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TOTAL FACTOR PRODUCTIVITY AND EXPORT RELATIONSHIP: THE CASE FOR AGRICULTURE SECTOR IN FOUR MEDITERRANEAN COUNTRIES

This study investigates the export and productivity growth in agriculture sector for 4 selected Mediterranean countries (France, Italy, Spain and Turkey) during 1975-2007. Despite increasing interest in the relationship between trade and productivity, very limited studies have been conducted on the causal links between exports and productivity in agricultural sector. The causal relationship between productivity and export is a debate still; there has been a more reasonable approach in other sectors such as in industry. In this study, the empirical analysis results provide support to a long-term relationship between agricultural export and productivity only for Italy among the 4 countries. The results suggest that the relation between agricultural export and productivity has been ambiguous in the long term still.

Keywords: *total factor productivity; trade; agricultural export; Mediterranean countries; agriculture sector.*

JEL Classifications: *F14; F17; Q17; O57.*

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ЗВ'ЯЗОК СУКУПНОЇ ФАКТОРНОЇ ПРОДУКТИВНОСТІ ТА ЕКСПОРТУ (ЗА ДАНИМИ СІЛЬСЬКОГОСПОДАРСЬКОЇ ГАЛУЗІ ЧОТИРЬОХ КРАЇН СЕРЕДЗЕМНОМОРСЬКОГО РЕГІОНУ)

У статті досліджено зростання експорту і продуктивності сільськогосподарської галузі в 4 країнах Середземноморського регіону (Франції, Італії, Іспанії і Туреччині) за 1975-2007 р.р. Незважаючи на зріст зацікавленості у вивченні залежності між торгівлею і продуктивністю, зв'язкам між експортом і продуктивністю сільськогосподарської галузі приділялося мало уваги. Ці причинно-наслідкові зв'язки досі є предметом дискусій, проте для інших галузей, зокрема промисловості, вони є очевиднішими. За результатами емпіричного аналізу такий взаємозв'язок підтверджено лише для Італії. Для інших країн результати в довгостроковій перспективі суперечливі.

Ключові слова: *сукупна факторна продуктивність; торгівля; сільськогосподарський експорт; країни Середземноморського регіону; сільськогосподарська галузь.*

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СВЯЗЬ СОВОКУПНОЙ ФАКТОРНОЙ ПРОИЗВОДИТЕЛЬНОСТИ И ЭКСПОРТА (ПО ДАННЫМ СЕЛЬСКОХОЗЯЙСТВЕННОЙ ОТРАСЛИ ЧЕТЫРЕХ СТРАН СРЕДИЗЕМНОМОРСКОГО РЕГИОНА)

В статье исследован рост экспорта и производительности сельскохозяйственной отрасли в 4 странах Средиземноморского региона (Франции, Италии, Испании и Турции) за 1975-2007 г.г. Несмотря на возрастающий интерес к изучению зависимости между торговлей и производительностью, связям между экспортом и производительностью в сельскохозяйственной отрасли уделялось мало внимания. Эти причинно-следственные

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связи до сих пор являются предметом дискуссий, однако для других отраслей, в частности промышленности, они являются более очевидными. По результатам эмпирического анализа такая взаимосвязь подтверждена только для Италии. Для остальных стран результаты в долгосрочной перспективе противоречивы.

Ключевые слова: *совокупная факторная производительность; торговля; сельскохозяйственный экспорт; страны Средиземноморского региона; сельскохозяйственная отрасль.*

1. Introduction. 4 selected countries (France, Italy, Spain and Turkey) are the major agricultural producers in the Mediterranean region, and also have important place in the world agriculture. These countries have regional and climate similarities but also productivity and export level disparities. The main agricultural export destinations of these countries are the EU member states, especially in consequence of climate differences.

It is important to examine the trade-productivity link at the sectoral level for the way agriculture policy can stimulate productivity growth. Productivity increases in agricultural sector have been not always desired by policy makers, because of mainly two reasons. Firstly, if productivity increases the supply of agricultural products hugely, the price of these goods can decrease causing an income decreases for farmers. Secondly, supply increases can cause more budged costs for governments as agriculture sector is supported widely in the world as it happened to the EU member states at the beginning of 1980s. These two reasons depend on supply exceeds and restrictions for international trade of agricultural products.

In theory, the causal relationship between productivity and export is two-way. Export-led growth theorists indicate that export enhance productivity growth. This view explained as firms tend to learn advanced technologies through exports and become more competitive by using these new technologies. Learning by doing and decreasing unit costs because of scale economies are other explanations of export-productivity causality. The second view which is productivity growth to export is also quite obvious. Productivity growth causes exports, because a country's competitiveness in price and quality is enhanced by an increase in productivity (Kim and Lim, 2009).

This study investigates the link between agricultural trade and productivity for the 4 selected Mediterranean countries. First, it estimats TFP (Total Factor Productivity) growth for these countries during 1975-2007. Second, it testifies the long-term relationship between export and TFP. Third, the cointegration analysis is applied to testify the long-term relationship. Finally, the direction of causality is investigated depending on the outcome of cointegration analysis.

2. Literature review. Empirical investigation of the relationship between exports and growth is an important issues in international economics literature. There have been on-going debates on the direction of causality between trade and productivity. These debates had a significant place also in the initial studies about the causality between export and economic growth on the aggregate level.

Export and economic growth relation has been discussed in literature widely, since the term "export-led growth" was introduced by Kindleberger (1962). Furthermore, initial empirical investigations have been done about the relations between export and GDP growth. Empirical studies have provided mixed support on the export-led growth hypothesis, but also productivity increase has been one of the explanations about existence relations between export and GDP growth. Kaldor (1967) argued that economic growth via increased productivity or reduced unit costs is expected to act as a stimulus to export. More recent but also fewer studies have analysed the direct relationship of productivity and export empirically.

Kunst and Marin (1989) investigated the causal relationship between labour productivity and export on Austrian data using time series analysis. The analysis included manufactured goods and indicated no causal link from export to productivity, but also it estimated positive causality from productivity to export. Marin (1992) applied similar analysis to 4 developed countries which are the United States, Japan, the United Kingdom and Germany, and his findings of the econometric analysis suggest that an "outward-looking" regime favours the productivity performance of developed market economies as well as that of developing economies.

Thangavelu and Rajguru (2004) investigated the relationship between trade and labour productivity for 9 rapidly developing Asian countries. The long-run result shows there is no causal effect from exports to labour productivity growth for Hong Kong, Indonesia, Japan, Taiwan and Thailand; thereby suggesting that there is no export-led productivity growth in these countries.

Hatemi and Irandost (2001) investigated the cointegration and causal relationship between export and two alternative measures of productivity rates which are labour productivity and TFP growth. The analysis included 5 developed countries. When TFP was used as productivity variable, the estimated results revealed that the flow of causality is bidirectional in Germany, Italy and the UK. In France the flow of causality runs in only one direction — from productivity growth to export growth, while in Sweden causality runs from export to productivity growth. Hacker and Hatemi (2003)'s results show a bidirectional causality relationship for Sweden, which differs from previous studyies of Hatemi and Irandost (2001).

Bernard and Jensen (2004) explored the relationship between TFP and export in the US manufacturing. They found the evidence of positive correlation between exporting and productivity levels coming from the fact that high productivity plants are more likely to enter foreign markets. Liao and Liu (2009) examined empirically the interplay between exports and productivity growth for East-Asian economies. They also used TFP instead of labour productivity and adopted the frontier approach to calculate TFP, which enables us to overcome some drawbacks of the nonfrontier measures of productivity and represents an improvement over the previous studies. Fu (2004) analysed the impact of exports on TFP growth in a transition economy using a panel of Chinese manufacturing industries. Fu (2004) also estimated TFP growth by using a nonparametric programming method developed by Fare et al. (1994). Following Fare's approach, TFP growth is defined as a geometric mean of two Malmquist productivity indexes, which is to be estimated as the ratios of distance functions of observations from the frontier.

3. Methodology and data.

3.1. Total Factor Productivity. In this paper we measure total factor productivity using the Malmquist index methods described in Fare et al. (1994) and Coelli and Rao (2003). This approach uses data envelopment analysis (DEA) methods to construct a piece-wise linear production frontier for each year in the sample. The Malmquist TFP index was first introduced by Caves et al. (1982) and it has been widely used to calculate TFP process.

Following Fare et al. (1994), the Malmquist TFP index is defined using an output distance function and it measures the TFP change between two data points (e.g., those of a particular country in two adjoining time periods) by calculating the ratio of the distances of each data point relative to a common technology. Firstly, a static production may be defined as:

$$P(x)=\{y : x \text{ can produce } y\}, x \in R_{+}^{N}$$

The output distance function may be defined on *P(x)* as follows:

$$D_0(x,y)=\inf\{\theta:(y/\theta \in P(x))\}$$

Thereby, TFP index between period *t* (the base period) and period *t+1* is given by:

$$M^t=\frac{D_0^t(x^{t+1},y^{t+1})}{D_0^t(x^t,y^t)}, \quad (3)$$

$$M^{t+1}=\frac{D_0^{t+1}(x^{t+1},y^{t+1})}{D_0^{t+1}(x^t,y^t)}. \quad (4)$$

Fare et al. (1994) attempted to remove the arbitrariness in the choice of benchmark technology by specifying their Malmquist productivity change index as the geometric mean of the two-period indices:

$$M_0(x^{t+1},y^{t+1},x^t,y^t)=\left[\left(\frac{D_0^t(x^{t+1},y^{t+1}}{D_0^t(x^t,y^t}\right)\left(\frac{D_0^{t+1}(x^{t+1},y^{t+1}}{D_0^{t+1}(x^t,y^t)}\right)\right]^{\frac{1}{2}} \quad (5)$$

In this study, each country is compared only to itself in previous periods, not to a common benchmark. On the other hand, an explicit benchmark can be used in the calculation of the Malmquist index of TFP, such as the world frontier constructed from the data. Furthermore, the Malmquist indexes scores could be taken as a decreasing progress on the time period. The aim of this study is to investigate the relationship of the TFP growth and agricultural export for each country. Thus, the Malmquist index investigation is applied for each country separately.

3.2. Unit Root Test. A natural first step is the analysis of OLS (Ordinary Least Squares) estimation to investigate the unit root which may be in the series of variables, because if series have unit roots, there will be a spurious regression between the variables (Greene, 2001). Unit process is also investigated by traditional unit root tests. But it is denoted that traditional unit root tests (Augmented Dickey-Fuller etc.) may give different results when there are structural breaks in the series. In other words, if there is a structural break in the series, the tradional unit roots may not reject the null hypothesis. For this reason, Perron (1989), Zivot and Andrews (1992) and Lumsdaine and Papell (1997) have developed unit root tests under structural breaks. In recent developments, these tests have been criticised by Lee and Strazicich (2003). They have pointed that these tests have developed critical values by assuming no structural break under the null hypothesis. According to the Lee and Strazicich's (2003) unit root test, there are two models which are called Model AA and Model CC respectively, and critical values of Lee and Strazicich (2003) are built by assuming structural break under null hypothesis. This test data generating process is equal to $y_t = \delta' Z_t + e_t,\ \ e_t = \beta e_{t-1} + \varepsilon_t e_t$. In this equation, exogenous variables have been included in Z_t and ε_t is an error term $(\varepsilon_t \approx iid\, N(0, \sigma^2))$. D_{jt} is a dummy variable which is 1 if $t \geq T_{Bj} + 1, j = 1,2,$ and 0 otherwise, and the date of the structural breaks have been represented by T_{Bj}. In Model AA unit process have been examined only in levels and, $Z_t = [1, t, D_{1t}, D_{2t}]$ but in Model CC $Z_t = [1, t, D_{1t}, D_{2t}, DT_{1t}, DT_{2t}]$ and unit process have been examined both in levels and trend. So, in Model CC DT_{jt}= t - T_{Bj} for $t \geq T_{Bj} + 1, j = 1,2,$ and 0 otherwise. The null and alternative hypothesis equations in Model AA and Model CC have been presented as follows:

Model AA:

$$H_0 : y_t = u_0 + d_1 B_{1t} + d_2 B_{2t} + y_{t-1} + v_{1t} \tag{6}$$

$$H_1 : y_t = u_1 + \gamma_2 t + d_1 D_{1t} + d_2 D_{2t} + y_{t-1} + v_{2t} \tag{7}$$

Model CC:

$$H_0 : y_t = u_0 + \gamma t + d_1 B_{1t} + d_2 B_{2t} + d_3 D_{1t} + d_4 D_{2t} + y_{t-1} + v_{1t} \tag{8}$$

$$H_1 : y_t = u_1 + \gamma t + d_1 D_{1t} + d_2 D_{2t} + d_3 DT_{1t} + d_4 DT_{2t} + v_{2t}\ , \tag{9}$$

where v_1 and v_2 are stationary error terms, with B_{jt}=1 for $t=T_{Bj}+1, j=1,2,$ and 0 otherwise. Then as the second step, Lee and Strazicich (2003) unit root test statictics have been derived by the following regression equation:

$$\Delta y_t = \delta' \Delta Z_t + \phi \tilde{S}_{t-1} + \sum_{i=1}^{k} \beta_i \Delta \tilde{S}_{t-i} + u_t , \tag{10}$$

where the detrended series $\tilde{S}$ is determined as follows: $\tilde{S} = y_t - \tilde{\psi}_x - Z_t \tilde{\delta}, t = 2$ .....T; $\tilde{\delta}$ are coefficients in the regression of Δy_t onto ΔZ_t; $\tilde{\psi}_x$ equals, $y_1 - Z_1 \tilde{\delta}$ where y_1 and Z_1 correspond to the first observations of y_1 and Z_t respectively. The lagged terms of $\Delta \tilde{S}_{t-i}$ are included for autocorrelation. Lee and Strazicich (2003) test statistic equals the *t-radio* $\tilde{\tau}$ testing the unit-root hypothesis $\phi = 0 [i.e., \tilde{\tau}(\lambda) = \phi / s.e.(\phi)]$. When we want to determine the relative location of structural breaks endogenously $(i.e., \lambda_1 = TB_1/T, \lambda_2 = TB_2/T)$ a grid search LM= $inf\, \tilde{\tau}(\lambda)$ over trimming region (0.10T,0.90T) is used by the minimum LM test, where $\hat{T}$ equals the number of observations and the critical values are in Lee and Strazicich (Hooi et al., 2005; Canarella et al., 2010; Lee and Strazicich, 2003).

3.3. Cointegration Test. Cointegration test is used for determining the long-run relationship between series. At the beginning, we see that the long-run relationship between series is investigated by Engle and Granger (1987) methodology. With this methodology we investigate the long-run relationship between the two variables. But if we have more than two variables, this test is not applied. In this case, Johansen and Juselius (1990) methodology is performed because this methodology allows determining the long-run relationship of two or more economic time series.

The first form of the Johansen and Juselius (1990) methodology is described as the following equation:

$$y_t = \mu + A_1 y_{t-1} + \ldots A_p y_{t-p} + \varepsilon_t \tag{11}$$

In this equation, p is order of the VAR model, y_1 is an $n \times 1$ vector of variables which are integrated of order one-commonly showed $I(1)$, and ε_t is an $n \times 1$ vector of innovations. This VAR model is rewritten as the following equation:

$$\Delta y_t + \Pi y_{t-1} + \sum_{i=1}^{p-1} \Gamma_i \Delta y_{t-1} + \varepsilon_t, \quad (12)$$

Where $\Pi = \sum_{i=1}^{p} A_i - I$ and $\Gamma_i = -\sum_{j=i+1}^{p} A_j$. The hypothesis of a cointegration rank of the reduced matrix Π is defined as $\Pi=\alpha\beta'$. α and β are $n\ x\ r$ dimensional matrices and their rank is represented by r. In addition, r defines the number of cointegration which is called rank, β' denotes the effects of the long-run equilibrium relations of variables in the cointegration vector. α is the adjustment parameter in the vector error correction model. Accordingly, in Johansen and Juselius procedure, we estimate Π matrix. The number of the rank in the Π matrix is determined by trace test and maximum eigenvalue, as below:

$$J_{trace} = -T \sum_{i=r+1}^{n} ln(1-\hat{\lambda}_i), \quad (13)$$

$$J_{max} = -T\, ln(1-\hat{\lambda}_{r+1}). \quad (14)$$

In these equations, T is sample size, $\hat{\lambda}_i$ is the i=th largest canonical correlation. In the trace test, we test the null hypothesis of r cointegrating vectors against the alternative hypothesis of n cointegrating vectors. On the contrary, in the maximum eigenvalue test, we test the null hypothesis of r cointegrating vectors against the alternative hypothesis r+1 cointegrating vectors (Hjalmarsson et al., 2007; Johansen and Juselius, 1990; Enders, 1995).

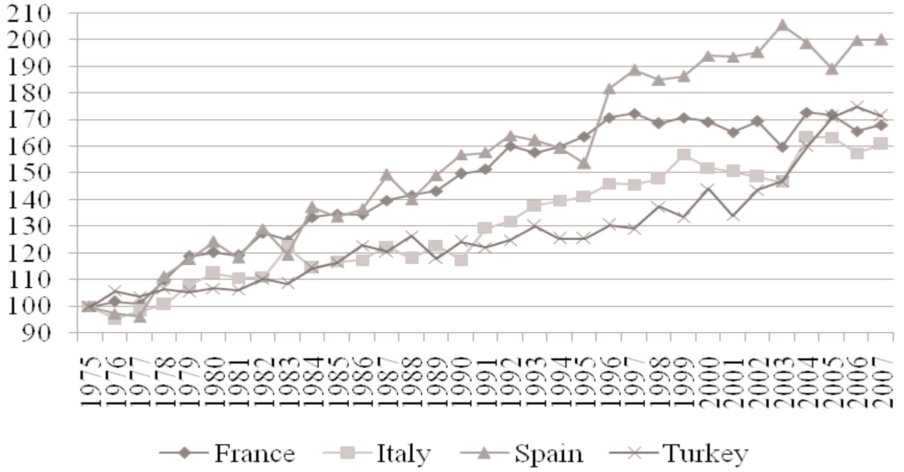
3.4. Causality Test. Toda and Yamamoto (1995) developed a method, which is based on VAR model, for investigating the Granger causality. The degree of integration or possible relationship between the series does not affect the validity of the test. This test uses a modified Wald (MWALD) test statistic restrictions that asymptotically has a Chis-quare distribution. The lag-length of the VAR *(k)* model and maximum cointegration level d(max) are the important parts of the test. There are certain the steps in the test. In the first step we determine the lag-length of the VAR model and maximum cointegration level. Then we estimate the VAR model with [k+d(max)] lags. In the third step the VAR model coefficents validity with *(k)* lags are tested by Wald restrictions. If the lags of the coefficents are significant, we reject the null hypothsesis against the alternative hypothesis which denotes that independent variable Granger-causes dependent variable in the model (Awokuse, 2002; Bhattacharya et al., 2002; Toda et al., 1995)

3.5. Data. The data used in this study are agricultural export and TFP index of 4 Mediterranean countries which are France, Italy, Spain and Turkey in the period of 1975-2007. Agricultural export series are taken from Food and Agriculture Organization of the United Nations (FAO) and they are in terms of 2004-2006 constant USD. TFP index is calculated for each country and the output-oriented model of the data envelopment analysis (DEA) is used for this calculation. One output and two inputs are used for the TFP calculation. Gross agricultural production value in terms of 2004-2006 constant USD has been used for output. The input variables are agricultural employment and agricultural capital stock calculated by FAO as in Box 1, Appendix 1. The agricultural employment series for France, Italy and Spain are taken from Organisation for Economic Cooperation and Development (OECD) database and Turkish Statistical Institute (TURKSTAT) database for Turkey. The series of capital stock are taken from FAO and they are calculated by FAO Statistics Division, using 2005 prices as the base year. The dataset has been developed by multiplying unit prices by the quantity of physical assets "in use" compiled from individual countries. The physical assets include assets used in the production process covering land development, irrigation works, structures, machinery and livestock.

4. Empirical results.

4.1. Total Factor Productivity. The first empirical analysis included Malmquist TFP indexices for selected Mediterranean countries which are France, Italy, Spain and Turkey. Figure 1 shows the cumulative process of TFP for each country. Each 4 TFPs index is taken as 100 in 1975. The first conclusion of our study shows that all countries' TFP increased in the same time period. Furthermore, it is seen that Spain succeeded the highest TFP improvement in its agricultural sector at the end of the period. But, it should also be noted that this process shows only the process of Spanish agricultural sector, but not a comparison of TFP level with other countries.

Figure 1. **TFP Process in Selected Mediterranean Countries**



4.2. Unit Root Test Results. We have performed Lee and Strazicich (2003) unit root test and presented the results in Table 1. A series, which is stationary without differencing, is said to be I(0). In general a series which is stationary after being differenced *d* times is said to be integrated of order *d*, denoted I(*d*) and the series which is stationary after being differenced once is said to be integrated of order 1 and is denoted by I(1). According to the results, all the series are not stationary in their levels. On the other hand, all series are stationary at first difference level and this is indicating that all the series are I(1).

Table 1. **Unit Root Test Results**

Series	Lee-Strazicich Unit Root Test Results							
	Level (t-statistics)		First Difference (t-statistics)		Breaks (level)		Breaks (first difference)	
(LNEX 1)	-5.54		-6.48		1994		1990	
					1998		1998	
(LNEX 2)	-5.44		-10.73		1985		1988	
					1996		1999	
(LNEX 3)	-5.83		-8.81		1983		1988	
					1997		1996	
(LNEX 4)	-5.71		-7.86		1987		1985	
					1997		2002	
(LNTF P1)	-6.30		-8.41		1986		1998	
					1997		2004	
(LNTF P2)	-5.02		-7.52		1979		1984	
					1992		1992	
(LNTF P3)	-5.99		-9.28		1978		1994	
					2003		1997	
(LNTF P4)	-6.19		-11.96		1985		2000	
					2002		2003	
Critical Values (1%)	(LNEX 1)	(LNEX 1)	(LNEX 1)	(LNEX 1)	(LNTF P1)	(LNTF P2)	(LNTF P3)	(LNTF P4)
	-6.45* -6.45**	-6.41* -6.45**	-6.41* -6.45**	-6.45* -6.33**	-6.41* -6.32**	-6.16* -6.16**	-6.33* -6.45**	-6.33* -6.32**

1) Lag lengths in unit root tests were chosen to ensure white-noise residuals.
2) (*), (**) denote critical values at level and first differences respectively.

4.3. Cointegration Test. The cointegration between the variables is investigated by using the methodology developed by Johansen et al. (1990) to determine the long-run relationship between the variables which are I(1). The cointegration analysis results are presented in Table 2. According to the results, a long-term relationship between agricultural export and TFP for France, Spain and Turkey is not found. However, a long-run relationship between the variables for Italy is found.

Table 2. **Cointegration Analysis Results**

Country 1: France					
H_0	H_1	Eigen value	Trace Statistics	Critical Value (1%)	Lag Length
$r=0$	$r\geq 1$	0.315085	17.47238	31.15385	1
$r\leq 1$	$r\geq 2$	0.154267	5.361653	16.55386	
H_0	H_1	Eigen value	Max-Eigen Statistics	Critical Value (1%)	Lag Length
$r=0$	$r=1$	0.315085	12.11073	23.97534	1
$r\leq 1$	$r=2$	0.154267	5.361653	16.55386	
Country 2: Italy					
H_0	H_1	Eigen value	Trace Statistics	Critical Value (1%)	Lag Length
$r=0$	$r\geq 1$	0.528529	32.11820	31.15385	1
$r\leq 1$	$r\geq 2$	0.222596	8.057444	16.55386	

The end of Table 2

H_0	H_1	Eigen value	Max-Eigen Statistics	Critical Value (1%)	Lag Length
$r=0$	$r=1$	0.528529	24.06075	23.97534	1
$r\leq 1$	$r=2$	0.222596	8.057444	16.55386	
Country 3: Spain					
H_0	H_1	Eigen value	Trace Statistics	Critical Value (1%)	Lag Length
$r=0$	$r\geq 1$	0.302418	16.53023	31.15385	1
$r\leq 1$	$r\geq 2$	0.144812	5.005885	16.55386	
H_0	H_1	Eigen value	Max-Eigen Statistics	Critical Value (1%)	Lag Length
$r=0$	$r=1$	0.302418	11.52435	23.97534	1
$r\leq 1$	$r=2$	0.144812	5.005885	16.55386	
Country 4: Turkey					
H_0	H_1	Eigen value	Trace Statistics	Critical Value (1%)	Lag Length
$r=0$	$r\geq 1$	0.315218	18.94890	31.15385	1
$r\leq 1$	$r\geq 2$	0.192247	6.831973	16.55386	
H_0	H_1	Eigen value	Max-Eigen Statistics	Critical Value (1%)	Lag Length
$r=0$	$r=1$	0.315218	12.11693	23.97534	1
$r\leq 1$	$r=2$	0.192247	6.831973	16.55386	

1) The lag length selection was based on Schwarz criterion test results (not reported in this paper).

2) H0 and H1 denote the null alternative hypothesis respectively and the number of cointegrating vectors.

4.4. Causality Test Results. The causal relationship between the variables for Italy is presented with following regression models:

$$LNEX2=\alpha_0+\sum_{i=1}^{k+d}\alpha_1 LNEX2_{t-1}+\sum_{j=1}^{l+d}\alpha_2 LNTFP2_{t-j}+\varepsilon_{t1} \quad (13)$$

$$LNTFP2=\alpha_3+\sum_{i=1}^{k+d}\alpha_4 LNTFP2_{t-1}+\sum_{j=1}^{n+d}\alpha_5 LNEX2_{t-j}+\varepsilon_{t2} \quad (14)$$

where t is time period, k,l,m and n is the optimal lag length, d is the maximal order of integration of the series in the system, α_0 and α_3 are constant terms, $\alpha_{1,}\alpha_{2,}\alpha_3$ and α_5 are regression coefficients of independent variables, ε_{t1} and ε_{t2} are white noise error terms. In the light of this information, we have estimated the regression equations and presented the results in Table 3. According to the result, there is a casual link from TFP to export in the agricultural sector of Italy, at the 10 % significance level.

Table 3. **Toda-Yamamoto Causality Test Results**

Hypothesis	Lag Length	MWALD t-statistics	Probability Values
H_0 : *LNTFP2* does not Granger-cause *LNEX2* H_1 : *LNTFP2* Granger-causes *LNEX2*	1	-0.1916	0.0668*
H_0 : *LNEX2* does not Granger-cause *LNTFP2* H_1 : *LNEX2* Granger-causes LNTFP2	1	1.4351	0.1637

1) The lag length selection was based on Schwarz criterion test results (not reported in this paper).
2) (*) denotes that a test statistics is significant at the 10% level.

5. Conclusion. The existing empirical literature on the relationship between trade and productivity focuses largely on the relationship between exports and productivity on the aggregate level, and also on the firm level. Our study will contribute substantially to the literature on the relationship between export and productivity in agricultur. In particular, 4 Mediterranean countries which have similar agricultural products have been chosen for our study.

The first conclusion of our study shows that the selected Mediterranean countries' TFP have increased since 1975, and Spain had the highest growth in the time period. Furthermore, agricultural exports of all the sample countries have increased at the same time period. Secondly, the stationarity of all the series have been checked to investigate long-term relationship between agricultural export and TFP for each country. It has been found that the first differences of series are stationary which is also can be shown as I(1). Thirdly, the long-term relationship between series has been tested by applying cointegration analysis and it has found the long-term relationship only for Italy. Furthermore, a causal link from TFP to export in agricultural sector in Italy has also been found.

We can conclude from our study that TFP/ export relationship is quite ambiguous for agricultural sector. In the literature one-way or two-way casual relationship between export and productivity in aggregate economy has been found. The ambiguous conclusion for agricultural sector may be caused by specific characteristics of agricultural sector.

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Appendix 1. **Estimation of Capital Stock in Agriculture**

*- Land development = **Σ** {(arable land) x (unit price) + (irrigated land) x (unit price)}*

*- Plantation crops = **Σ** (land under permanent crop) x (unit price)*

*- Total value of livestock = Livestock as fixed assets used for agriculture + Livestock kept as inventory = **Σ** {(number of livestock for i) x (unit price of livestock for i) x (share of total livestock used in agriculture = 0.6245) + (number of livestock for j) x (unit price of livestock for j)} Where i stands for camels, cattle, buffalos, goats, horses, mules and asses and j stands for pigs, poultry and sheep. 85% of the total value is treated as fixed assets and remaining 15% as value of inventory.*

- Structures for livestock

1. The number of structures has been estimated for cattle, buffalo, goats, horses, camels, pigs and poultry.

2. Value of structures has been estimated as US $1800 for cattle and buffalo, US $180 for goats and US $1.5 for poultry (birds) based on the FAO AT 2010 study. The values were applied to the 1990 and 1995 series after superimposing price rises as estimated from implicit GDP deflator.

3. Structures have been estimated to reflect for 30% of cattle, buffalo, horse and goat for developed countries and 5% for cattle, buffalos, horses and goats for countries in transition and developing countries. Poultry structures have been estimated for 60% of the birds uniformly across countries.

*- Machinery and equipment = **Σ** {(number of machinery for i) x (unit price of machinery for i) + (economically active population in agriculture) x US $35)}*

Where i stands for tractors, harvesters & threshers and milking machines.

US $ 35 has been taken from 1995 series after adjusting for price rises.

- Consumption of fixed capital =

1. Consumption of fixed capital has been estimated for land development, plantation crops, structure for live-

The End of *Appendix 1*

2. No value has been estimated on livestock.   *3. Consumption of fixed capital is estimated as 2% for land development which includes irrigation works, 4.5% for plantation and structures of livestock and 12.5% for machinery and equipment as suggested in the FAO AT 2010 study. This assumption implies a life of 50 years for land development, about 22 years for plantation and struc-*

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