for a better fit of the model.

[5] Fob stands for "fee on board", that is exclusive to freight and insurance.

per kilometer by the mean distance in kilometers to area *i*. Then, we increased them with the external costs (air pollution, congestion, noise, infrastructure, accidents and emission of greenhouses gases) based on the estimations of Pérez-Mesa et al. (2012). The authors calculated that these environmental externalities increase road transport cost of Spanish agri-food exports to main destinations in Europe by 2.8 percent[6].

— Supply concentration index ($CON_t$): % that the top ten exporting companies represent. This index was elaborated by using data provided by the Association of Fruit and Vegetable Growers of Almería (COEXPHAL), an organization created in 1977 which represents 80% of all F&V commercialization in Almería. Bear in mind that this province is the leading F&V exporter in Spain, meaning the index is highly representative. This index attempts to determine whether business concentration has improved access to export markets (Galdeano et al., 2016).

### 4.3. Methodological specifications

The specification process has taken into account the stationarity of the data. The use of non-stationary variables may give rise to problems of spurious regressions. However, an exception arises when the variables are integrated to order one, and the combinations of the variables are stationary, that is, they are co-integrated. Given the relationship of co-integration, an Error Correction Mechanism (ECM) can be formulated to model the short and long-term dynamics of the data, according to the following model calculated in 2 stages (Engle and Granger, 1987):

$$\Delta \ln \frac{Y_{it}}{n_{it}} = \alpha + \partial_{1i} \Delta \ln p_{it} + \partial_{2i} \Delta \ln p_{it-1} + \partial_{3i} \Delta \ln p_t^c + \partial_{4i} \Delta ln \frac{r_{it}}{n_{it}} + \partial_{5i} \Delta \ln T_{it} + \partial_{6i} \Delta \ln CON_t + \emptyset_i ECM_{it-1} + \varepsilon_{it} \qquad (1)$$

where the equilibrium model is calculated incorporating the long-term residual $ECM_{it-1}$ estimated in a previous stage:

$$ECM_{it-1} = \ln \frac{Y_{it-1}}{n_{it-1}} - \beta_{1i} \ln p_{it-1} + \beta_{2i} \ln p_{it-2} + \beta_{3i} \ln p_{t-1}^c + \beta_{4i} ln \frac{r_{it-1}}{n_{it-1}} + \ln T_{it-1} + \ln CON_t + \mu_{it} \qquad (2)$$

The graphs showing the evolution of the variables reveal a marked tendency. The augmented Dickey-Fuller (ADF) test proves that all the temporal series are order 1 integrated,

[6] They estimate these externalities as 0.0095 €/ton/km for Ro-Ro sea transport and 0.0299 €/ton/km for land transport in refrigerated trucks. These results are consistent with Nam and Bert (2014).

and therefore model (1) is applied to the data. The stationarity of the residuals is tested by applying the ADF test once more. The proven specifications basically consisted of including exports per capita (the dependent variable) expressed as either value or tonnage. In the end, the second option was chosen, transforming the data into natural logarithms. Variable $p_{it}$, lagged one period, was tested for all the areas. In view of the overall improvement of the model, it was decided to include this variable definitively.

## 5. RESULTS

The results of the Equation (1) estimation are shown in Table 1.

[Insert Table 1 about here]

The most noteworthy of the estimations in Table 1 is the significance of ECM in almost all the equations, which demonstrates that co-integration exists in the relationships. It also tells us that the behaviour differs depending on whether it is short or long-term, producing a very high fit in the long term for all areas (over 70 percent on average). This was to be expected in the case of perishable produce, in which the urgency of sales leads operators to act in a different way, and even more so in a market where long-term agreements ("programmes" with customers) seldom occur.

The data also reflect the fact that transport costs are a major variable in exports of Spanish F&V produce to Europe, as they prove influential in almost all markets (p<10 percent). The sign obtained is the correct one, since an increase in transport costs implies a reduction of exports. For two of the main import areas (Germany and Austria, and France) the significance of transport is weaker, possibly due to the fact that, in both areas, prices at destination *(Cif)* are more fixed (non-significant). In Germany and Austria this is because of the final client, that is, the distribution chain, and in France it is the consequence of a high degree of competition from other markets of origin such as Morocco, meaning prices have a strong influence when exporting to this market. The elasticity of exports-transport costs (coefficient calculated for the variable $T_i$) is less than the unit in all cases. Expressed in average terms (0.30), a 10 percent reduction in transport costs would increase exports by 3.0 percent. This result is very similar to that found by Cresimanno et al. (2013) in the case of Italian agri-food exports (0.29). The most sensitive areas are the United Kingdom and Central and Eastern Europe. The high value for Central Europe is noteworthy as in this area the logistics cost constitutes the competitive advantage on which the re-exporting capacity is based: in other words, if operators in these countries achieve good transport combinations at a lower price, they are more likely to import more with a view to resale. It can be observed that the price *Fob* ($p_{it}$) in Central Europe is not relevant, which confirms that logistics management is the fundamental variable.

The price of *Fob* ($p_{it}$) is also one of the variables that most influence exports and its sign is also correct: if the operators at origin are able to reduce sales prices, then demand will increase. The elasticities calculated are less than one. It is particularly noteworthy that in France this variable is more influential than in other areas, and this may be due to the high level of competition at destination, which obliges operators to adjust prices as much as possible if they are to sell. The areas where prices are less significant are Central Europe, United Kingdom and Scandinavia, and this may be a result of the generally high purchasing power in these zones. The importance of lagged prices in Central Europe and the United Kingdom gives evidence that exporters consider these areas as a secondary option, taking as a reference the prices obtained in the previous year. This is patent in the case of Central Europe, where the price of the other competitive areas ($p^c$) is relevant: it reveals the dependence of Central Europe on Spanish supplies and its urgency to receive produce in order to satisfy its commercial requirements (re-exportation), when there is a general shortage of produce.

As regards the income proxy variable ($\frac{r_{it}}{n_{it}}$), the sign is positive and significant, but only in certain areas. The elasticities are low, indicating that F&V demand grows with an overall increase in purchasing power, but less than proportionally. It is apparent that the Spanish exporter must confront a degree of variability in the influences and tastes that shape demand, as the European market is far from homogeneous. The most sensitive areas are the United Kingdom and Scandinavia.

Rather interesting results were obtained by including the variable *CON* as the supply concentration index. Said index is significant in most cases, indicating that greater organization of production has positive effects on sales. This fact offers a competitive opportunity and is made possible by business concentration, or at least by operations coordination, which can counteract the negative effects caused by the increasing trend towards higher transport costs.

Next, the elasticities of exports-transport costs calculated in the model are used to determine the increase in agri-food exports that would result from the change in transport costs according to the export destination area (Table 2).

[Insert Table 2 about here]

Several research works have attempted to provide an alternative to road transport in the F&V sector, putting forward the option of intermodal transport (Pérez Mesa et al. 2010, 2012). All of these works highlight the savings in transport costs that the intermodal option would entail. On the other hand, transit time (Figure 1), which is greater in all cases, counteracts the savings, and therefore has a negative influence on operators' decisions (Pérez Mesa et al., 2012). The third line in Table 2 reflects the transport costs of intermodal transport (truck plus ship, return trip) from southeast Spain to the seven destinations in Europe, including optimized calls in different ports on both the Atlantic and Mediterranean routes. The weighted mean savings made by adopting the intermodal system is in the order of 14.37 percent. It must be noted that these suppositions require the use of sea transport departing from southeast Spain, which does not exist at present. If the current intermodal channels were used, the only destination that would display savings in costs would be the United Kingdom, departing from the Port of Bilbao (Pérez-Mesa and Abellay, 2019). Using the elasticities of exports-transport costs calculated in Table 1, we calculate the increase in demand (tonnes) as a result of the savings according to the destination. In general terms, a 14.37 percent savings in transport costs due to utilizing intermodal transport would mean a 3.80 percent increase in agri-food exports (last line in Table 2).

## 6. DISCUSSIONS AND CONCLUSION

The present research has analyzed F&V exports from Spain to the main import areas in the European Union in order to provide evidence on the effects of transport costs. It considers land and intermodal transportation, concentration index and environmental externalities (Marquez-Ramos, 2015), which are explicitly incorporated in a gravity model.

The main findings highlight the weakness of the F&V sector in the face of the trend towards increasing transport costs, and the potential to improve the competitiveness of this sector by employing an intermodal transport system. In particular, the factors that significantly influence F&V trade are prices, income and transport costs.

Import prices have a significant and negative effect on exports, which is expected and in line with other studies such as Baier and Bergstrand (2001) and Emlinger et al. (2008). This result proves that Spanish agri-food exports depend on price competitiveness when positioning in the European market. In this regard, the exception is Central Europe, where the price of other competitive areas is relevant due to its role as a re-exporter. In the Netherlands, re-exportation is highly important due to its logistic structure and geographical location.

In relation to income, agri-food demand grows as purchasing power increases (such as in Cresimanno et al., 2013, or Ozer and Koksal, 2016, among many others), especially in the United Kingdom, Germany and Austria, and Italy, and also Central Europe, again for the same reason above.

Regarding transport costs, they are found to be an important determinant of F&V exports, without exceptions. The results reveal that an increase in the value of transport costs has a negative bearing on exports to the main destinations in this sector. In mean terms, an annual increase of 5 percent (approximately the current figure) will result in a negative impact on exports volume in the order of 2.25 percent. This result is in line with other works on this subject which demonstrate the negative impact of transport costs (Bensassi et al., 2014; Márquez-Ramos, 2007; Martínez-Zarzoso et al., 2003; Xu et al., 2013).

Operators in southeast Spain are currently trying to offset rising transport costs by adjusting other costs, yet such an approach is unsustainable in the medium term (Pérez-Mesa et al., 2012). Almost 100 percent of Spanish F&V produce is currently transported by truck. At the same time, a continuing rise in the cost of road transport is foreseen, as a result of increasing fuel prices on the one hand and environmental taxes on the other (Galati et al., 2016). Therefore, transport policies should promote a change to exporting firms towards increasing the use of more efficient means of transport. Along these lines, using shipping by sea as part of an intermodal system might help to maintain costs and, therefore, to improve the competitiveness of exporters in the F&V sector (Paixao and Marlow, 2005; Lupi et al., 2017). Based on our results, intermodal transportation would reduce transport costs by 14.37 percent and consequently increase agri-food exports by 3.80 percent. In addition, the location of Spain in the extreme southwest of Europe adds difficulties to road transport, as it is frequently necessary to cross numerous countries, which involves different languages and traffic laws. In this sense, the savings of intermodality will likely increase as the distance between Spain and the destination area increases (Galati et al., 2016; Kotowska, 2014). Moreover, the length of the coastline in Spain is a suitable condition for the development of the intermodal alternative. The main drawback of this option resides in increased transit time, which is a key issue in the case of perishable produce, and, consequently, operators must consider this variable when adopting decisions regarding the use of intermodal transport systems (Liu and Yue, 2013). SSS transit time is a real concern as it decreases product shelf life in retail shops. In addition, for many products and short to medium term destinations, road transport is a competitive advantage of Spanish F&V exports against la competencia, por ejemplo, los Moroccan products. over the competition, like Moroccan products, for example.

Policies should also support innovations in the shipping sector and invest in the improvement of equipment and infrastructures and additional forms of transport (for example, complementarities by train, based on forecasts of improvements on this transport). In this regard, the vast capacity of SSS (i.e. high volume that can reduce unit costs) actually proves to be a disadvantage due to the necessity to organize cargo optimally, which requires a great deal of organization by exporting regions to ensure regular shipments. Thus, the present study shows that business concentration, which entails a better organization of sales, has an influence on the improvement of shipments, capable of counteracting the effects of increasing transport costs. In any case, the participation of customers (mainly big retailers) is fundamental as they take charge of coordinating the largest portion of transport through their centralized buying centers, acting essentially as logistics operators.

In the long term, the incorporation of the train option into the intermodal framework would be viable if a unified "Mediterranean Corridor" project were achieved and connected to the European railway network. However, this scenario seems rather difficult to accomplish as the rest of the arteries in Europe are not forecast to be completed before 2030. In any case, many of the operational problems related to the modal switch to sea transport are identical to those of train, for example, the obligatory consolidation of cargo to ensure optimal shipment frequency.

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## Tables

**Table 1.** Estimates of the gravity equations (Dependent variable $=\Delta \ln \frac{Y_{it}}{n_{it}}$)

| | Germany & Austria | France | United Kingdom | Central Europe | Eastern Europe | Scandinavia | Italy |
|---|---|---|---|---|---|---|---|
| Constant | 0.179 | 0.321** | -0.190 | 0.317* | 0.093 | 0.638*** | 0.854*** |
| $\Delta \ln p_{it}$ | -0.321 | -0.790** | -0.376 | 0.058 | -0.610** | -0.341 | -0.682** |
| $\Delta \ln p_{it-1}$ | -0.052 | 0.193 | 0.676** | 0.515** | -0.080 | 0.120 | 0.138 |
| $\Delta \ln p_t^c$ | 0.435* | -0.130 | -0.802 | 0.257* | -0.134 | 0.541 | 0.745 |
| $\Delta ln \frac{r_{it}}{n_{it}}$ | 0.146 | 0.034 | 0.575** | 0.244 | -0.245 | 0.276* | 0.194 |
| $\Delta \ln T_{it}$ | -0.113 | -0.127 | -0.330* | -0.510** | -0.393** | -0.352*** | -0.288* |
| *CON* | 0.146* | 0.178* | 0.013 | 0.382** | 0.349** | 0.318** | 0.317* |
| $ECM_{it-1}$ | -0.757*** | -0.475** | -0.731*** | -0.844*** | -0.670** | -0.769*** | -0.851*** |
| $R^2$ | 0.665 | 0.6399 | 0.7940 | 0.740 | 0.766 | 0.705 | 0.7468 |
| Sample (years) | 23 | 23 | 23 | 23 | 23 | 23 | 23 |
| $R^2$ adjusted | 0.484 | 0.446 | 0.683 | 0.600 | 0.641 | 0.546 | 0.610 |
| F | 3.690** | 3.300** | 7.158*** | 5.295*** | 6.107*** | 4.445*** | 5.478*** |
| Resid ADF [a] | -4.012** | -3.886*** | -4.012** | -5.135*** | -4.910** | -3.001** | -5.737*** |
| Q-Stat (1) | 0.901 | 0.542 | 0.236 | 0.56 | 0.891 | 0.127 | 0.911 |
| Akaike | -2.891 | -3.609 | -3.400 | -2.870 | -4.010 | -2.002 | -1.938 |

[a] ADF stands for Augmented Dickey-Fuller Test (with tendency and independent term, two lags).
Level of significance of parameters (p-values) in parenthesis: ***, **, * indicates significance at 1 percent, 5 percent and 10 percent, respectively.

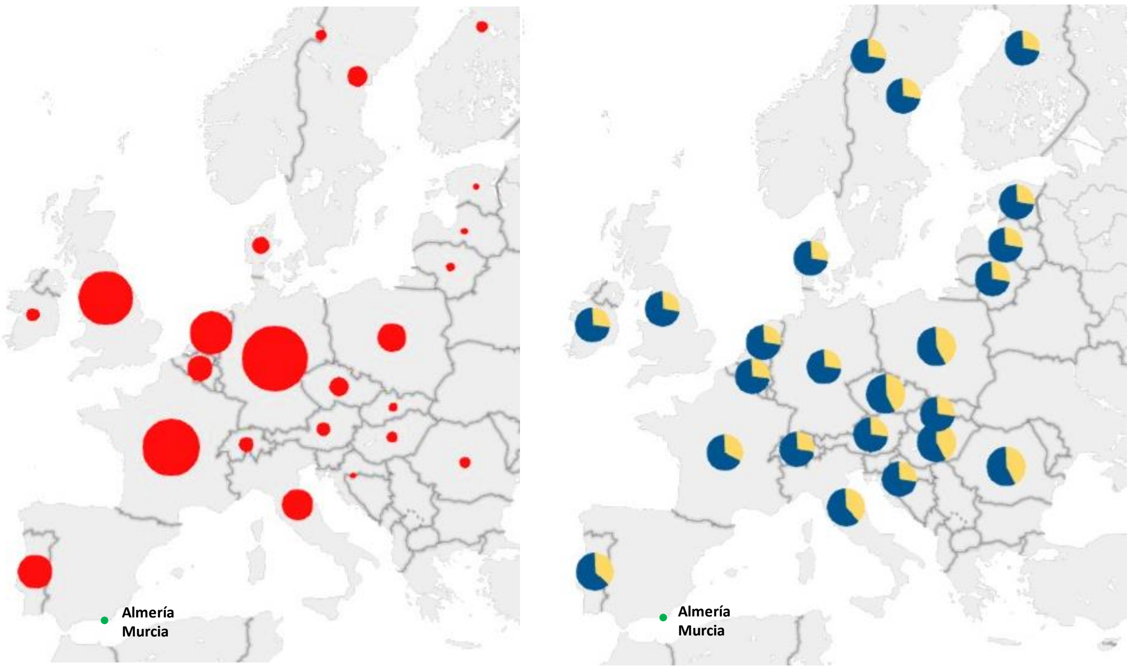
**Table 2.** Increase in exports as a result of the change in transport costs

| | Germany & Austria | France | United Kingdom | Central Europe | Eastern Europe | Scandin. | Italy | Mean / Sum |
|---|---|---|---|---|---|---|---|---|
| Truck [a] | 4,172.99 | 2,860.98 | 3,583.00 | 3,656.90 | 5,017.28 | 5,899.51 | 3,385.22 | 4,082.29 |
| Intermodal [b] | 3,718.89 | 2,318.76 | 2,973.14 | 3,031.90 | 3,886.35 | 5,226.00 | 3,212.05 | 3,495,49 |
| Savings ($\%\Delta T_i$) [c] | -10.88% | -18.95% | -17.02% | -17.09% | -22.54% | -11.42% | -5.12% | -0,1437 |
| Demand ($Y_i$) [d] | 1,413,368 | 768 | 550,512 | 564,332 | 282,417 | 275,83 | 218,813 | 4,073,272 |
| $\Delta Y_i$ | 17,377 | 18,044 | 30,92 | 49,187 | 25,017 | 11,088 | 3,227 | 154,859 |
| $\%\Delta Y_i$ | 1.23% | 2.35% | 5.62% | 8.72% | 8.86% | 4.02% | 1.47% | 3.80% |

[a] Mean road transport costs (€) in the model, including externalities. Transport by truck from Almería to the final customer's door (and back).
[b] Mean intermodal transport costs (€) (truck plus ship and back). Calculations based on optimized data on destinations and costs from Pérez-Mesa et al. (2012).
[c] Differences in costs between truck and intermodal transport, both including environmental externalities.
[d] Spanish agri-food exports in tonnes demanded by destination area.
[e] Consequence of savings in transport costs, using the elasticities of exports-transport costs calculated in the model.
Source: Own elaboration.

## Figures

**Figure 1.** Spanish agri-food exports in tons by country (left map); and % intermodal transit time[a] in relation to truck[b] time (right map).

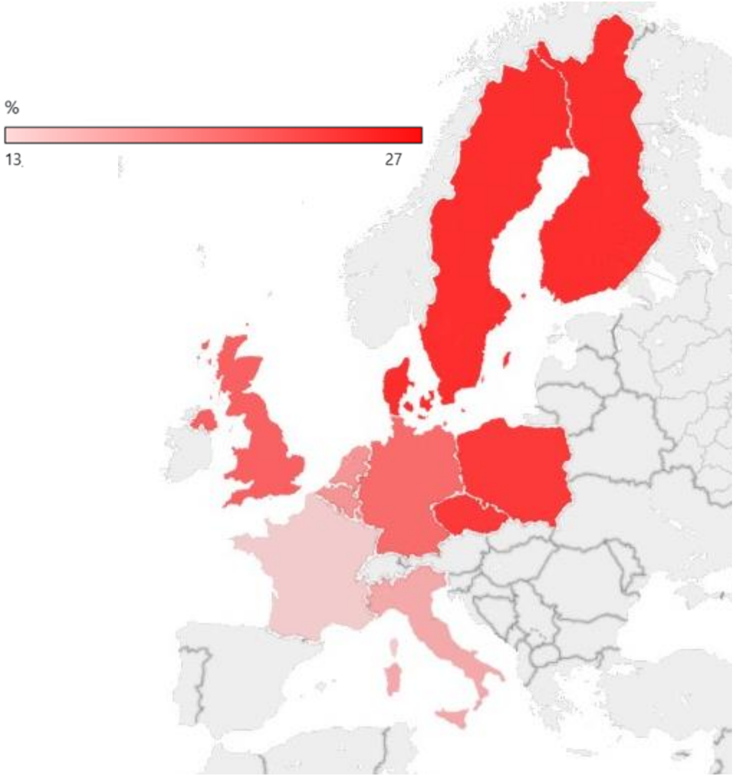



a) Transport from the port of Almería to the destination port, plus land transit to the final customer´s door. The destination ports are those found optimum by Pérez-Mesa et al. (2012): Rotterdam (Holland) and Port Vendres (Southeast France) for areas 1 and 6; Port Vendres for areas 2, 5 and 7; Dunkirk (Northeast France) for area 3; and Rotterdam and Bruges (Belgium) for area 4.

b) Transport by truck from Almería to the final customer's door.

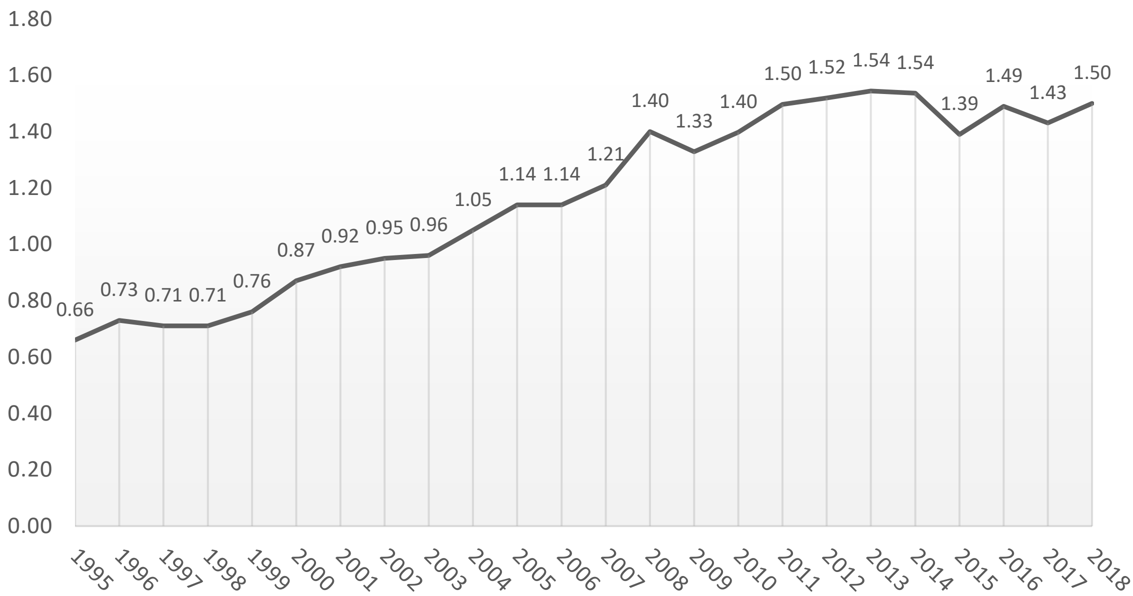
Source: Own elaboration.

**Figure 2.** Transport costs expressed as percent of import price (Cif), 2017



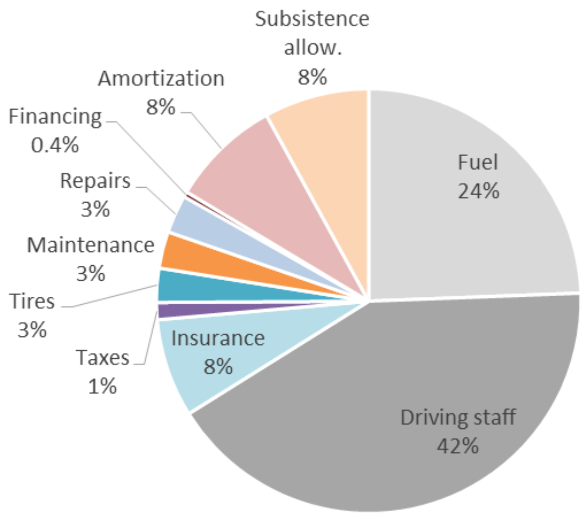

Source: Own elaboration based on customs data.

**Figure 3.** Evolution of the cost of a loaded articulated refrigerated truck (€/km)




Source: Own elaboration based on Spanish Ministry of Public Works and Transport data.

**Figure 4.** Different costs of a loaded articulated refrigerated truck, 2017




Source: Own elaboration based on Spanish Ministry of Public Works and Transport data.