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Growing Olive Oil Export and Intra-Industry Trade in Mediterranean Countries: Application of Gravity Model

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Abstract: While olive oil production is spreading to the non-traditional producer countries, including the US, Australia, and New Zealand, Mediterranean countries are still major producers and exporters. However, little is known about their olive oil exports simultaneously growing in tandem with their large volume of imports. This paper examines the factors that affect olive oil exports and imports in Mediterranean countries. Using balanced panel data of olive oil trade in Mediterranean countries from 1998 to 2016, we estimated the commodity-specific gravity model. Results suggest that an increase in the overall bilateral size of trading partners positively affects the flow of olive oil trade. The difference in factor endowments has a negative impact on exports, whereas its effect is positive on their imports. The members of the European Union (EU) are competitive in olive oil export, and the volume of its import is large among the EU countries whose per capita income and demand properties are similar. These results support Linder’s hypothesis rather than the predictions from the traditional Heckscher–Ohlin trade theory. The simultaneous export and import of olive oil in Mediterranean countries implies the relevance of a growing intra-industry trade rather than a country’s specialization following its comparative advantage.

Keywords: olive oil; gravity model; Linder’s hypothesis; intra-industry trade; Mediterranean countries

1. Introduction

Over the last quarter-century, the size of the global olive oil market has been growing. According to statistics from the International Olive Council, the annual global export of olive oil increased from 337 to 778 thousand tones between 1990/91 and 2016/17. In the last five years, the European Union (EU) has not only dominated the export market, shipping out 66.4% of all olive oil globally, but has also had 15% of the world import share. While the EU’s export of olive oil continues to grow, a large import volume has also been observed. Traditionally, olive oil is produced in the Mediterranean basin and traded among Mediterranean countries, which have a comparative advantage in the production and export of olive oil [1]. However, little is known about the trend reflecting sizable and simultaneous growth in the import of olive oil. Figure 1 presents the increase in export volume in the Mediterranean countries, which also coincides with substantial import volume. As shown in Figure 2, these Mediterranean countries produce a surplus of olive oil but face declining consumption. Despite this excessive supply of olive oil, these countries continue to import a large volume of olive oil from other countries. This phenomenon is typically observed in traditional olive oil producers such as Italy, Spain, and France.
The questions are “What explains the simultaneous growth in sizable olive oil export and import?”
and “What factors affect the export and import of olive oil?” Although there are Mediterranean
countries that specialize in the production and export of olive oil, some countries import olive oil
despite having a surplus from over-production. Meanwhile, others experience excess demand for olive
oil but continue to export. The orthodox theories of international trade, including the Heckscher–Ohlin
(H–O) theory, assume that countries tend to specialize in producing and exporting goods for which
they have a comparative advantage. The difference in factor price caused by the difference in relative
factor endowments is one of the major triggers of international trade. Following this argument,
the rapid increase in the export of olive oil from Mediterranean countries seems to be consistent with
the idea of specialization based on comparative advantage. However, olive oil export by Mediterranean
countries is growing coincidently with the sizable import. Particularly, imports of EU countries
from southern Mediterranean countries and the subsequent re-export to the world are increasing
rapidly. This simultaneous export and import of goods by a country is inconsistent with the trade
patterns based on the comparative advantage. Currently, Krugman [2], and Helpman and Krugman [3]
developed a new trade theory that emphasizes the significance of economies of scale combined with
product differentiation and transportation costs. According to Helpman [4], large volumes of trade flow are typically observed between countries with similar factor proportions, where factor endowment differences do not drive a considerable proportion of trade.

Linder [5] suggests that the greater the similarity in factor endowments between two countries, the larger the expected trade flows between the two. The trade flow of olive oil observed in the Mediterranean region may have more relevance in the context of the new trade theory than the traditional discussions. Such trade flow of olive oil can be considered a typical pattern of intra-industry trade. Along these lines, the objective of this paper is to examine the factors that affect the export and import of olive oil in Mediterranean countries. To achieve this, the commodity-specific gravity model is estimated in order to investigate the determinant factors that explain the growth in exports and imports [6,7]. The data used in this study are the balanced panel data of export and import flows from 1998 to 2016. Following the empirical studies of the gravity model by Egger [8], Baltagi et al. [9], and Paas et al. [10], we examine the variables that assess the validity of the new trade theory, assuming that bilateral trade is a function of the sum of two countries’ real gross domestic product (GDP); the similarity of two trading countries; and the difference in relative factor endowments between the two. Further, we assume a positive effect of dummy variables including common border, common language, former colonial relationships, and EU membership as components for analysis.

This paper provides empirical evidence on olive oil trade that support Linder’s hypothesis rather than the traditional H–O trade theory. It suggests that the differences in relative factor endowments cannot adequately explain the trend of olive oil export observed among Mediterranean countries. This is because the trade pattern of olive oil including specialization of production and export does not follow the law of comparative advantage in a straightforward way. Trade volume is becoming larger among EU countries whose per capita income and demand properties are more similar. The simultaneous export and import of olive oil in Mediterranean countries implies the relevance of a growing phenomenon of intra-industry trade. The Grubel–Lloyd index applied to measure the degree of intra-industry trade of olive oil suggests that intra-industry trade constitutes more than half of trade flow. As policy implications, this paper emphasizes the significance of product differentiation among olive oils in response to the growing phenomenon of intra-industry trade. As it relates to the promotion of exports, we note that product differentiation is becoming more crucial for the quality improvement that results in competitive advantage.

2. Literature Review

The gravity model is one of the most frequently used models for empirical studies on international trade. Most traditional international trade theories do not consider the distance effect as a resistant factor. However, Isard [11] introduced a physics-based spatial interaction theory into international trade. According to Isard [11], Tinbergen [12], and Pöyhönen [13], the gravity force in the international economics, i.e., trade flows between two countries, increases with country size and decreases with trade costs. As the distance between countries that are trade partners increases, trade costs are expected to rise proportionately.

Formal theoretical foundations of the gravity model were provided by Anderson [14] and Bergstrand [15,16], who argue that international trade flows between two countries are proportional to the scale of their economies and are inversely affected by their distance as a resistance factor. Apart from the effect of the sizes of two countries, which can be represented by the GDP or GDP per capita [17,18], the difference in their GDP per capita is considered a proxy variable for the difference in relative factor endowments. Following the neoclassical trade theory of the H–O model, the difference in factor price caused by the difference in factor endowments determines the pattern of trade between countries. Under the assumption of the H–O model, larger volumes of trade are expected as the difference in factor endowments expands.

Regarding the effect of the difference in factor endowments, Linder [5] developed an alternative trade model in the early 1960s. Linder assumed that the trade volume between trading countries
increases if per capita income levels between the two are similar. The income similarity model, as
the hypothesis is known, states that the demand propensity becomes similar at the same time as the
resemblance of per capita income increases [19]. The hypothesis also suggests that the trade volume
between two countries increases as the relative factor endowments between them becomes more
similar [9]. Helpman [4] argues that the quantity of trade between two countries is expected to be larger
when they have similar factor proportions and the difference in factor endowments does not drive a
substantial portion of the business. Unlike the classical H–O theory, Linder’s hypothesis assumes that
bilateral trade is positively related to the similarity in relative country size and negatively related to
increases in the difference in relative factor endowments. Since the mid-1990s, the specification of the
gravity model derivations based on the new trade theory has become increasingly popular [3,20,21].

Based on this argument, we employ the commodity-specific gravity model to a single agricultural
commodity. While many estimations of that model use aggregate data of trade flows, several studies
applied it to a specific sector or a particular commodity. On the sectoral level, Martínez-Zarzoso and
Nowak-Lehmann [22] estimated the modified gravity model by using disaggregated trade data to
explain Mercosur’s export to the EU. For the agricultural sector, Koo et al. [6] estimated the gravity
model to explain the trade flows of agricultural commodities. Crescimanno et al. [23] applied the
gravity model to Italy’s agro-food exports to non-EU Mediterranean partner countries. This study
found that the income of trading partners, colonial and historical relationships, and distance between
trading partners affect trade flow. The gravity model has been applied to specific agro-food products
as well to find factors that explain the trade flow of agricultural products, such as wine, beef, fruits,
and vegetables [7,24,25]. Sheldon et al. [26] examined the effect of exchange rate uncertainty on the US
bilateral trade of fresh fruit and fresh vegetables. The results showed that it has negatively affected fresh
fruit trade and fresh vegetable export. For citrus exports of Turkey, Özer and Koksal [27] suggested
that trade agreements and increases in real exchange rates have a positive effect on export volume,
while transportation costs represented by the distance between Turkey and its trade partners affect
exports negatively. The gravity model estimation by Márquez-Ramos and Martinez-Gomez [28] found
that trade preferences positively affect exports of fruit and vegetables from Morocco to EU countries.

For the trade of olive oil, Vlontzos and Duquenne [29] estimated the commodity-specific gravity
model for export in Greece using data from 1991 to 2005. This study found that the country’s virgin
olive oil exports were positively impacted by the change in the GDP per capita of trade partners,
the existence of a Greek community in partner countries, and tourist inflows to Greece. Regarding
imports of olive oil, Kavallari et al. [30] estimated the gravity equation in Germany using the random
effects model using panel data from 1995 to 2006 with 14 exporting partners. This study discovered
that tourism, being a Mediterranean partner country of the EU, and the presence of direct marketing
channels have a positive impact on Germany’s olive oil import. In southern Mediterranean countries,
Angulo et al. [31] estimated the gravity model as applied to olive oil exports from Tunisia. Using panel
data from 2001 to 2009, they found that the income level, human development index, and existence of
a common language between Tunisia and its trading partners had a positive impact on Tunisia’s olive
oil exports.

Most studies applied the gravity model on olive oil trade in line with the orthodox H–O discussion.
However, studies examining Linder’s hypothesis are missing. The effect of variables related to the
new trade theory (overall country size, the similarity index, and the difference in relative factor
endowments) on the olive oil trade has not been explicitly examined. Most studies applied to olive
oil trade have focused on exports and a single country’s case. However, our study uses panel data of
multiple countries and examines determinant factors affecting exports and imports. Rallatou and
Tzouvelekas [32] estimated the gravity equation using panel data of olive oil trade within 28 member
states of the EU over the period from 2000 to 2015. They confirmed the positive effect of per capita GDP
by eliminating the country-specific unobserved effects; however, the potential endogeneity problem of
the explanatory variable was not well-controlled. This study attempts to fill these gaps. What is more,
we employed Arellano–Bond dynamic panel-data estimation with the system Generalized Method of
Moment (GMM) to solve the problems of serial correlation, heteroscedasticity, and endogeneity of some of the regressors.

3. Materials and Methods

3.1. Model Specification

Following Egger [8], Baltagi et al. [9], and Paas et al. [10], we employ the gravity model derived from the new trade theory. Bilateral trade is a function of the overall country size, relative country size, and the difference in relative factor endowments:

\[ X_{ijt} = \beta_0 + \beta_1 DIS_{ij} + \beta_2 GDT_{ijt} + \beta_3 SIM_{ijt} + \beta_4 RFE_{ijt} + Z_{ijt}'\delta + u_{ijt}, \] (1)

where \( X_{ijt} \) denotes the log of the volume of bilateral trade between country \( i \) and country \( j \) at year \( t \); \( \beta_k \) \( (k = 0, 1, 2, 3, 4) \) denotes unknown parameters to be estimated; \( DIS_{ij} \) is the log of geographical distance between country \( i \) and \( j \); \( \delta \) is a vector of unknown parameters to be estimated; \( Z_{ijt} \) is the \( h \times 1 \) vector of other explanatory variables. The error term, \( u_{ijt} \), comprises the fixed or random unobserved effect that controls an individual country’s characteristics, time-specific fixed or random effects, and the remaining error term. \( DIS_{ij} \) is a proxy for trade costs and its coefficient should be negative because it is a resistance factor on trade.

\[ GDT_{ijt} = \log\left(\frac{GDP_i + GDP_j}{GDP_{ij}}\right). \] (2)

\( SIM_{ijt} \) represents the similarity index calculated by two trading countries’ GDPS to measure the relative country size:

\[ SIM_{ijt} = \log\left|1 - \left(\frac{GDP_i}{GDP_i + GDP_j}\right)^2 - \left(\frac{GDP_j}{GDP_i + GDP_j}\right)^2\right|. \] (3)

This similarity index is expected to have a positive effect on trade flows between country \( i \) and \( j \) because more similar countries prefer to engage in larger trade flow.

The absolute difference in relative factor endowments, \( RFE_{ijt} \), is given as follows:

\[ RFE_{ijt} = \left|\log\left(\frac{GDP_i}{POP_i}\right) - \log\left(\frac{GDP_j}{POP_j}\right)\right|. \] (4)

where \( POP \) denotes a country’s population. According to Liner [5], the greater the difference in factor endowments between two countries, the smaller their expected trade flows. Linder’s hypothesis suggests that \( RFE_{ijt} \) is expected to have a negative effect on trade flow. Regarding the explanatory variables of \( Z_{ijt} \), we include dummy variables of EU membership, contiguity, common language, and former colonial relationships. Many studies confirm a positive effect of free-trade agreements on trade flow [12,33–38]. For wine trade, Dsacal et al. [7] found a positive impact of having EU-membership on exports and imports. Kavallari et al. [28] confirmed with the olive oil import of Germany that being an EU member had a positive impact. Following these findings, we assume being an EU member has a positive effect on trade flow. Several studies confirmed the positive impact of contiguity, sharing a common official language, and former colonial relationships with a trade partner, on trade flow [39,40]. Angulo et al. [31] found with the olive oil export in Tunisia that having a common language has a positive impact. We follow the same assumption as these studies for the sign of coefficients of contiguity, common language, and former colonial relationships.
In this study, Equation (1) is applied to the export and import of olive oil in Mediterranean countries. The gravity equations of olive oil export and import are expressed as follows:

\[ \begin{align*}
EX_{ijt} &= γ_0 + γ_1 DIS_{ijt} + γ_2 GDP_{ijt} + γ_3 SIM_{ijt} + γ_4 RFE_{ijt} + γ_5 DEI_{ijt} \\
&+ γ_6 DEJ_{ijt} + γ_7 DEB_{ijt} + γ_8 DCB_{ijt} + γ_9 DCL_{ijt} + γ_{10} DCR_{ijt} + μ_{ijt}, \\
IM_{ijt} &= ν_0 + ν_1 DIS_{ijt} + ν_2 GDP_{ijt} + ν_3 SIM_{ijt} + ν_4 RFE_{ijt} + ν_5 DEI_{ijt} \\
&+ ν_6 DEJ_{ijt} + ν_7 DEB_{ijt} + ν_8 DCB_{ijt} + ν_9 DCL_{ijt} + ν_{10} DCR_{ijt} + ν_{ijt},
\end{align*} \]  

(5)

where \( EX_{ijt} \) denotes the log of the volume of export, i.e., export of country \( i \) to country \( j \) at year \( t \); \( IM_{ijt} \) is the log of the volume of import, i.e., import of country \( i \) from country \( j \) at year \( t \), measured by the real value of US dollars; \( γ_l, ν_m \ (l, m = 0, 1, 2, 3, \ldots, 10) \) denote unknown parameters to be estimated; \( DIS_{ij} \) is the log of the geographical distance between capital cities of country \( i \) and \( j \), measured by kilometers; \( DEI_{ijt} \) is a binary variable that takes the value of 1 if country \( i \) becomes an EU member, and 0 otherwise; \( DEJ_{ijt} \) is a binary variable that takes the value of 1 if country \( j \) becomes an EU member, and 0 otherwise; \( DEB_{ijt} \) is a binary variable that takes the value of 1 if both \( i \) and \( j \) are EU members, and 0 otherwise; \( DCB_{ij} \) is a dummy variable that is equal to 1 if country \( i \) and \( j \) share a common border, and 0 otherwise; \( DCL_{ij} \) is a dummy variable that is equal to 1 if country \( i \) and \( j \) have a common official language, and 0 otherwise; \( DCR_{ij} \) is a dummy variable that is equal to 1 if country \( i \) and \( j \) had colonial relationships, and 0 otherwise. The dummy variables of EU membership are expected to positively impact trade flow. The variables of sharing a common border, having a common language, and having former colonial relationships are assumed to have a positive influence on trade flows. The error terms, \( μ_{ijt}, ν_{ijt}, \) are decomposed into the fixed or random unobserved individual country’s characteristics, time-specific fixed or random effects, and remaining error terms.

3.2. Linear Dynamic Panel Gravity Model

We estimate Equations (5) and (6) by applying static panel data methods, including the random-effects and fixed-effects model. The random-effects estimator regards intercept as random variables, assuming no correlation between explanatory variables and unobservable country-specific characteristics. On the other hand, the fixed-effects model assumes that the country-specific effects appeared in intercepts. It provides a consistent estimator even if the country-specific effects correlate with explanatory variables. Yet, the time-invariant variables appearing in the equations, including \( DIS_{ijt}, DCB_{ijt}, DCL_{ijt}, \) and \( DCR_{ijt} \), cannot be estimated in the fixed-effects model. What is more, due to the large panel data set, we have to consider the problem of heteroscedasticity and autocorrelation of error terms that lead to an unbiased estimator. Moreover, the bias caused by missing unobservable country-specific effects may be mitigated by the fixed-effects estimator, yet the endogeneity bias still remains, for instance, the relation between \( GDP_{ij} \) and bilateral trade flows. Similar to \( GDP_{ij} \), \( SIM_{ij} \) and \( RFE_{ij} \) would not be strictly exogenous.

Considering these limitations, we extend our model from static to a dynamic panel data model, i.e., the system GMM technique augmented by Arellano and Bover [41] and developed by Blundell and Bond [42]. In GMM, the dynamic relationships are characterized by the introduction of the lagged dependent variable of the regressors. Based on Equation (1), a dynamic panel model can be rewritten as follows:

\[ \begin{align*}
X_{ijt} &= β_0 + ρ X_{ijt-1} + β_1 DIS_{ijt} + β_2 GDP_{ijt} + β_3 SIM_{ijt} + β_4 RFE_{ijt} + Z'_{ijt} δ + φ_{ij} + ε_{ijt}, \\
\Delta X_{ijt} &= π X_{ijt-1} + δ GDP_{ijt} + ζ SIM_{ijt} + η RFE_{ijt} + ζ_{ijt} + \Delta ε_{ijt},
\end{align*} \]  

(7)

where \( X_{ijt-1} \) denotes the lagged dependent variable; \( ρ \) is a parameter to be estimated; \( φ_{ij} \) denotes country-pair specific effects; \( ε_{ijt} \) is the error term. Following Arellano and Bond [43], the first difference transformation of Equation (7) removes both the constant terms and country-pair specific effects:

\[ \begin{align*}
\Delta X_{ijt} &= ρ \Delta X_{ijt-1} + β_2 Δ GDP_{ijt} + β_3 Δ SIM_{ijt} + β_4 Δ RFE_{ijt} + Δ Z'_{ijt} δ + Δ ε_{ijt}.
\end{align*} \]  

(8)
By taking the first difference, the potential bias due to the omitted variables arising from unobserved country-pair-specific effects is removed, but there is still a correlation between the differenced lagged dependent variables ($\Delta X_{ij,t-1}$) and the disturbance process ($\Delta e_{ij,t}$). To deal with bias caused by the endogeneity problem, the first difference of this explanatory variable is instrumented by their lagged values (in levels). Under the assumption of no-autocorrelation in the error terms, the explanatory variable may strongly correlate with its lagged variables, but not with future values of the error term. Therefore, instrumental variable estimators can deal with the endogeneity of the lagged dependent variables.

However, the first difference GMM estimator is likely to suffer from poor performance and weakness instruments, as the lagged levels of explanatory variables are weak instruments for the first differences [41]. They perform poorly as instruments if the dependent variable is close to follow a random walk [42]. Alternatively, Arellano and Bover [41] and Blundell and Bond [42] introduced a system GMM estimator to deal with the shortcomings of the first difference approach. The GMM system estimator combines the equation in difference with an equation in levels. Namely, it simultaneously estimates Equation (8) with Equation (7). In Equation (7), the explanatory variables of the equation in levels are instrumented by their most recent lags in the first differences. To examine the validity of using lagged variables as instruments, we test the Sargan/Hansen test of overidentification restrictions [41,43]. In addition, the GMM estimator is consistent if no second-order serial correlations exist in the residuals of the equation in differences [43]. We expect to reject the null hypothesis of first-order autocorrelation in Equation (8), but not the null of the second-order autocorrelation.

Given the above conditions, the following linear dynamic panel equation (in levels) is employed to empirically estimate the gravity model:

$$EX_{ijt} = \theta_0 + \theta_1EX_{ij,t-1} + \theta_2DIS_{ij} + \theta_3GDT_{ij} + \theta_4SIM_{ij} + \theta_5RFE_{ij} + \theta_6DEI_{ij} + \theta_7DEJ_{ij} + \theta_8DEK_{ij} + \theta_9DCB_{ij} + \theta_{10}DCL_{ij} + \theta_{11}DCR_{ij} + \tau_t + \epsilon_{ijt},$$

$$IM_{ijt} = \omega_0 + \omega_1IM_{ij,t-1} + \omega_2DIS_{ij} + \omega_3GDT_{ij} + \omega_4SIM_{ij} + \omega_5RFE_{ij} + \omega_6DEI_{ij} + \omega_7DEJ_{ij} + \omega_8DEK_{ij} + \omega_9DCB_{ij} + \omega_{10}DCL_{ij} + \omega_{11}DCR_{ij} + \eta_t + \epsilon_{ijt},$$

where $EX_{ij,t-1}$ denotes the lagged dependent variable of the export equation; $IM_{ij,t-1}$ is the lagged dependent variable of the import equation; $\theta_k, \omega_k, \lambda_k, \eta_k, \epsilon_k$ ($k = 0, 1, 2, 3, \ldots, 11$) denote unknown parameters to be estimated. The terms $\lambda_k, \epsilon_k$ are unobserved country-pair specific effects, which are independently and identically distributed, i.e., $\lambda_k \sim \text{iid}(0, \sigma^2_k)$, $\epsilon_k \sim \text{iid}(0, \sigma^2_k)$. The terms $\tau_t, \eta_t$ are the time-fixed effects. The remaining error terms, $\epsilon_{ijt}, \eta_{ijt}$, are also distributed independently and identically, and serially uncorrelated, i.e., $\epsilon_{ijt} \sim \text{iid}(0, \sigma^2), \eta_{ijt} \sim \text{iid}(0, \sigma^2)$. In the estimation procedure, we regard $GDT_{ij}$, $SIM_{ij}$, and $RFE_{ij}$ as endogenous variables, which may correlate with the error term. Following Roodman [44], we use STATA’s estimator “xtabond2” to derive the coefficients using the system GMM estimator controlling potential bias due to the endogeneity of some of the regressors.

3.3. Data

The major exporters and importers of olive oil in the Mediterranean countries included in the analysis are reported in Table 1. The estimation of the gravity model is implemented for the export of olive oil from 12 Mediterranean countries to their 125 major trading partners from 1998 to 2016 (Appendix A Table A1). The dataset for the estimation contains balanced panel data of olive oil export with the number of observations set at 11,476. During the same period, we use panel data of the import from 7 Mediterranean countries to their 31 major trading partners (Appendix A Table A2). In total, we use balanced panel data of olive oil import with 1843 observations. Data regarding the export and import of olive oil are used for estimation and are extracted from the UN Comtrade Database, which is available from: https://comtrade.un.org/ (Accessed: 30 July 2018). We used data of olive oil trade by HS commodity code 1509. According to this database, olive oil is defined as “olive oil and its fractions, whether or not refined, but not chemically modified.” We measure the dependent
variable as \( \log(1 + X_{ijt}) \), where \( X_{ijt} \) indicates either the export value or the import value. The reason behind this transformation is that we cannot take the log of \( X_{ijt} \) in some cases, because the trade volume is reported as zero. Regarding independent variables, trade costs are proxied by the distance in kilometers between two countries’ capitals. The distance is measured by the straight line between capital cities, using the Distance Calculator. It is available from: https://www.distancecalculator.net/ (Accessed: 11 August 2018).

**Table 1.** Major exporters and importers of olive oil in the Mediterranean countries.

| Country Group | Countries                                      |
|---------------|------------------------------------------------|
| Exporters     | Croatia, Cyprus, Egypt, France, Greece, Israel, Italy, Lebanon, Morocco, Spain, Tunisia, Turkey |
| Importers     | Egypt, France, Greece, Italy, Morocco, Slovenia, Spain |

The real GDP and the real GDP per capita were used to calculate \( GDT_{ijt}, SIM_{ijt} \), and \( RFE_{ijt} \). The data source is the World Development Indicators provided by the World Bank. Tables 2 and 3 present the summary statistics of the variables for the gravity model for export and import, respectively.

**Table 2.** Summary statistics of the variables for the gravity model of olive oil export.

| Variables | Number of Observations | Mean   | Standard Deviation | Minimum | Maximum |
|-----------|------------------------|--------|--------------------|---------|---------|
| \( EX_{ijt} \) | 11,476 | 10.467 | 5.136             | 0       | 21.083  |
| \( DIS_{ij} \) | 11,476 | 8.152  | 0.916             | 4.443   | 9.899   |
| \( GDT_{ijt} \) | 11,476 | 52.69  | 2.362             | 43.979  | 59.123  |
| \( SIM_{ijt} \) | 11,476 | –2.245 | 1.428             | –7.922  | –0.693  |
| \( RFE_{ijt} \) | 11,476 | 1.508  | 1.101             | 0       | 5.244   |
| \( DEI_{it} \) | 11,476 | 0.516  | 0.5               | 0       | 1       |
| \( DEJ_{jt} \) | 11,476 | 0.236  | 0.425             | 0       | 1       |
| \( DEB_{ijt} \) | 11,476 | 0.109  | 0.312             | 0       | 1       |
| \( DCB_{ij} \) | 11,476 | 0.05   | 0.217             | 0       | 1       |
| \( DCL_{ij} \) | 11,476 | 0.103  | 0.304             | 0       | 1       |
| \( DCR_{ij} \) | 11,476 | 0.056  | 0.23              | 0       | 1       |

**Table 3.** Summary statistics of the variables for the gravity model of olive oil import.

| Variables | Number of Observations | Mean   | Standard Deviation | Minimum | Maximum |
|-----------|------------------------|--------|--------------------|---------|---------|
| \( IM_{ijt} \) | 1843 | 10.457 | 5.565             | 0       | 21.119  |
| \( DIS_{ij} \) | 1843 | 7.332  | 0.952             | 4.762   | 9.666   |
| \( GDT_{ijt} \) | 1843 | 54.128 | 2.175             | 48.23   | 59.123  |
| \( SIM_{ijt} \) | 1843 | –1.717 | 0.954             | –5.407  | –0.693  |
| \( RFE_{ijt} \) | 1843 | 0.932  | 0.877             | 0.001   | 2.997   |
| \( DEI_{it} \) | 1843 | 0.802  | 0.398             | 0       | 1       |
| \( DEJ_{jt} \) | 1843 | 0.569  | 0.495             | 0       | 1       |
| \( DEB_{ijt} \) | 1843 | 0.451  | 0.498             | 0       | 1       |
| \( DCB_{ij} \) | 1843 | 0.196  | 0.397             | 0       | 1       |
| \( DCL_{ij} \) | 1843 | 0.072  | 0.259             | 0       | 1       |
| \( DCR_{ij} \) | 1843 | 0.062  | 0.241             | 0       | 1       |

4. Empirical Results

Equations (5) and (6) were applied to the static panel data regression approach, including four types of models: A pooled ordinary least squares model (POL), a fixed-effect model (FEM), a random-effects model (REM), and a Tobit model. Table 4 presents the estimation results of the export of olive oil by using the four models. The estimation results of the import of olive oil are presented in Table 5. As expected, the POL and Tobit estimator gave similar results with respect to signs and the significance of estimated coefficients. In the FEM, the time-invariant variables including \( DIS_{ij}, DCB_{ij}, DCL_{ij}, \) and \( DCR_{ij} \) were automatically dropped. The Hausman test is applied to test the null hypothesis of the REM against the FEM. In both estimations of export and import, the null hypothesis of the REM over the FEM is rejected. The Breuch–Pagan test rejects the null hypothesis that POL is more appropriate than the REM. The F-test strongly rejects the null hypothesis of coefficients of country-dummies being equal
to zero. Thus, we confirm the proper estimators of the FEM over those of the POL. These results suggest that the estimation of FEM is appropriate for the specification in both export and import models.

Table 4. Results of panel-data estimation of export model.

| Variable   | Pooled OLS | Fixed-Effects Model | Random-Effects Model | Tobit Model |
|------------|------------|---------------------|----------------------|-------------|
| Constant   | -25.531 ***| -58.132 ***         | -30.341 ***          | -30.075 *** |
| DIS$$_{ij}$$ | 0.196     | [21.987]            | [4.456]              | [4.493]     |
| GDT$$_{ijt}$$ | 0.656 *** | 1.312 ***           | 0.797 ***            | 0.727 ***   |
| SIM$$_{ijt}$$ | 0.051     | -0.498              | -0.123               | 0.029       |
| RFE$$_{ijt}$$ | -0.465 ***| -1.973 ***          | -0.862 ***           | -0.506 ***  |
| DEI$$_{ijt}$$ | 0.051     | -0.498              | -0.123               | 0.029       |
| DCR$$_{ij}$$ | 1.286 *** | -0.942              | 1.376 *              |             |
| DCL$$_{ij}$$ | 0.735     | 0.623               | 0.726                |             |
| DCR$$_{ij}$$ | 0.615     | -1.177              | 0.768                |             |
| Time dummies | Yes       | Yes                 | Yes                  | Yes         |
| R$$^2$$     | 0.261      |                     |                      |             |
| Within R$$^2$$ | 0.155     | 0.151               |                      |             |
| Between R$$^2$$ | 0.258     | 0.329               |                      |             |
| Overall R$$^2$$ | 0.019     | 0.249               |                      |             |
| Pseudo-R$$^2$$| 0.048     |                     |                      |             |
| Log pseudo-likelihood | 78.3     | ***                 | -31,892.5            |             |
| Hausman test |   (0.000) |                      |                      |             |
| Breush–Pagan test | 21.692.2 | ***                 |                      |             |
| Number of groups | 604      | 604                 | 604                  |             |
| Number of observations | 11,476   | 11,476              | 11,476               |             |

Notes: Figures in square brackets are standard errors clustered by country pair. Figures in parentheses are p-values.

* *, **, *** indicate significant at the 10% level, 5% level, and 1% level, respectively.

Tables 6 and 7 present the results of the linear dynamic panel data model estimated by the two-step GMM estimation method. According to Windmeijer [45], the two-strep GMM gives lower bias and standard errors in estimating the coefficient. As a rule of thumb, we keep the number of instruments less than or equal to the number of groups. The Hansen J statistics test of overidentification restrictions is applied to check the validity of instrumental variables. In all models, the Hansen test fails to reject the null hypothesis that overidentification restrictions are valid, i.e., we cannot reject the null hypothesis that the instruments as a group are exogenous. The Arellano–Bond test with a null hypothesis of no autocorrelation is applied to the residuals of the equation in differences. The Arellano–Bond test rejects the null hypothesis of no first autocorrelation in the differenced residuals AR(1), but it fails to reject the null hypothesis in the differenced residuals AR(2). The lagged dependent variables are positive and statistically significant in all GMM estimators.

In most cases of both export and import models, the estimated coefficient of the overall country size ($GDT_{ij}$) is positive and significant. This result suggests that an increase in the bilateral size of trading partner countries positively affects the trade flow in olive oil. The 0.122 estimated coefficient of $GDT_{ij}$ in the GMM estimator of the export model suggests that a 1% increase in overall bilateral country size will result in a 0.122% growth in olive oil exports, keeping other variables constant. Similarly, the 1.734 parameter size of $GDT_{ij}$ in the import model implies that a 1% increase in bilateral size will lead to a 1.734% increase in imports, ceteris paribus. These results are consistent with the finding of a positive impact of overall bilateral country size under the assumptions of the new trade theory [8–10].
Table 5. Results of panel-data estimation of import model.

| Variable    | Pooled OLS       | Fixed-Effects Model          | Random-Effects Model          | Tobit Model       |
|-------------|------------------|-----------------------------|------------------------------|-------------------|
| Constant    | −14.583          | −158.955 *                  | −30.139 *                    | −19.670           |
| DIS$_{ij}$  | [13.108]         | [92.643]                    | [16.606]                     | [15.346]          |
| [0.607]     |                  |                             |                             |                   |
| GDT$_{ij}$  | 0.543            | 3.237 *                     | 0.905 ***                    | 0.639 **          |
| [0.251]     | [1.688]          | [0.311]                     | [0.289]                      |                   |
| SIM$_{ij}$  | 0.346            | 4.877                       | 0.304                        | 0.339             |
| [0.476]     | [3.550]          | [0.644]                     | [0.555]                      |                   |
| RFE$_{ijt}$ | 0.532            | 6.812 *                     | 0.996 *                      | 0.509             |
| [0.718]     | [3.142]          | [0.735]                     | [0.841]                      |                   |
| DEI$_{ij}$  | −0.038           | −6.343 ***                   | −4.736 ***                   | −0.088            |
| [1.796]     | [1.101]          | [1.161]                     | [2.116]                      |                   |
| DEB$_{ijt}$ | 2.715            | 8.130 ***                   | 6.692 ***                    | 3.053             |
| [2.292]     | [1.253]          | [1.338]                     | [2.734]                      |                   |
| DCR$_{ij}$  | −0.237           | −0.196                      | −0.268                       |                   |
| [1.315]     |                  |                             |                              |                   |
| DCL$_{ij}$  | −0.901           | −2.613                      | −1.278                       |                   |
| [1.718]     |                  |                             |                              |                   |
| DCR$_{ij}$  | 1.364            | 1.804                       | 1.851                        |                   |
| [1.727]     |                  |                             |                              |                   |
| Time dummies| Yes              | Yes                         | Yes                          |                   |
| $R^2$       | 0.154            |                             |                              |                   |
| Within $R^2$| 0.133            | 0.120                       |                              |                   |
| Between $R^2$| 0.044           | 0.143                       |                              |                   |
| Overall $R^2$| 0.036          | 0.129                       |                              |                   |
| Pseudo-$R^2$|                 |                              |                              | 0.028             |
| Log pseudo-likelihood| 35.4              | *                           |                              | −5309.8           |
| Hausman test |                  |                             |                              |                   |
| Breush–Pagan test | 4152.48         | ***                         |                              |                   |
| Number of groups | 1843             | 97                          | 97                           | 1843              |
| Number of observations | 1843             | 1843                        | 1843                         | 1843              |

Notes: Figures in square brackets are standard errors clustered by country pair. Figures in parentheses are $p$-values.

*, **, *** indicate significant at the 10% level, 5% level, and 1% level, respectively.

More interestingly, for most of the export models, we found a negative and significant effect of the difference in relative factor endowments ($RFE_{ijt}$) at the 1% level of significance. This result suggests that olive oil exports decrease with the increase in the difference in relative factor endowments between two countries. In the GMM estimator, the estimated parameter of $RFE_{ijt}$ is −0.141. This suggests that a 1% increase in the difference of relative factor endowments decreases olive oil exports by 0.141%, ceteris paribus. This finding does not support the classical H–O trade theory, which states that the difference in relative factor endowments is what drives trade. On the other hand, the difference in relative factor endowments has a positive and significant impact on olive oil imports. The relatively large size of the coefficient in the GMM estimator suggests that a 1% increase in the difference in factor endowments causes a 3.25% increase in imports.

For the export of olive oil, the coefficient of the dummy variable of EU membership for the home country (country $i$) ($DEI_{ijt}$) is positive and statistically significant. This result suggests exports from EU countries are greater in volume compared to those of non-EU countries. The GMM estimator found that the estimated parameter is 0.314, suggesting that exports from EU member countries are 31.4% higher compared to those of others. This finding is consistent with the fact that EU countries are competitive as major olive oil exporters. On the other hand, we found a positive and statistically significant effect of EU membership on imports if countries $i$ and $j$ ($DEB_{ijt}$) both join the EU. The positive sign of this parameter indicates that olive oil imports among EU members are intensive. This suggests that olive oil imports of EU countries from other EU countries are much higher compared to other combinations, including their imports from outside the EU and imports by non-EU members.
Regarding the time-invariant variables, the estimation results suggest that the coefficient of the geographical distance between trading partners ($DIS_{ij}$) does not significantly affect exports and imports. In addition, we cannot confirm the consistent and robust result of the effect of a common official language between trade partners ($DCL_{ij}$).

Table 6. Results of dynamic panel-data estimation of export model.

| Variable | OLS | Fixed-Effects Model | Two-Step System GMM |
|----------|-----|---------------------|---------------------|
| Constant | $-6.237$ | *** | $-7.467$ | *** | $-4.811$ | *** |
|          | [1.037] |       | [14.858] |       | [1.241] |       |
| $EX_{ij,t-1}$ | $0.496$ | *** | $0.327$ | *** | $0.661$ | *** |
|          | [0.014] |       | [0.018] |       | [0.037] |       |
| $EX_{ij,t-2}$ | $0.265$ | *** | $0.11$ | *** | $0.169$ | *** |
|          | [0.014] |       | [0.015] |       | [0.035] |       |
| $DIS_{ij}$ | $-0.018$ |       | $-0.017$ |       |          |       |
|          | [0.046] |       | [0.038] |       |          |       |
| $GDT_{ij}$ | $0.162$ | *** | $0.282$ |       | $0.122$ | *** |
|          | [0.018] |       | [0.276] |       | [0.024] |       |
| $SIM_{ij}$ | $0.001$ |       | $0.145$ |       | $-0.087$ | * |
|          | [0.029] |       | [0.334] |       | [0.045] |       |
| $RFE_{ij}$ | $-0.098$ | *** | $-1.067$ | *** | $-0.141$ | *** |
|          | [0.032] |       | [0.343] |       | [0.051] |       |
| $DEI_{ij}$ | $0.504$ | *** | $-0.449$ |       | $0.314$ | *** |
|          | [0.099] |       | [0.495] |       | [0.105] |       |
| $DEB_{ij}$ | $0.036$ |       | $-0.853$ |       | $0.006$ |       |
|          | [0.126] |       | [0.553] |       | [0.104] |       |
| $DCL_{ij}$ | $0.081$ |       | $0.913$ |       | $0.018$ |       |
|          | [0.156] |       | [0.575] |       | [0.133] |       |
| $DEJ_{ij}$ | $0.255$ |       | $-0.161$ |       | $0.161$ |       |
|          | [0.164] |       | [0.146] |       | [0.121] |       |
| $DCB_{ij}$ | $0.182$ |       | $-0.106$ |       | $0.006$ |       |
|          | [0.152] |       | [0.121] |       | [0.159] |       |
| $DCR_{ij}$ | $-0.048$ |       |          |       | $-0.106$ |       |
|          | [0.191] |       |          |       | [0.159] |       |
| Time dummies | Yes |       | Yes |       | Yes |       |
| $R^2$ | 0.636 |       |       |       |       |       |
| Within $R^2$ | 0.253 |       |       |       |       |       |
| Between $R^2$ | 0.691 |       |       |       |       |       |
| Overall $R^2$ | 0.505 |       |       |       |       |       |
| Hansen J statistics test | 596.19 |       |       |       | $-0.217$ |       |
| Arellano–Bond Test for AR(1) | $-9.01$ | *** |       |       | (0.000) |       |
| Arellano–Bond Test for AR(2) | 0.66 |       |       |       | (0.506) |       |
| Number of instruments | 599 |       |       |       |       |       |
| Number of groups | 604 |       |       |       | 604 |       |
| Number of observations | 10,268 |       |       |       | 10,268 |       |

Notes: Figures in square brackets in OLS and fixed-effects model are robust standard errors clustered by country pair. Figures in square brackets in two-step system GMM are Windmeijer’s corrected standard errors. Figures in parentheses are $p$-values. *, ** indicate significant at the 10% level, and 1% level, respectively.
Table 7. Results of dynamic panel-data estimation of import model.

| Variable | Dynamic Panel-Data Estimation |  |  |
|----------|-------------------------------|---|---|
|          | OLS                           | Fixed-Effects Model | Two-Step System GMM |
| Constant | $-5.703$                       | $-86.727$            | $-83.070$            |
|          | [4.953]                       | [76.501]             | [55.571]             |
| $IM_{ij,t-1}$ | $0.681$ *** | $0.298$ *** | $0.358$ *** |
|          | [0.030]                       | [0.041]             | [0.083]             |
| $DIS_{ij}$ | $-0.200$                       | $-1.169$            | $-1.169$            |
|          | [0.181]                       | [0.767]             | [0.767]             |
| $GDT_{ij}$ | $0.187$ **                    | $1.813$             | $1.734$             |
|          | [0.092]                       | [1.391]             | [1.391]             |
| $SIM_{ij}$ | $0.164$                       | $3.659$             | $1.761$             |
|          | [0.160]                       | [2.356]             | [2.356]             |
| $RFE_{ij}$ | $0.302$                       | $3.939$             | $2.50$              |
|          | [0.245]                       | [2.096]             | [2.096]             |
| $DE_{ij}$ | $-0.046$                       | $-2.832$ ***        | $-1.542$            |
|          | [0.615]                       | [0.502]             | [2.606]             |
| $DEI_{ij}$ | $-0.716$                       | $-2.701$ *          | $-4.205$            |
|          | [0.756]                       | [1.629]             | [1.629]             |
| $DEB_{ij}$ | $1.519$ *                    | $4.647$ ***         | $7.215$ **          |
|          | [0.883]                       | [0.693]             | [3.397]             |
| $DCB_{ij}$ | $-0.024$                       | -                   | $-0.306$            |
|          | [0.417]                       | [1.224]             | [1.224]             |
| $DCL_{ij}$ | $0.322$                       | -                   | $5.010$             |
|          | [0.676]                       | [3.850]             | [3.850]             |
| $DCR_{ij}$ | $0.636$                       | -                   | $-2.174$            |
|          | [0.321]                       | [2.330]             | [2.330]             |
| Time dummies | Yes                         | Yes                  | Yes                  |
| $R^2$    | 0.554                         | 0.192                | 0.164                |
| Within $R^2$ | 0.164                        | 0.164                | 0.164                |
| Between $R^2$ | 0.135                        | 0.135                | 0.135                |
| Hansen J statistics test | 84.8 (0.184) | 84.8 (0.184) | 84.8 (0.184) |
| Arellano–Bond Test for AR(1) | $-5.53$ *** | $-5.53$ *** | $-5.53$ *** |
|          | (0.000)                       | (0.000)             | (0.000)             |
| Arellano–Bond Test for AR(2) | 1.16 (0.244) | 1.16 (0.244) | 1.16 (0.244) |
| Number of instruments | 97                           | 97                   | 97                   |
| Number of groups | 97                           | 97                   | 97                   |
| Number of observations | 1649                         | 1649                 | 1649                 |

Notes: Figures in square brackets in OLS and fixed-effects model are robust standard errors clustered by country pair. Figures in square brackets in two-step system GMM are Windmeijer’s corrected standard errors. Figures in parentheses are p-values. *, **, *** indicate significant at the 10% level, 5% level, and 1% level, respectively.

5. Discussion

The empirical results mentioned above are summarized in the following three points. First of all, we confirmed the significant effect of the variables that support the new trade theory, i.e., bilateral overall country size and the difference in relative factor endowments [9]. An increase in the GDPs of two countries positively affects the export and import of olive oil. More interestingly, we found the negative effect of difference in relative factor endowments on olive oil export. This result suggests that Linder’s hypothesis is relevant as the difference in relative factor endowments is not a major trigger of export. Rather, olive oil exports grow between two countries as their factor endowments become more similar. It is consistent with the results by Baltagi et al. [9] and Paas et al. [10], supporting Linder’s hypothesis that trade flows become smaller between two countries as their factor endowments grow more dissimilar. In the case of olive oil trade in Germany, Kavallari et al. [30] found a negative effect of the increase in GDP per capita on import, while the effect on the GDP per capita of its trade partner remained positive. These results imply that Germany’s olive oil importation decreases if the difference in relative factor endowments, i.e., the difference in GDP per capita of Germany and partner countries, becomes smaller. Although this study does not explicitly test Linder’s hypothesis, Germany’s case is also consistent with Linder’s hypothesis.
According to Paas et al. [10], the variable of difference in relative factor endowments would have a negative (or positive) effect on trade in situations where intra-industry (or inter-industry) trade dominates. Therefore, it implies that countries with more similar factor endowments would most likely engage in more intra-industry trade. As presented in Figure 1, the simultaneous export and import of olive oil in Mediterranean countries means that the intra-industry trade has more relevance rather than the specialization in production and export in particular countries.

Secondly, we could not confirm the relevance of Linder’s hypothesis for olive oil import. The positive coefficient of the difference in relative factor endowments suggests that Mediterranean countries import olive oil more from countries with a difference in relative factor endowments. This trade pattern of olive oil importation is consistent with the predictions of the traditional H–O trade model rather than Linder’s hypothesis. Indeed, olive oil production and, by consequence, the volume of exports fluctuate annually due to the biennial bearing of olives. Some olive oil-importing countries increase their import when their production is low in order to stabilize their domestic supply and consumption. What is more, some countries in the EU import olive oil in bulk as a raw material so that it can be processed as a domestic product for re-export. As most olive oil importers are also exporters (Table 1), we can infer that they import olive oil from countries that have different factor endowments in order to stabilize their exports to other countries that have similar factor endowments.

Thirdly, the enlargement of the EU had a positive impact on olive oil exports and imports among EU member states. Kavallari et al. [30] found similar results on Germany’s import of olive oil. This study suggests that being an EU member positively affects the import of olive oil by Germany. While the olive oil market is growing in non-traditional producer countries such as Australia, New Zealand, the US, and Chile, traditional exporter countries in EU such as Spain, Italy, and Greece are still competitive [46]. The latter group also imports olive oil from the EU members to stabilize their domestic supply and exports. These findings of trade patterns are consistent with Linder’s prediction. It is implied that trade volume is expected to be larger among EU member states whose per capita income and demand properties are more similar. As shown in Figure 1, an increase in the volume of olive oil export is observed with sizable imports among the Mediterranean countries. Among them, particularly in EU member countries, the volume of the intra-industry trade of olive oil is growing. From 1990/91 to 2016/17, the Grubel–Lloyd index was applied to data gleaned from major olive oil producers in the EU in order to measure the degree of intra-industry trade. The figure, calculated at 0.538 on average, suggests that intra-industry trade constitutes more than half of the trade flow in the region. The calculation of the index of intra-industry trade is based on Grubel and Lloyd [47,48]. The data source is World Olive Oil Figures, International Olive Oil Council, which is available from: http://www.internationaloliveoil.org (Accessed: 19 July 2018). During the same period, 69.6%, 46.0%, and 45.7% of trade flow was intra-industry trade occurring in Italy, France, and Spain, respectively.

6. Conclusions

The orthodox theories of international trade uphold the hypothesis that countries specialize in the production and export of goods in which they have a comparative advantage. The difference in factor price caused by the difference in factor endowments determines the pattern of trade between countries. However, actual trade flows often suggest the simultaneous import and export of goods by a particular country. This is true of olive oil trade in Mediterranean countries, where their exports grow simultaneously alongside the large volume of imports. This study investigated the factors that affect olive oil export and import in Mediterranean countries using balanced panel data from 1998 to 2016. We estimated the commodity-specific gravity model by employing POL, FEM, and REM. The results of the Hausman test, the Breuch–Pagan test, and the F-test suggest that the estimation of FEM is appropriate for the specification in both export and import models. In addition to the static analysis, we applied Arellano–Bond dynamic panel-data estimation with the two-step system GMM to solve the problem of serial correlation, heteroscedasticity, and endogeneity of some of regressors.
The empirical findings mostly support the predictions on new trade theory where an increase in the overall country size positively impacts the trade flow of olive oil. It is noteworthy that the difference in factor endowments has a negative impact on export flow. An increase in the similarity of factor endowments and, thus, in demand propensities, has a positive impact on export flow. The enlargement of the EU had a positive effect on the volume of olive oil export and import. Among EU member states whose per capita income and demand properties are similar, the volume of imports is larger than those of countries dealing in olive oil commerce outside of the EU. These results are consistent with Linder’s hypothesis as opposed to the traditional H–O trade theory. Unlike the predictions of the H–O trade theory, the difference in relative factor endowments does not seem to be a significant determinant of olive oil exportation. The specialization in olive oil production and exportation does not merely follow with comparative advantage.

The simultaneous increase in olive oil exportation alongside sizable import volume implies a growing phenomenon of intra-industry trade in the value chain of Mediterranean countries. Based on this empirical finding, this paper recommends two directions for the promotion of olive oil export. One direction is to encourage production of competitive olive oil at lower prices following the law of comparative advantage. This direction is significant for quantity expansion of olive oil production at lower costs. On the contrary, the other direction is focused on producing differentiated olive oil that responds to the growing phenomenon of intra-industry trade. Product differentiation in the interest of promoting exportation is becoming increasingly important in the context of product quality improvements that foster a competitive advantage in olive oil trade.

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**Conflicts of Interest:** The authors declare no conflict of interest.

**Appendix A**

**Table A1.** The trade partners of olive oil exports for the Mediterranean countries.

| Albania     | Cameroon | Gambia | Korea     | Slovenia | Zimbabwe |
|-------------|----------|--------|-----------|----------|----------|
| Algeria     | Canada   | Germany| Kuwait    | South Africa | Moldova  |
| Andorra     | Cambodia | Georgia| Kyrgyzstan| Spain     | Myanmar  |
| Angola      | Cabo Verde | Ghana | Latvia Lebanon | Sri Lanka | Netherlands |
| Argentina   | Chile    | Greece | Liberia   | Sweden   | Nepal    |
| Armenia     | China    | Guatemala | Lithuania | Switzerland | New Zealand |
| Australia   | Columbia | Hong Kong | Luxembourg | Tanzania | Nicaragua |
| Austria     | Cote d’Ivoire | Honduras | Malaysia | Thailand | Nigeria |
| Azerbaijan  | Costa-Rica | Hungary | Malta     | Tunisia | Norway |
| Bahrain     | Croatia | India | Maldives | Turkey | Oman |
| Bangladesh  | Cyprus   | Indonesia | Mauritania | Turkmenistan | Panama |
| Belarus     | Denmark | Iran | Mauritius | Trinidad-Tobago | Pakistan |
| Belgium     | Dominica | Iraq | Mexico   | United Arab Emirates | Peru |
| Belize      | Ecuador | Ireland | Mongolia | Emirates | United Kingdom | Portugal |
| Benin       | Egypt    | Israel | Morocco  | United States | Philippines |
| Bolivia     | El-Salvador | Italy | Saudi Arabia | United States | Poland |
| Bosnia-Herzegovina | Estonia | Jamaica | Senegal | Ukraine | Portugal |
| Brazil      | Ethiopia | Japan | Seychelles | Uruguay | Uzbekistan |
| Brunei      | Finland | Jordan | Singapore | Russia |
| Bulgaria    | France   | Kazakhstan | Slovakia | Vietnam | Russia |
| Burkina Faso | Gabon | Kenya | Yemen | Zambia |
Table A2. The trade partners of olive oil imports for the Mediterranean countries.

| Country     | Algeria | Croatia | Israel | Portugal | Turkey |
|-------------|---------|---------|--------|----------|--------|
| Andorra     | Egypt   | Japan   | Saudi Arabia | United Kingdom |
| Argentina   | France  | Lebanon | South Africa | United States |
| Austria     | Germany | Luxembourg | Spain | Belgium |
| Australia   | Greece  | Morocco | Switzerland | Bulgaria |
| Belgium     | Italy   | Netherlands | Tunisia | |

References

1. Klonaris, S.; Agiangkatzoglou, A. Competitiveness of Greek virgin olive oil in the main destination markets. *Br. Food J.* 2018, 120, 80–95. [CrossRef]
2. Krugman, P. Scale economies, product differentiation, and the pattern of trade. *Am. Econ. Rev.* 1980, 70, 950–959.
3. Helpman, E.; Krugman, P. *Market Structure and Foreign Trade: Increasing Returns, Imperfect Competition and the International Economy*; MIT Press: Cambridge, MA, USA, 1985.
4. Helpman, E. The structure of foreign trade. *J. Econ. Perspect.* 1999, 13, 121–144. [CrossRef]
5. Linder, S.B. *An Essay on Trade and Transformation*; Almqvist & Wiksell: Stockholm, Sweden, 1961.
6. Koo, W.W.; Karemera, D.; Taylor, R. Gravity model analysis of meat trade policies. *Agric. Econ.* 1984, 10, 81–88. [CrossRef]
7. Dascal, D.; Mattas, K.; Tzouvelekas, V. An analysis of EU wine trade: A gravity model approach. *Int. Adv. Econ. Res.* 2002, 8, 135–147. [CrossRef]
8. Egger, P. An econometric view on the estimation of gravity models and the calculation of trade potentials. *World Econ.* 2002, 25, 297–312. [CrossRef]
9. Baltagi, B.; Egger, H.P.; Pfaffermayr, M. A generalized design for bilateral trade flow models. *Econ. Lett.* 2003, 80, 391–397. [CrossRef]
10. Paas, T.; Tafenau, E.; Scannell, N.J. Gravity equation analysis in the context of international trade: Model specification implications in the case of the European Union. *East. Eur. Econ.* 2008, 46, 92–113. [CrossRef]
11. Isard, W. Location theory and trade theory: Short-run analysis. *Q. J. Econ.* 1954, 68, 305–320. [CrossRef]
12. Tinbergen, J. *Shaping the World Economy: Suggestions for an International Economic Policy*; The Twentieth Century Fund: New York, NY, USA, 1962.
13. Pöyhönen, P. A tentative model for the volume of trade between countries. *Weltwirtschaftliches Arch.* 1963, 90, 93–100.
14. Anderson, J.E. A theoretical foundation for gravity equation. *Am. Econ. Rev.* 1979, 69, 106–116.
15. Bergstrand, J.H. The gravity equation in international trade: Some microeconomic foundations and empirical evidence. *Rev. Econ. Stat.* 1985, 67, 474–481. [CrossRef]
16. Bergstrand, J.H. The generalized gravity equation, monopolistic competition, and the factor-proportions theory in international trade. *Rev. Econ. Stat.* 1989, 71, 143–153. [CrossRef]
17. Bergstrand, J.H. The Heckscher-Ohlin-Samuelson model, the Linder hypothesis, and the determinants of bilateral intra-industry trade. *Econ. J.* 1990, 100, 1216–1229. [CrossRef]
18. Sanso, M.; Cuairán, R.; Sanz, F. Bilateral trade flows, the gravity equation, and functional form. *Rev. Econ. Stat.* 1993, 75, 266–275. [CrossRef]
19. Keum, K. Tourism flows and trade theory: A panel data analysis with the gravity model. *Ann. Reg. Sci.* 2010, 44, 541–557. [CrossRef]
20. Helpman, E. Imperfect competition and international trade: Evidence from 14 countries. *J. Jpn. Int. Econ.* 1998, I, 62–81. [CrossRef]
21. Deardorff, A. Determinants of bilateral trade: Does gravity work in a neoclassical world. In *The Regionalization of the World Economy*; Frankel, J.A., Ed.; University of Chicago Press: Chicago, IL, USA, 1998; pp. 7–32.
22. Martínez-Zarzoso, I.; Nowak-Lehmann, F. Economic and geographical distance: Explaining Mercosur sectoral exports to the EU. *Open Econ. Rev.* 2004, 15, 291–314. [CrossRef]
23. Crescimanno, M.; Galati, A.; Yahiaoui, D. Determinants of Italian agri-food exports in non-EU Mediterranean partner countries: An empirical investigation through a gravity model approach. *New Medit* 2013, 12, 46–54.
24. Emlinger, C.; Lozza, E.C.; Jacquet, F. EU market access for Mediterranean fruit and vegetables: A gravity model assessment. In Proceedings of the European Association of Agricultural Economists 98th Seminar, Crete, Greece, 29 June–2 July 2006.
25. Ghazalian, P.L.; Tamini, L.D.; Larue, B.; Gervais, J. A gravity model to account for vertical linkages between markets with an application to the cattle/beef sector. *J. Int. Trade Econ. Dev.* 2011, 21, 579–601. [CrossRef]
26. Sheldon, I.M.; Mishra, S.; Pick, D.; Thompson, S.R. Exchange rate uncertainty and US bilateral fresh fruit and fresh vegetable trade: An application of the gravity model. *Appl. Econ.* 2013, 45, 2067–2082. [CrossRef]
27. Özer, O.O.; Koksal, O. Determinants of Turkey’s citrus exports: A gravity model approach. *New Medit* 2016, 15, 37–42.
28. Márquez-Ramos, L.; Martínez-Gomez, V. On the effect of EU trade preferences: Evidence for monthly exports of fruit and vegetables from Morocco. *New Medit.* 2016, 15, 14–21.
29. Vlontzos, G.; Duquenne, M.N. Greek olive oil: How can its international market potential be realized. *Estey J. Int. Law Trade Policy* 2008, 9, 32–47.
30. Kavallari, A.; Maas, S.; Schmitz, P.M. Evidence on Euromediterranean trade integration: The case of German olive oil imports. *Ger. J. Agric. Econ.* 2010, 59, 40–46.
31. Angulo, A.M.; Mtimet, N.; Dhehibi, B.; Atwi, M.; Ben Youssef, O.; Gil, J.M.; Sai, M.B. A revisited gravity equation in trade flow analysis: An application to the case of Tunisian olive oil exports. *Investig. Reg.* 2011, 21, 225–239.
32. Rallatou, D.; Tzouvelekas, V. An analysis of the trade patterns of olive-oil in the European Union. *Agric. Econ. Rev.* 2016, 17, 55–69.
33. Aitken, N.D. The effect of the EEC and EFTA on European trade: A temporal cross-section analysis. *Am. Econ. Rev.* 1973, 5, 881–892.
34. Abrams, R.K. International trade flows under flexible exchange rates. *Econ. Rev.* 1980, 65, 3–10.
35. Brada, J.C.; Mendez, J.A. Economic integration among developed, developing and centrally planned economies: A comparative analysis. *Rev. Econ. Stat.* 1985, 67, 549–556. [CrossRef]
36. Baier, S.L.; Bergstrand, J.H. Do free trade agreements actually increase members’ international trade? *J. Int. Trade Econ.* 2007, 71, 72–95. [CrossRef]
37. Oh, C.H.; Selmier, W.T., II. Expanding international trade beyond the RTA border: The case of ASEAN’s economic diplomacy. *Econ. Lett.* 2008, 100, 385–387. [CrossRef]
38. Yao, X.; Yasmeen, R.; Li, Y.; Hafeez, M.; Padda, I.U.H. Free trade agreements and environment for sustainable development: A gravity model analysis. *Sustainability* 2019, 11, 597. [CrossRef]
39. Cheng, I.; Wall, H. Controlling for heterogeneity in gravity models of trade and integration. *Econ. Rev.* 2005, 87, 49–63. [CrossRef]
40. Shepherd, B.; Wilson, J.S. Trade facilitation in ASEAN member countries: Measuring progress and assessing priorities. *J. Asian Econ.* 2009, 20, 367–383. [CrossRef]
41. Arellano, M.; Bover, O. Another look at the instrumental variable estimation of error-components models. *J. Econ.* 1995, 68, 29–51. [CrossRef]
42. Blundell, R.; Bond, S. Initial conditions and moment restrictions in dynamic panel data models. *J. Econ.* 1998, 87, 115–143. [CrossRef]
43. Arellano, M.; Bond, S. Some tests of specification for panel data: Monte Carlo evidence and an application to employment equations. *Rev. Econ. Stud.* 1991, 58, 277–297. [CrossRef]
44. Roodman, D. How to do xtabond2: An introduction to “difference” and “system” GMM in Stata. *Stata J.* 2009, 9, 86–136. [CrossRef]
45. Windmeijer, F. A finite sample correction for the variance of linear efficient two-step GMM estimators. *J. Econ.* 2005, 126, 25–51. [CrossRef]
46. Mili, S. Olive oil marketing on non-traditional markets: Prospects and strategies. *New Medit* 2006, 5, 27–37.
47. Grubel, H.G.; Lloyd, P.J. The empirical measurement of intra-industry trade. *Econ. Rec.* 1971, 47, 494–517. [CrossRef]
48. Grubel, H.G.; Lloyd, P.J. *Intra-Industry Trade: The Theory and Measurement of International Trade in Differentiated Products*; Wiley: New York, NY, USA, 1975.

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