Productivity and product quality: Evidence from agricultural products in South Mediterranean Countries

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Abstract

This paper aims to investigate the relationship between trade openness and productivity in the Mediterranean countries agricultural sector. The study basically focuses on analyzing the effects of exports quality on productivity growth at the aggregate farming sector. The impact of quality on productivity is evaluated through the estimation of a dynamic production function by the GMM estimator over five groups of agricultural products on a panel of nine South Mediterranean Countries and five European Union Countries for the period 1990 to 2005. The model is expanded with a range of countries specific characteristics and competitive conditions such as trade barriers and exports varieties among the explanatory variables. The empirical findings suggest that trade openness may enhance agricultural productivity growth. It appears from the results that products quality, as inferred from trade data, contributes to productivity gains.

Keywords: Productivity, Product Quality, Trade Liberalization, Agriculture.

Résumé

Ce travail étudie la relation entre l'ouverture commerciale et la productivité dans le secteur agricole des pays Méditerranéens. L'étude se penche principalement sur l'analyse des effets de la qualité des exportations sur la croissance de la productivité dans le secteur agricole. L'impact de la qualité sur la productivité est évalué à travers l'estimation d'une fonction de production dynamique par la méthode des MMG sur un panel de cinq groupes de produits agricoles, neuf pays Sud Méditerranéens et cinq pays de l'Union Européenne pour la période entre 1990 at 2005. Le modèle englobe certaines caractéristiques spécifiques à chaque pays ainsi que divers facteurs résumant les conditions de compétitivité tels que les barrières à l'exportation et la variété des exportations parmi les variables explicatives. Les résultats empiriques suggèrent que l'ouverture commerciale pourrait inciter la croissance de la productivité agricole. Les résultats montrent également que la qualité des produits, inférée à partir des observations sur le commerce extérieur, contribue aux gains de productivité.

***Mots Clé**: Productivité, Qualité des produits, Libéralisation commerciale, Agriculture.*

I. Introduction

The Euro-Mediterranean conference, held in Barcelona in November 1995, led to the negotiation and signature of partnership agreements between the European Union (EU) and several Southern Mediterranean Countries (SMC) like: Tunisia, Turkey, Morocco, Algeria, Egypt, Lebanon, Jordan, Israel and Syria. The Barcelona conference launched the process for a gradual establishment of a Euro-Mediterranean free trade area by 2010. The association arrangements, currently limited to the removal of tariff and non-tariff barriers on manufactured goods, are going to be enlarged to farm products. Agricultural goods exchange remains governed by the specific concessions and trade preferences granted under the bilateral agreements concluded between the committed countries (Legrand, 2002; CIHEAM, 2002; Corrons and al, 2004). The Barcelona process represents however an important step towards greater agricultural liberalization, the debates over the progressive elimination of tariff barriers on farming products are still underway (Bouët and al, 2004).

Agriculture, one of the most important sectors in the SMCs, will be significantly affected by the increasing openness of these economies. With agricultural liberalization, the SMC farming sector is going to face ambitious challenges and interesting perspectives.

SMCs enjoy a good potential in agricultural trade due to favorable climatic conditions, competitive advantage of cost of production especially labor and closeness to the EU markets. South Mediterranean governments implemented important agricultural development projects directed towards modernizing the agricultural sector and enhancing the efficiency and quality in the plant production. The government strategies placed an increased emphasis on promoting relatively high value export goods like citrus, some fresh fruits and vegetables, wines and olive oil… at the expense of the more traditional farming productions (CIHEAM, 2002). These policies aggravated the heterogeneity that characterizes the SMC agricultural sector, where a modern exportoriented agriculture which mobilizes an important fraction of fertile lands and irrigation water, is combined with a poor traditional farming mainly based on rainfed production systems and particularly vulnerable to irregular weather conditions. The rainfed agriculture represents the essential economic activity in the rural areas and suffer from the use of traditional practices, the lack of logistic and human skills, the weak productivity and the low quality of its products. This sector appears to be particularly sensitive to agricultural trade liberalization since the rural farmers may have severe difficulties to sustain the competition

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coming from the more effective EU producers (Corrons, 2000 ; Corrons and al., 2004).

The underlying idea in the Barcelona process is that trade may play a key role in encouraging rural development and enhancing economic integration in the Mediterranean region. The increasing competition resulting from trade barriers reduction may bring a push to promote product quality and export diversification towards high value markets which may contribute to efficiency and productivity growth in the farming sector. A less optimistic view cannot however deny the challenges facing the most vulnerable SMC sectors such as the agro-food industries and the rain-fed agriculture which may be seriously affected by the growing competitive pressures (Akesbi, 2000; Legrand, 2002; CIHEAM, 2002).

Several empirical studies using applied general equilibrium models showed that a free trade policy can substantially boost the Mediterranean agricultural exports, with a wide expansion of the products having appreciable comparative advantages. They concluded that the openness process should be carried out with accompanying policies for restructuring the rural sector to cope with the fierce international competition (Chemengui and Dessus, 1999; Corrons, 2000; Jabarin, 2001; Muaz, 2004). These studies mainly focus their analysis on the impact of tariff reduction on output, employment and trade flow variations and take little consideration of productivity differences, countries characteristics and products differentiation in their analysis.

SMC share some common features like the environmental conditions, agricultural practices and cropping patterns and face similar policy and institutional challenges. They, nevertheless, differ in their resource endowments, production methods and their ability to meet food import requirements. These countries are expected to be affected in different ways by the free trade policy; their faculty to benefit from opportunities arising from the new trade environment being closely related to their production capacity and to their aptitude to improve their efficiency and to meet the increasing international demand for high-quality goods.

In this paper we aim to investigate the relationship between trade openness and productivity in the Mediterranean countries agricultural sector. Our study basically focuses on analyzing the effects of exports quality and variety on productivity growth at the aggregate farming sector, using a panel of advanced and developing Mediterranean countries involved in the process of global market liberalization. The analysis may help to reveal the potential for each country to reap the benefits of a free trade policy.

Recent empirical research has highlighted a positive correlation between international trade and productivity growth (Grossman and Helpman, 1991; Clerides and al., 1998; Bernard and Jensen, 1999; Kraay, 1999; Melitz, 2003; Bigsten et al 2004; Biesebroeck, 2005). The effect of trade openness on productivity is frequently associated in the literature with specialization, competition and variety. Several studies show that exposure to higher level of competition enhances productivity performance (Pilat 1996; Nickel, 1996; Okada, 2005). The benefit of greater variety of outputs on productivity has been investigated in some recent works. Gains of productivity resulting from higher export varieties have been confirmed by Feenstra et al (1999) for Taiwan and South Korea, by Funke and Ruhwedel (2001a, 2001b) for the OECD and East Asian countries and by Feenstra and Kee (2004) for a sample of 34 exporting countries.

A growing body of empirical analysis also underlined the relevance of product quality in international trade patterns (Hallak, (2003, 2005); Hummels and Klenow, 2004; Hallak and Schott, 2005). These studies found a significant positive influence of product quality on country's competitiveness. A positive link between product quality and productive efficiency was invoked in the literature[3] (Kraay et al., 2002), little attention has however been devoted in the empirical studies to investigating this issue.

Opening a country to trade opportunities might induce an increase of the export's quality which in turn can contribute to productivity expansion. This can be explained by the fact that with the fall of tariff barriers and exposure to higher level of competition, the market access is becoming increasingly dependent on the ability to meet international demand for high quality goods. The competitive pressures will force farmers to restructure by using higher skill factors and by reallocating scarce resources towards better quality products which accordingly lead to productivity gains[4].

We start our analysis by evaluating product quality indexes across a range of countries, products and years. We use the procedure developed by Hallak (2003, 2005) to infer quality indices from trade data. We analyze the relationship between productivity and quality using a dynamic production function approach. The impact of quality on productivity is evaluated through the estimation of a productivity equation including quality among the explanatory variables. We expand the model with a range of countries specific characteristics and competitive conditions such as trade barriers, output varieties and products diversification. To alleviate endogeneity biases we use the GMM estimator of Blundell and Bond (1998, 2000). The analysis is conducted over a range of five groups of agricultural products in a panel of nine South Mediterranean Countries: Algeria, Tunisia, Morocco, Lebanon, Turkey, Jordan, Syria, Egypt and Israel; and five European Union Countries: France, Spain, Italy, Greece and Portugal for the period 1990 to 2005.

The paper is organized as follows: Section 2 describes the methodology used to construct product quality indexes. Section 3 outlines the empirical model. In section 4 we

[3] Feenstra and Kee (2004) argued that outputs differentiation lead's to the use of different factor intensities and then to productivity gains.
[4] Producing higher quality products without increasing costs lead's to productivity growth (Melitz, 2003).

provide an overview of the data used and report the main econometric results. Section 5 summarizes the essential findings and conclusions.

2. Construction of product quality index

In the international exchange of differentiated goods the variation of export prices across countries within narrowly defined product categories suggests a disparity in their quality. Different varieties of a same product, originating from diverse countries have often different prices. In the category of citrus fruits for example, Clementine originating from Spain that are twice as expensive as those coming from Egypt can be considered as being of better quality. In this section we seek to identify the extent to which price variation across product varieties reflects differences in product qualities. We assume that export prices variation reflects a proportional difference in the quality, the observed prices can be decomposed therefore in a quality component and a price component under the following form:

$$1)\quad p_{hi} = \theta_{hi}\tilde{p}_{hi}$$

where p_{hi} is the export price of the variety h originating from country i, θ_{hi} its quality and $\tilde{p}_{hi}$ the common price adjusted by the quality or "pure price". This formulation catches the idea according to which, for a given product variety, consumers face a multitude of price-quality combinations and a variety of better quality necessarily generates a higher price (Bils and Klenow, 2001; Hallak, (2003, 2005); Hallak and Schott, 2005).

Since θ_{hi} and $\tilde{p}_{hi}$ are not observable, we use the methodology of Hallak (2003, 2005) to infer a measure for quality indexes from trade statistics databases.

These databases report detailed information on exports by country of origin and type of goods in value and quantity. For each goods category, export prices (or unit values) are obtained from the ratio between the value and quantity of the exports. If a product category includes different varieties of goods, then differences in unit values merely reflect differences in prices and differences in the composition of exports within the category. To palliate this problem, it is useful to use observations at a desegregated level of products.

Let's consider a product category k composed of h: 1…nk varieties, originating from country i. Hallak (2003, 2005) suggests to decompose the value of exports in quantity and price indexes from the following equality:

$$2)\quad X_{ki} = \sum_{h\in k} p_{hi}q_{hi} = P_{ki}Q_{ki}$$

where X_{ki} is the value of export of (k,i), p_{hi} and q_{hi} the respective price and quantity of variety (h,i), P_{ki} and Q_{ki} price and quantity indexes of product k.

Price indexes can be interpreted as an approximation of quality indexes from:

$$3)\quad X_{ki} = \sum_{h\in k} p_{hi}q_{hi} = \sum_{h\in k} \theta_{hi}\tilde{p}_{hi}q_{hi} = \sum_{h\in k} \theta_{hi}\tilde{q}_{hi} = \theta_{ki}\tilde{Q}_{ki}$$

The average quantity index $\tilde{Q}_{ki}$ is obtained using the ideal Fisher index[5].

By dividing the total value of exports from each country X_{ki} by the quantity indexes $\tilde{Q}_{ki}$ we obtain quality indexes.

3. Productivity and product quality

The relationship between international trade and productivity has been widely investigated in the empirical literature and the positive impact of exporting and competition on productivity growth has been well established by several analyses (Bigsten et al., 2004; Biesebroeck, 2005; Okada, 2005). Recent studies in international trade, exploring the determinants of country's competitiveness, show that products quality play an essential role in overall competitiveness (Erkel-Rousse and Le Gallo, 2002; Hallak, 2003, 2005; Hallak and Schott, 2005).

This section examines the interaction between the determinants of competitiveness and countries characteristics in increasing productivity in the Mediterranean agricultural sector, looking particularly at the effect of product quality on productivity. We begin our analysis by outlining the mechanism by which quality may interact with productivity levels. Increases in the country's exposure to international competition enhance the producer's incentive to export higher quality goods and lead to the reallocation of scarce resources and higher skill factors towards better quality products. Producing higher-quality goods without substantially increasing production costs might ensure productivity promoting (Melitz, 2003) as only the most productive farms can survive the competitive process.

The link between productivity and competition is verified by using a simple production function framework. We begin by assuming that a country-specific production function can be depicted by a Cobb-Douglas form. Notwithstanding the inherent restrictive properties of the Cobb-Douglas functional form, it has been widely used in the empirical estimation of productivity models since more flexible forms such as the Translog function consumes more degrees of freedom and reduces the precision of the estimated parameters. We suppose that:

$$4)\quad y_{kit} = A_{kit}{}^{\gamma} K_{kit}{}^{\beta_K} N_{kit}^{\beta_n} L_{kit}{}^{\beta_l} W_{kit}^{\beta_w} F_{kit}^{\beta_f}$$

Where y indicates the output, K, N, L, W and F are capital, labour, land, water and fertilizers respectively. β_K, β_n, β_l, β_w *and* β_f are parameters to be estimated representing factor share coefficients. The subscripts *k, i* and *t* make reference to the k^{th} product, i^{th} country and t^{th} period respectively. γ allows for factors affecting and changing the productivity and efficiency of the production process (Milner and Wright, 1998). The factors considered here are related to international competitiveness. The productivity will

[5] Hallak (2003, 2005) uses a modified version of the Fisher index to calculate the average quantity index.

also be adjusted to account for relevant time invariant variables, that is, country's characteristics, like natural resources, land partition, soil degradation… By including countries specificities, we control for possible differences in target output among countries of different characteristics. This makes it possible to evaluate productivity differences associated with countries of different characteristics.

Following Bigsten et al. (2004) and Okada (2005) we assume that productivity depends on countries characteristics and international competitiveness in the subsequent log form:

$$5)\quad Log(A_{kit}) = \alpha\, comp_{kit} + \mu S_i + \omega_{ki}$$

Where $comp_{kit}$ is a measure of international competition, S_i are variables associated with countries characteristics and ω_{ki} are unobserved country specific factors.

International competition is conventionally measured by market share, which is defined in the empirical literature as a function of products quality, outputs variety and trade barriers as following:

$$6)\quad \begin{aligned} &Log(mshare_{kit}) = \alpha_1 Log(quality_{kit}) + \alpha_2\, Log(variety_{kit}) + \\ &\alpha_4 Log(dist_i) + \alpha_4 Log(Tariff_{ki}) + \xi_{ki} \end{aligned}$$

Where *quality* is product quality, *variety* is the number of varieties, *dist* is the average geographic distance between exporting countries and destination markets introduced as a proxy for transport and transaction costs, *tariff* are custom duties.

We can investigate the direct impact of product quality on productivity by replacing (6) in (5).

By extending the production function defined in equation (4) to include adjustment dynamics and substituting productivity by its expression in (5) we obtain the log linear model:

$$7)\quad \begin{aligned} &Log(y_{kit}) = \alpha_0 + \lambda Log(y_{kit-1}) + (1-\lambda)\beta_K Log(K_{kit}) + \\ &(1-\lambda)\beta_N Log(N_{kit}) + (1-\lambda)\beta_L Log(L_{kit}) + (1-\lambda)\beta_W Log(W_{kit}) + \\ &(1-\lambda)\beta_F Log(F_{kit}) + \ddot{a} Log(quality_{kit}) + \c{c}\, Log(\text{var}iety_{kit}) + \\ &\varphi Log(dist_i) + \varpi Log(Tariff_{ki}) + \grave{\imath} S_i + \psi_{ki} + v_{kit} \end{aligned}$$

v_{kit} captures all other shocks to country productivity, and is supposed to be serially uncorrelated. Absence of serial correlation is assisted by the inclusion of dynamics in the form of a lagged dependent variable. This dynamic form represents also a simple way of capturing the adjustment process associated with an increase of inputs, as expanding production factors require time for these factors to become fully operational and therefore for output to reach its new long-run level. The adjustment costs associated with inputs variations can be captured empirically through the parameter λ[6] (Nickell et al., 1992; Nickell, 1996). An instantaneous adjustment of output to inputs gives λ=1. The long-term input elasticities can be obtained from (7) by dividing factor elasticities by (1-λ).

[6] The output is adjusted to its optimal level y* as $(\frac{y_{it}}{y_{it-1}})^* = (\frac{y_{it}}{y_{it-1}})^{\lambda}$

4. Data and estimation methods

4.1. Data

In this study the empirical application considers panel data at the national level for agricultural productions in nine south Mediterranean countries involved in the partnership agreements with the EU such as: Algeria, Egypt, Israel, Jordan, Lebanon, Morocco, Syria, Tunisia and Turkey; and five EU Mediterranean countries presenting a strong potential in agricultural production as: France, Greece, Italy, Portugal and Spain for the period 1990-2005. The data used come from the FAO (FAOSTAT), World Bank, AOAD, Eurostat, CEPII and AMAD databases as well as from the different reports of the FEMISE and the ESCWA. Our data set includes observations on the main crops grown in these countries, inputs use, determinants of market competition and countries characteristics. The model includes some non observable explanatory variables; we approximate these variables by available proxies. The variables used in the empirical analysis are summarized as follows:

Output and input: we consider five aggregate product categories: fruits (apricots, dates, figs, peaches and nectarines, pears, apples, plums, grapes, almonds, peanuts, hazelnuts, pistachios), citrus fruits (lemons, oranges, tangerines, other citrus fruits), vegetables (artichokes, carrots, cucumbers and pickles, strawberries, watermelons and melons, pepper, potatoes, tomatoes), cereals (rice, wheat, maize, barley) and pulses (beans, peas, chick-peas, lentils, vetches). Inputs are classified into four groups: cropland, irrigation water, fertilizers, labor and machines. The data for the input use by crop for each country are constructed according to the information collected from recently published reports by FAO, FEMISE, ESCWA and the Ministries of Agriculture in the considered countries. Table A1 in the appendix presents summary statistics on the sample.

Determinants of market competition: these variables include products quality, products variety and trade barriers. Product quality indexes are constructed from equation (3) in section II, using the trade data from the FAO database. Quality indexes are summarised in table A3 in the appendix.

Output variety was assimilated to the linear combination of two factors:

$$variety_{kit} \approx \eta Log(spe_{kit}) + \kappa Log(spread_{kit})$$

$$\text{Where: } spe_{ki} = \left[\frac{\frac{X_{ki}}{X_{.i}}}{\prod_{i'\neq i}\left(\frac{X_{ki'}}{X_{.i'}}\right)^{a_{ki'j}}}\right]$$

is an indicator of relative specialisation, representing the share of exports of product k in the total exports of country i compared to the weighted average of the same ratio calculated for its main competitors (Crozet and Erkel-Rousse, 2000; Erkel-Rousse and Le Gallo, 2002).

$$spread_{ki} = \left[\frac{\sqrt{\sum_{k=1}^{cl} (X_{ki.} - \overline{X}_{cli.})^2}}{N(\overline{X}_{cli.})} \right]$$

captures the degree of product diversification; it calculates for each country the distribution of export products compared to the average export value. Where $X_{ki.}$ is the country's i exports of product k, $X_{.i.}$ is the country i total exports, $a_{ki'}$ the market share of country i' for product k, $\overline{X}_{cli.}$: the country i average exports in the category cl and N the number of products in category cl.

Trade barriers are evaluated by trade costs and customs duties. Trade costs are approximated by the weighted average of the geographic distance between the exporting country and destination markets. Tariff barriers represent an aggregate measure of *ad valorem* tariffs and entry prices imposed on each product category and exporting country. The data used come from the FEMISE and the ESCWA reports and the CEPII and AMAD databases.

Country characteristics: we use variables on the agricultural productive capacity of each country such as water resources; environmental variables as part of agricultural area incurring severe and very severe degradation; and land fragmentation evaluated by the part of farms having an area under five ha. Country statistics are summarized in table A2 in the appendix.

2. Estimation method

Our dynamic model specified in equation (7) is characterised by the presence of the lagged dependent variable in addition to time-variant and time-invariant variables among the regressors. Since the lagged dependent variable is correlated with the disturbance term, it needs to be instrumented in order to obtain consistent estimates. This renders the classical estimators using panel data, that is within and random effect estimators, biased and inconsistent (Baltagi, 1995). The widely used estimator in this context is obtained by generalised method of moments (GMM) after first differencing to eliminate the correlated country specific effects. Lagged levels of are used as instruments for equations in first differences (Arellano and Bond, 1991). The first difference transformation wipes out the time-invariant variables, consequently we can not identify the effects of countries characteristics. More recently, Arellano and Bover (1995) and Blundell and Bond (1998) have shown that, under further and quite reasonable conditions relating to the properties of the initial condition process, there are additional moment conditions that are available for equations in levels. Exploiting these extra moment restrictions offers efficiency gains (Blundell and Bond, 1998) and allows for controlling time invariant variables in estimating production function. These restrictions imply that values of the dependent variable lagged two or more periods are valid instruments in the first differenced equations. Blundell and Bond (1998) propose a system estimator which uses: first differences as instruments for levels as well as the usual levels as instruments for first differences.

In addition, we can exploit the exogeneity or the predeterminess assumptions about some or all of the explanatory variables outside the lagged dependent variable (Arellano and Bond, 1991). The GMM techniques also enable us to tackle with the endogeneity of some explanatory variables as the output quality index.

To summarize, this implies a set of moment conditions relating to the equations in first differences and a set of moment conditions relating to the equations in levels, which need to be combined to obtain more efficient GMM estimator. This linear GMM estimator obtained on a system is more efficient than the one obtained from the standard first-differenced model. The primary virtue of the system GMM estimator in the context of productivity estimation, is that it allows the presence of time-invariant regressors. The validity of orthogonality conditions is tested by the Sargan test based on the two-step GMM estimator (Arellano and Bond, 1991)[7].

5. Empirical results

We estimate the dynamic model specified in equations (7) which allows for specific effects to control for time-invariant country unobservable characteristics by the generalised method of moment (GMM) as suggested by Blundell and Bond (1998, 2000), without assuming any distribution for the error terms, taking into consideration the dynamic form and the presence of variables that are invariants over time.

5.1. Specification tests

We achieved different groups of estimations. We started with appraising results from the C-D production function using the pooled products data, stacking the product categories in one model. We estimated then the model for each group of outputs. Table 1 reports the estimation results of the dynamic production function defined by equation (7) in the pooled products case and estimated by the system generalized method of moment (GMM). The results by product category are described in table A4 in the appendix. Since it is known that the coefficient on lagged output will be biased in the presence of fixed effects, we use the GMM procedure suggested by Blundell and Bond (1998). The first column reports the results for the five product categories pooled, the second reports the results after the introduction of product categories dummies to take account of the product heterogeneity. The test of the hypothesis $\lambda=1$[8] that there is no difference between target and actual production, or that the adjustment costs are null, is rejected at the 5% lev-

[7] The statistic used, $S = (\hat{u}^+)'Z^+\left[\sum_{i=1}^{N} Z_i^{+\prime}(\hat{u}_i^+)(\hat{u}_i^+)Z_i^{+\prime}(\hat{u}^+)\right]^{-1} Z^{+\prime}(\hat{u}^+)$ is distributed as a chi square with (m-k-1) degree of freedom under the null hypothesis of the validity of instruments.

[8] For testing this hypothesis, a Student test of significativity of the coefficient associated to the lagged variable, that is (1-λ), is sufficient.

el of significance for the different specifications.

The validity of the instrument set is checked using a Sargan test. This is asymptotically distributed as chi-squared under the null hypothesis. The instruments used in the system GMM are not rejected by the Sargan test of over-identifying. Tests of no serial correlation in the v_{kit} (M_1 and M_2) provide evidence to suggest that this assumption of serially uncorrelated errors is appropriate in the dynamic model as is shown in the different columns[9]. We note that the dynamic production equations perform well in conventional statistical terms with no second order serial correlation and with a Sargan test for instrumental validity indicating that the instrument set and the residuals are not correlated. However, the test of no serial correlation of residuals is rejected if we estimate the static model. This indicates that the presence of misspecification may be due to the omission of the lagged dependent variable. The difference between the results of the static model[10] and the dynamic one are not negligible. The estimated values of coefficients estimates are different and are more precise when costly adjustment of product is accounted for in the model.

5.2. Interpretations

As regards the production equation, we obtain fairly reasonable estimates. The input elasticities are globally positive and significant at 5% level. Table 1 shows that water, cropland and labour have globally the largest values, indicating that the increase of Mediterranean agricultural productions depends mainly on these inputs. Fertilizers have a on limited effect in the production of selected crops. The fertilizer elasticity is weak and rarely significant, this may be explained by the fact that the selected crops are not very intensive in fertilizers moreover several farmers in south Mediterranean countries use fertilizers as complementary factor to organic manure which is much less expensive. It appears from table A4 that water is the most important factor in citrus fruits and vegetables productions, these crops being highly water intensive. The production function estimates indicate also the relative importance of labour in vegetables production. Land seems the most important factor of production for cereals with an elasticity of 0.584; being consistent with the fact that this commodity requires large agricultural plots.

The coefficient on the lagged dependent variable is of 0.22 for the pooled products case and is strongly significant. The speed of adjustment is of 0.78, which means that countries adjust 78 percent of their deviations from the production optimality in one year. This confirms the fact that production takes some time to reach its optimal level which is consistent with the existence of adjustment costs.

Concerning the market competition factors effects on productivity, the results show a significant positive impact of product quality on productivity. The estimated elasticity of quality is of 0.29 in table 1 and is significantly different from zero at 1% level. This is consistent with the hypothesis of a positive link between product quality and productive efficiency. Table A4 reveals that quality enhances productivity growth for vegetables, fruits and citrus productions. The impact of quality on cereals and pulses is however negligible and non significant. This result may be explained by the agricultural strategy adopted in SMC which is mainly oriented towards promoting vegetables, citrus and fruits productions considered as high value export goods and which mobilize an important fraction of fertile lands and irrigation water, whereas pulses and cereals are mostly planted in rain-fed areas and use traditional production methods.

The impact of specialization on productivity was not captured by the model. The estimated elasticity is negative and not statistically significant. This may be explained by the collinearity between the quality and the specialization indexes. The results show however that an increase in product dispersion affects negatively productivity. An important dispersion of the varieties in a same group may prevent an efficient management of the resources and impedes productivity growth. The results reveal also that agricultural productivity in Mediterranean countries is highly constrained by tariff barriers and trade costs. South Mediterranean agricultural products and mainly fruits and vegetables are currently submitted to high custom duties especially during the growing season in EU countries, it appears from tables 1 and A4 that tariff removals may substantially enhance productivity incentives for agricultural products and mainly for vegetables, citrus and fruits.

The negative effect of the distance on the agricultural productivity ensues from the fact that agricultural products are strongly perishable and require an important conditioning and developed structures of merchandising and transport guaranteeing the preservation of the product quality and the speed of deliveries. This generates costs as much elevated as the distance with markets of destination is important, which therefore affects negatively export and productivity.

The estimation of the system (first differences and levels equations) has made the identification of time invariant variables effects possible. The country specific variables are often found to be significantly different from zero. It appears from the results that land fragmentation is negatively correlated with productivity. This negative impact is particularly important for cereals production. Land fragmentation may lead to sub-optimal usage of factor inputs due to inadequate monitoring, the inability to use certain types of machines, and wasted space among borders[11]. A high percentage of land fragmentation may also reflect the existence of an important number of small farms with limited financial

[9] These tests statistics, distributed normally under the null of no serial correlation, are calculated and presented in tables 1 and A4.
[10] To save space, the results of this estimation work are not reported.
[11] A recent study conducted by Raghbendra, Nagarajan and Prasanna, (2005) in southern India, showed that land fragmentation impacts significantly negatively production efficiency.

resources, low skills and inefficient traditional production methods.

The negative impact of soil degradation on agricultural productivity is depicted from the estimation results. This effect is however significantly negative in the stacked product estimation and rarely significant in product categories results.

The relative importance of water resources for Mediterranean agricultural productivity is also captured by the model. Considering that irrigation is the major land – quality augmenting input, an increase in water availability may improve the quality of existing land by raising yield per hectare and enhancing productivity.

Table 1: *GMM System Estimates (first differenced and level equations) for all product categories*

Variables	**Model without product categories dummies**	**Model with five product categories dummies**
Lagged production	0.561** (38.48)	0.227** (12.92)
Inputs		
Land	0.394** (11.23)	0.316** (3.15)
Capital	0.210* (2.08)	0.159** (2.48)
Labour	0.166* (4.05)	0.480** (6.29)
Fertiliser	0.162 (1.02)	0.118* (1.68)
Water	0.300** (6.94)	0.269** (4.99)
Market competition factors		
Quality	0.375** (16.65)	0.287** (10.86)
Specialization	-0.0074** (-4.97)	0.0017 (1.09)
Spread	-0.533** (-11.63)	-0.205** (-4.97)
Distance	- 0.69** (- 8.57)	-0.15** (-3.56)
Tariffs	-1.793** (-7.61)	-0.545* (-2.33)
Country characteristics		
Land partition	-0.518* (-2.23)	-1.174** (-3.90)
Water resources	0.016** (4.73)	0.025** (4.39)
Degradation	-0.329** (-3.33)	-0.435** (-3.36)
M1:1st order serial correlation	z = -4.42 p = 0.000	Z= -4.13 p = 0.000
M2: 2nd order serial correlation	z = 1.30 p = 0.193	z = 0.65 p = 0.515
Sargan instrumental validity test (degrees of freedom are in parentheses)	Chi2(111) = 74.30 p= 0.997	chi2(106) = 65.77 p = 0.999
No. of observations	1260	1260

Note: *the dependent variable is Log of output. Numbers in (.) are t-statistics. The significance at 5% and 1% levels is indicated by * and ** respectively.*

6. Concluding remarks

A great attention has been devoted to investigating the relationship between international trade and productivity in the recent empirical literature. The estimation of trade openness on productivity growth has been frequently associated with competition, export variety and specialization. Despite the relevance of product quality in international trade patterns underlined in recent works, little attention was devoted to investigating the impact of product quality on productivity gains. Moreover, the existing analyses of international trade and productivity restricted their attention to the manufacturing sector; few studies have been applied to agriculture.

In this paper we have attempted to examine the relationship between trade openness and productivity in the Mediterranean countries agricultural sector. Our study basically focused on analyzing the effects of exports quality on productivity growth at the aggregate farming sector, using a panel of advanced and developing Mediterranean countries involved in the process of global market liberalization.

The impact of quality on productivity is evaluated through the estimation of a dynamic production function by the G-MM estimator. We expanded the model with a range of countries specific characteristics and competitive conditions such as trade barriers and exports varieties. The estimation results are globally significant at 5% level. The empirical findings suggest that trade openness may enhance agricultural productivity growth. The hypothesis that higher quality products would induce productivity gains is verified by the model. The elasticity estimates of quality indexes are relatively important for vegetables, fruits and citrus. As these commodities are considered like high value exports, SMC had embarked on policies aiming to promote these products by allocating them an important part of their scarce resources as water and fertile lands. Quality elasticity estimates are however weak and non significant for cereals and pluses. These products being mainly planted in rain-fed areas and using traditional production methods are characterized by their low quality and their weak productivity. The empirical findings provided here raise the issue that with trade liberalization and exposure of Mediterranean agricultural products to the fierce international competition, countries endowed with relatively limited arable lands and water resources as Tunisia, Jordan, Israel and Lebanon could compete with those offering similar products like Spain, Turkey, France and Morocco through their comparative advantage in their product quality. One way for getting growth for these countries rests in promoting the quality of their productions through the modernization of their agricultural sector and the reallocation of their scarce resources and high skill factors towards their advantaged activities. Producing higher quality products without greatly increasing their production costs may be ensured by improving their efficiency and their productivity performances.

The analysis highlighted also the negative impact of trade barriers on productivity. The important customs duties imposed on the South Mediterranean agricultural exports and the substantial transport costs supported by the producers, hinder their competitiveness and impede their productivity. The results suggest that opening the agricultural sector to international trade occurring through dropping the tariff barriers and that improving the merchandising structures and the distribution chains in view of reducing the transport costs, may provide a significant positive contribution to productivity growth.

The present study may help shed some light on the effects of agricultural liberalization on the Mediterranean farming sector. It is important to underline that without trying to quantify the effects of trade openness, what would require a deep investigation of the economic situation of the concerned countries, our analysis attempts to give some indications permitting to distinguish the potential for these countries to reap the benefits of a free trade policy. It appears from the analysis that the lack of competition reduces the pressures on the economies to improve their productivity performances. Exposure to international trade of countries with limited resources as Tunisia, Jordan, Israel and Lebanon may be particular profitable in terms of growth opportunities. To survive the competitive process, these countries should however undertake some restructuring policies aiming mainly to promoting their product quality and ameliorating their environmental conditions notably through reducing the agricultural land fragmentation, developing the structures for mobilizing water resources and limiting the soil degradation.

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Appendix

Table A1. *Some summary statistics per country*

Production	Fruits		Citrus		Shell Fruits		Vegetables		Cereals		Pulses	
1000 Mt	**Mean**	**S. Dev**	**Mean**	**S. Dev**	**Mean**	**S. Dev**	**Mean**	**S. Dev**	**Mean**	**S. Dev**	**Mean**	**S. Dev**
Algeria	1157	229	418	94	28	7	2779	526	2490	1297	46	13
Spain	12744	2645	5305	537	271	51	10030	527	17992	3608	335	133
France	10654	1006	28	3	10	2	7933	641	58823	5401	2746	705
Greece	4758	453	1216	135	66	9	3923	260	4793	396	43	4
Italy	17135	1377	2985	381	218	21	10495	825	19572	1369	154	43
Portual	1802	294	278	51	17	7	2429	158	1333	154	30	9
Israel	395	42	811	275	28	3	1338	274	255	70	11	3
Jordan	348	360	146	30	2	1	663	94	91	35	6	2
Lebanon	649	109	352	54	32	7	844	119	107	28	25	11
Morocco	1518	156	1249	173	94	24	2923	577	5576	2750	235	93
Syria	1585	290	589	151	120	56	1586	405	4993	1199	222	68
Tunisia	1309	419	266	33	47	11	1596	323	1618	697	77	19
Turkey	9147	680	2005	378	631	99	19699	2654	30131	2080	1691	233
Egypt	3049	849	2399	280	123	69	10501	2808	16835	2764	488	53

Cropland	Fruits		Citrus		Shell Fruits		Vegetables		Cereals		Pulses	
1000 ha	**Mean**	**S. Dev**	**Mean**	**S. Dev**	**Mean**	**S. Dev**	**Mean**	**S. Dev**	**Mean**	**S. Dev**	**Mean**	**S. Dev**
Algeria	485	80	44	7	31	9	197	18	2374	837	85	17
Spain	4156	365	272	23	648	28	315	70	6195	427	464	140
France	1044	36	2	0	4	0	211	14	8422	334	580	115
Greece	1011	25	66	28	45	9	119	5	1265	72	27	3
Italy	2442	74	177	4	169	13	319	17	3984	164	97	27
Portual	775	25	27	1	41	2	159	177	461	79	53	17
Israel	43	6	27	5	6	0	36	4	92	12	7	1
Jordan	70	10	7	1	0	0	18	2	73	34	7	3
Lebanon	103	3	15	2	7	2	30	4	46	13	14	5
Morocco	787	82	76	2	148	14	117	9	5265	509	397	52
Syria	630	47	26	2	38	7	82	12	3369	316	260	38
Tunisia	1815	158	23	3	237	55	100	9	1195	419	111	25
Turkey	1854	52	84	8	416	25	797	477	13582	185	1771	246
Egypt	244	57	135	7	45	18	370	50	2478	156	172	16

Source: FAOSTAT

Table A2. *Countries characteristics*

	Water Resources in Km3	Soil degradation [1]	Land Fragmentation [2]
Algeria	14.3	21%	48.0%
Spain	111.5	38%	42.0%
France	203.7	9%	17.0%
Greece	74.3	48%	48.0%
Italy	191.3	28%	56.0%
Portual	68.7	21%	49.0%
Israel	1.7	6%	58.0%
Jordan	0.9	31%	56.0%
Lebanon	4.4	25%	53.0%
Morocco	29.0	14%	71.0%
Syria	26.3	60%	43.0%
Tunisia	4.6	79%	53.0%
Turkey	229.3	89%	39.0%
Egypt	58.3	9%	45.0%

Source: FAOSTAT and World Bank databases.
1 Part of agricultural area incurring severe and very severe degradation in %.
2 Part of farms having an area under five hectares in %.

Table A3. *Quality indexes*

	FRUITS	CITRUS	VEGETABLES	CEREALS	PULSES
ALGERIA	0.659	0.630	0.646	0.318	0.226
SPAIN	0.841	1.013	1.014	0.367	0.689
FRANCE	0.942	0.770	0.671	0.347	0.217
GREECE	0.678	0.654	0.541	0.433	0.882
ITALY	0.844	0.933	0.868	0.448	1.050
PORTUGAL	0.690	0.650	0.915	0.290	0.753
ISRAEL	1.318	0.750	0.950	0.420	0.912
JORDAN	0.423	0.579	0.255	0.464	0.264
LEBANON	0.258	0.322	0.264	0.281	0.718
MOROCCO	0.855	0.733	0.489	0.458	0.537
SYRIA	0.644	1.172	0.610	0.339	0.584
TUNISIA	0.741	0.851	0.814	0.409	0.462
TURKEY	0.435	0.689	0.378	0.318	0.519
EGYPT	0.224	0.553	0.371	0.463	0.522

Source: Authors' calculations

Table A4. *System gmm estimates (system of first differenced and level equations) for the different categories*

Variables	Fruits	Citrus	Cereals	Vegetables	Pulses
Lagged production	0.549** (9.44)	0.561 (6.2)**	0.018 (0.34)	0.874 (25.92)**	0.479 (7.62)**
Inputs					
Land	0.158 ** (3.52)	0.326 (3.76)**	0.584 (6.05)**	0.077 (2.81)*	0.185 (1.81)*
Capital	0.106* (2.01)	0.08 (1.21)	0.129 (1.94)*	0.056 (2.16)*	0.111 (2.32)*
Labour	0.17* (2.49)	0.132 (2.82)*	0.012 (0.27)	0.188 (2.10)*	(0.156) (0.60)
Fertiliser	0.12* (2.38)	0.0782 (2.01)*	0.107 (2.05)*	0.016 (1.21)	0.125 (2.66)*
Water	0.176** (3.89)	0.299 (3.41)**	0.288 (4.12)**	0.311 (4.78)**	0.123 (1.50)
Market competition factors					
Quality	0.195* (2.96)	0.15* (2.22)	0.0018 (0.04)	0.297* (2.01)	0.055 (0.60)
Specialization	0.016 (1.07)	0.044 (1.07)	0.0137 (1.07)	0.006 (0.80)	-0.0009 (-0.66)
Spread	-0.204** (-3.09)	-0.0023 (-0.03)	0.106 (0.81)	0.014 (0.51)	0.312* (1.87)
Distance	-0.304* (-2.63)	-0.047** (-3.16)	-0.044* (-2.95)	-0.269** (-3.36)	-0.137* (-2.38)
Tariffs	-0.899* (-1.9)	-1.216* (-2.23)	-0.164 (-0.47)	-0.284* (-2.86)	-0.278 (-1.23)
Country characteristics					
Land partition	-0.024 (-0.11)	0.316 (0.59)	-1.075784 (-4.41)**	-0.1461364 (-1.27)	-1.695 (-4.80)**
Water resources	0.00326** (4.91)	0.0049* (3.06)	0.002** (3.18)	0.0006* (2.19)	0.01 (1.39)
Degradation	-0.192 (-0.94)	0.282 (1.16)	0.0064 (0.06)	-0.077* (-1.94)	-0.2 (-1.46)
M1:1st order serial correlation	z = -7.25 p= 0.000	z = -6.67 p = 0.000	z = -6.17 p = 0.000	z = -6.80 p = 0.000	z = -10.13 p = 0.000
M2: 2nd order serial correlation	z = 1.09 Pr > z = 0.275	z = 0.46 p = 0.648	z = 1.46 Pr > z = 0.146	z = 0.10 p = 0.922	z = 0.75 p = 0.454
Sargan instrumental validity test (degrees of freedom are in parentheses)	chi2(198) = 194.57 Prob > chi2 = 0.556	chi2(81) = 77.09 p = 0.602	chi2(164) = 162.84 p = 0.511	Chi2(197) = 177.06 p = 0.843	chi2(171) = 172.79 p = 0.447
No. of observations	210	210	210	210	210

Note: the dependent variable is Log of output. Numbers in (.) are t-statistics. The significance at 5% and 1% levels is indicated by * and ** respectively.