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Sarantis Kalyvitis

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Economic Analysis and Research Department – Special Studies Division
21, E. Venizelos Avenue
GR-102 50 Athens
Tel: +30210-320 3610
Fax: +30210-320 2432

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WHO EXPORTS HIGH-QUALITY PRODUCTS? SOME EMPIRICAL REGULARITIES FROM GREEK EXPORTING FIRMS

Sarantis Kalyvitis
Athens University of Economics and Business

Abstract

This study assesses the quality of Greek exports and links the estimates with exporters' characteristics. Export quality in manufacturing is estimated to have fallen by 1% per year on average for the period 1998-2010, but recovered in 2011 and 2012 when export quality displayed a cumulative rise of 25.7%, yielding a cumulative rise of 9.2% for the entire period 1998-2012. Export quality in agriculture displays a slightly upward trend with the average annual rise over the period 1998-2012 amounting to 1.6%. Linking the quality estimates at the product level with exporting firms in the manufacturing sector shows that higher product quality is associated with firms that have a higher share of their wage bill paid to skilled workers. This positive relationship stems from firms with higher skilled to unskilled employment ratios, rather than higher wage skill premia, and is more pronounced in large and rich destinations.

Keywords: international trade, firm exporting, product quality

JEL classification: F14, L15, L25, J31.

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Correspondence:
Sarantis Kalyvitis
Athens University of Economics and Business
Patision Str. 76,
Athens 10434 Greece
e-mail: skalyvitis@aueb.gr

1. Introduction

A number of recent studies have pointed out the importance of the *quality* of goods produced and exported for economic outcomes. In particular, product quality is a key feature that affects both how countries specialize in production and the direction of trade between countries, as higher-quality varieties of existing products help build on existing comparative advantages to boost productivity and export revenues (see, among others, Schott, 2004; Hallak, 2006; Hausmann et al., 2007; Sutton and Trefler, 2011). Hummels and Klenow (2005) infer quality by adopting the premise that if large exporters systematically sell high quantities at high prices, this is consistent with these exporters producing higher-quality goods, and show that richer countries export higher quality goods at modestly higher prices. Fontagné et al. (2008) report that, on average, Japanese unit values are 2.9 times higher than for China, for the same products, shipped to the same markets, within the same year. They analyze unit prices of HS 6-digit products for 200 countries and find that the products of developed countries are not directly competing with those of developing countries. Crozet et al. (2012) obtain direct measures of quality for one industry and show that firms with higher measured quality have a higher ratio of consumer benefits to producer costs and are more likely to export higher quantities at higher prices.

As pointed out by Harrigan et al. (2015), these stylized facts are broadly supportive of models where consumers value quality, but quality is expensive to produce. Consumers choose goods on the basis of "quality-adjusted" prices and are willing to pay a higher price for an expensive, high-quality good. In turn, the marginal firm sells low-quality goods at a low price. Market entrants charge lower prices and thus *average* unit value in a market will fall. When markets differ in their level of competition, more entry implies lower average prices in less competitive markets. Yet a simple comparison of average nominal prices across markets will have misleading implications, since the quality-adjusted price index can be lower when the average nominal price is higher. Johnson (2012) checks if quality is "homogeneous" (meaning there is no difference in quality and thus firms compete only on price) or heterogeneous (meaning quality varies and thus firms compete on quality-adjusted price), and shows that heterogeneous quality is dominant.

The present study provides new elements to understand the relation between export quality and firm characteristics by investigating whether key attributes at the firm level are related to the estimated quality of exported products. To this end, I obtain a measure of the quality of Greek exports at the product level based on a modified version of the rationale

followed by Khandelwal (2010) for US imports, who develops an estimation strategy that utilizes both unit value and quantity information to infer quality and has a straightforward intuition extensively used in the industrial organization literature: "*conditional on price, [...] higher market shares are assigned higher quality*" (Khandelwal, p. 1451). The measure of export quality is based here on the choice of 'consumers' (destinations) between alternative varieties within an exported Greek product category, after controlling for differences in price. Hence, it largely avoids the shortcomings of using unit values to proxy quality.[1] I use disaggregated trade data covering the period 1998-2012 to obtain the quality of Greek exports based on estimated regressions for 71 manufacturing and 13 agricultural products. Export quality in manufacturing is estimated to have fallen by 1% per year on average for the period 1998-2010, but recovered in 2011 and 2012 when it displayed a cumulative rise of 25.7%, yielding a cumulative rise of 9.2% for the entire period 1998-2012. An important finding is that export quality at the sectoral level in manufacturing reveals substantial heterogeneity, which indicates that there are differential dynamics among products. On the other hand, export quality in agriculture displays a slightly upward trend with the average annual rise over the period 1998-2012 amounting to 1.6%. The estimates show that substantial changes in export quality have occurred over this period, both at the aggregated and disaggregated product levels.

To get then a sense of how closely the quality estimates of exports at the product level are related to the characteristics of exporting firms, I examine how product quality in the manufacturing sector is correlated with the key characteristics of exporting firms, like employment, wages, R&D and other types of outlays. I find that firms with higher wage-bill skill premia (higher wage bill ratios of skilled to unskilled labor) export higher-quality products. When the wage-bill skill premia are decomposed into the skilled to unskilled employment ratios and the wage-rate skill premia, I find that firms with more skilled relative to unskilled labor export higher-quality products, whereas there is no correlation with skill premium based on the wage rate. When I look at the interaction of these variables with destinations characteristics, I find that the positive correlations between the wage bill ratio and the ratio of skilled to unskilled workers with product quality are mainly driven by large and rich destinations.

These findings are consistent with the idea that there is a 'quality sorting' of firms across destinations based on the use of their labor inputs and expenses that are, directly or indirectly, related to firm exporting. The estimated correlations could be largely explained by

[1] See section 2 for a more detailed survey of related empirical literature.

unobservable differences in the quality of inputs, which are in turn reflected in output quality as in Kugler and Verhoogen (2012). There are various reasons why quality in exporting may demand relatively more skilled employment. For instance, international marketing and commercialization, transportation and distribution, advertising require expertise in international businesses, languages, foreign technologies, and in the social idiosyncrasies of foreign markets. Verhoogen (2008) develops a model where exporting allows for quality upgrading and skill-intensive services, a channel that might be particularly relevant if it involves accessing high-income destinations with higher valuation for quality (Brambilla et al., 2012). In a related vein, exporting may require varying levels of skills due to "skilled-bias globalization", in which international trade activities use skill-intensive resources (Matsuyama, 2007). Consistent with the quality interpretation, Atkin et al. (2015) point out that larger firms have greater costs primarily because they use higher-quality, more costly inputs, which is also corroborated by the additional finding that older -and typically larger- Greek firms with higher export intensity are associated with higher product quality.

The results also extend the well-known in the international trade literature that examines how export unit values (prices) vary with destination characteristics, like size, income per capita and distance. Schott (2004, 2008) has documented a large difference in product prices within the most disaggregated level of product classification and that US consumers pay less for similar goods that are "Made in China" than for those "Made in OECD". Manova and Zhang (2012) establish that Chinese export prices are higher in richer and larger destinations, and support the empirical relevance of trade models with endogenous product quality. Bastos and Silva (2010) and Baldwin and Harrigan (2011) find that export unit values within products increase systematically with distance, tend to be higher in shipments to richer nations and are negatively related to market size. In line with the findings presented here, their estimated relationships also reflect a 'quality sorting' of heterogeneous firms across markets: within product categories, higher-productivity firms tend to ship greater quantities at higher prices to a given destination, consistent with higher quality. I stress that the estimated correlations are identified across firms within products and the fact that highly productive, skill-intensive firms export higher-quality products corroborates and extends the aforementioned evidence in the micro-exporting literature on the important quality variations across firms.

The rest of the study is structured as follows. Section 2 reviews the related empirical literature on the quality of exports and derives the quality estimates of Greek exports. Section 3

links the quality estimates at the product level with key characteristics of exporting firms and section 4 draws the main conclusions.

2. Estimating the quality of Greek exports

2.1. Related empirical literature

The importance of export quality in analyzing the determinants of trade flows sparked an interest in estimating export quality. The main challenge faced by this literature is that product quality is unobserved. Research in the international trade literature has attempted to exploit the availability of trade data at a highly disaggregated level for many countries and has used readily observable prices (or unit values), defined as the ratio of export value over quantity for a given product category, as a proxy for export quality. However, this strategy is not viable to study the relationship between quality and firm characteristics, because unit values suffer from several shortcomings generated by differences in the composition of goods, their production costs, or pricing strategies within a given product category across exporters. If, for instance, exporters that use lower-cost inputs are systematically less productive than competitors they will sell more expensive varieties, by measuring relative quality with relative prices we may wrongly attribute to lower-cost inputs a positive effect on output quality. Moreover, standard supply or demand shocks will affect equilibrium prices, and hence unit values, without necessarily affecting product quality. Indeed, some recent papers, which have developed strategies for quality estimation using explicit microeconomic foundations, have established that observed unit values can be a poor approximation for export quality (Khandelwal, 2010; Hallak and Schott, 2011; Henn et al., 2013; Feenstra and Romalis, 2014).

In the context of a cross-country setup, Hallak and Schott (2011) rely on trade balances to identify quality: holding observed export prices constant, countries with trade surpluses are inferred to offer higher quality than countries running trade deficits. Consumers are assumed to care about price relative to quality in choosing among products and hence two countries with the same export prices but different global trade balances must have products with different levels of quality. Among countries with identical export prices, the country with the higher trade balance is revealed to possess higher product quality. This procedure requires extensive data on tariffs, which is unavailable even for many relatively large countries before 1989. Feenstra and Romalis (2014) exploit supply-side features of trade data to decompose available unit values of internationally traded goods into quality and quality-adjusted price

components using an endogenous quality decision. Based on two different unit-value observations for each product, derived from import and export data, they are able to aggregate individual products to industry-level indexes of export quality and prices covering the period 1984-2011. Vandenbussche (2014) develops an export quality indicator based on Di Comité et al. (2014), which disentangles quality from cost and taste effects, to generate quality ranks of EU manufacturing products at the CN8 level over the period 2007-2011. His rankings suggest that quality upgrading results in a higher willingness to pay by consumers and therefore offers a way to escape cost competition.

In terms of country time-series estimates of export quality, Henn et al. (2013) use reduced-form quality-augmented gravity equations based on Hallak (2006), to estimate export quality indices for 178 countries covering the period 1962-2010 at the product and aggregate levels. In a single-country setup Khandelwal (2010) exploits price and quantity information to estimate the quality of US imports, where higher quality is assigned to products with higher market shares conditional on price. He finds that the estimated qualities reveal substantial heterogeneity in product markets' scope for quality differentiation ("quality ladders") and that markets characterized by relatively short quality ladders are associated with larger employment and output declines resulting from low-wage competition.

2.2. The empirical model for the quality of Greek exports

The empirical identification of export quality relies on the assumption that, conditional on export price, $price_{hd}$, measured by the unit values of variety h (captured by their CN8 classification), shipped to destination d, varieties with higher shares in export markets at the product level (captured by their Standard International Trade Classification; henceforth SITC) are assigned higher quality. To assess product quality the following specification is estimated:

$$\ln(S_{hdt}) = a \times \ln(price_{hdt}) + \beta \times \ln(pop_{dt}) + \gamma \times \ln(NS_{hdt}) + \lambda_{1,h} + \lambda_{2,t} + \lambda_{3,ht} \quad (1)$$

where S_{hdt} denotes the share of shipments of variety h to destination d in aggregate shipments of product p (e.g. cotton shirts exported to Germany relative to total Greek exports of shirts) at time t, and NS_{hdt} denotes the 'nested' share of variety's h shipments to destination d in aggregate shipments of variety h (e.g. cotton shirts exported to Germany relative to total Greek exports of cotton shirts) at time t. Both S_{hd} and NS_{hd} are measured in terms of quantities. Notice that a larger market share of a product may reflect that exports include more 'hidden' variables, due to the aggregation of more finely classified products that

are unobserved (Khandelwal, 2010). Suppose that exports to Germany and the Netherlands split the market of Greek exports in shirts equally at a non-observed disaggregation level (e.g. colour of shirts), yet exports to Germany are larger as they include more colours. Aggregation to the observed level (shirts) would assign a larger market share at identical prices to Germany and yield an upwards biased estimate of quality. To account for this potential caveat, destination population pop_d, obtained from World Development Indicators, is also included in the estimated regression to proxy for destination size.

The quality of variety h to destination d at time t, λ_{ht}, is defined using the estimated parameters $\lambda_{ht} \equiv \lambda_{1,h} + \lambda_{2,t} + \lambda_{3,ht}$. Since the trade data do not record detailed characteristics of varieties, I exploit the panel dimension of the data by specifying a time-invariant component of quality $\lambda_{1,h}$ with variety fixed effects (some products have a better quality than others) and a common quality component $\lambda_{2,t}$ with year-fixed effects (quality might vary through time). The third component of quality, $\lambda_{3,ht}$, is unobservable (for instance, quality might change because of some upgrading of plant and equipment) and plays the role of the estimation error.[2]

Specification (1) allows for the plausible correlation structures among consumer preferences through the nest share, NS_{hd}. Consider for instance two varieties, wool shirts exported to France and cotton shirts to Italy. Suppose that they are identical in every dimension (including price) and evenly split the market of Greek exports in shirts. We would infer their qualities also to be equal. Now suppose a cotton shirt is exported to Germany: the new market shares for both cotton shirts would *ceteris paribus* be one-fourth each and the wool shirts exported to France would capture the remaining half. In other words, we might expect the market share of cotton shirts exported to Italy to adjust more than the market share of wool shirts exported to France, because shirts exported to Germany are also cotton. However, we do not want the inferred quality of the existing varieties to fall simply because varieties within nests are closer substitutes than varieties across nests. The nested specification alleviates this concern preferences by placing varieties into appropriate nests, with the nest share, NS_{hd}, adjusting to account for changes in market shares.[3]

[2] The identification of coefficients relies on the assumption that prices are exogenous. Khandelwal (2010) points out that this assumption may not hold if exporters choose prices and quality simultaneously, and instruments prices with transportation costs (captured by the distance of the destination country) and the 'nested' share with the number of destinations per variety. A similar identification strategy for Greek exports did not prove successful, as both instruments contained little information for the variables of interest.

[3] In addition, the nest share, NS_{hd}, accounts for trade redirection that is important for quality. Estimated export quality will not change simply because exports to a certain destination are adjusted due e.g. to an external shock,

It should be stressed that a major difference with Khandelwal's (2010) approach is that he assesses the quality of US imports with the dependent variable being the market share of a country's imports to the US in total consumption of the product in the US (including domestic versions of the product). In contrast, equation (1) looks at Greek exports with the dependent variable being the share of Greek exports of product *p* to destination *d* in total Greek exports of the product. The approach adopted here looks across destinations by assuming that Greek exports of a product form a 'market' with destinations acting as 'consumers'. Hence, it neglects the concept of the market defined in terms of e.g. a German consumer who has a choice of Greek versus domestic products, Italian products, etc. However, it avoids the pitfalls associated with the spurious impact of domestic developments in the assessment of export quality. For instance, the recession in Greece after 2010 has shifted Greek exports upwards due to the lack of domestic demand, an outcome that would spuriously attribute higher shares of Greek exports in world markets to higher quality.

Given these insights, an alternative interpretation of λ_{ht} is that it represents a shift parameter in the variety's demand schedule: a variety's quality will rise if its price in a market (destination) can rise without losing market share (Sutton, 1991). Quality here represents any attribute that encompasses consumers' willingness to pay for a variety (valuation for quality or 'perceived quality') and the technology of the variety ('technical efficiency'). The associated quality estimate does therefore not compare the quality of a single country's exports relative to competitors, which would require access and processing of disaggregated global trade flows as in Henn et al. (2013) and Feenstra and Romalis (2014), but rather assesses changes in market (destination) shares of a country's products that cannot be attributed to price changes.

2.3. Trade data

The empirical definition of an exported product follows the SITC classification system, which is a product classification of the United Nations used for external trade statistics (export and import values and volumes of goods), allowing for international comparisons of commodities and manufactured goods. The groupings of SITC reflect the production materials, the processing stage, market practices and uses of the products, the importance of the goods in world trade, and technological changes. The main categories are *food, drinks and*

as the nest part will adjust as well. Thus the assessed impact can be considered as a proxy of 'non-price' effects.

tobacco (Sections 0 and 1 - including live animals), *raw materials* (Sections 2 and 4), *energy products* (Section 3), *chemicals* (Section 5), *machinery and transport equipment* (Section 7), *other manufactured goods* (Sections 6 and 8). Given the relatively large size of the agricultural sector in Greece and its importance for Greek exports, I analyze two distinct sectoral categories of goods: (i) manufacturing sector products (SITC Categories 5-8), (ii) agricultural products (SITC Categories 0-1). I exclude the homogeneous goods defined by Rauch (1999) since these products, by definition, exhibit no quality differentiation. Given the noise in monthly exports, the data are trimmed along three dimensions. The first trim excludes varieties (defined as CN8 classifications) that are exported for less than 6 months and also those that are exported for less than 3 months to a single destination. Unit values are then calculated as ratios of export value to quantity.[4] The second trim removes varieties with extreme unit values that exceed 10 times, or fall below 10% of, the median product (SITC) price. The third trim allows for variation across nested shares (CN8) within a product category; only products with three or more CN8 classifications per SITC are used in the estimation.[5] Tables D1 and D2 in the Data Appendix summarizes the products used in the estimation process after excluding those values that are not exported for all data years over the sample period considered here (1998-2012).

2.4. Quality estimates

Equation (1) is run separately for 71 SITC categories in the manufacturing sector and 13 SITC categories in the agricultural sector, which fulfill the criteria described in the previous section. The results of these regressions are summarized in Table 1 for manufacturing (Panel A) and agriculture (Panel B). Panel A shows that 68 of the regressions, or 97% of the total 37.688 observations in the entire sample, have a negative and statistically significant price coefficient. Row 1 in Panel A indicates that the average OLS price coefficient in manufacturing amounts to -0.61. Rows 2 and 3 indicate that the average coefficients on the conditional market share and the population also have the expected positive signs (and are

[4] Notice that this approach implies that the observed unit values are averages across firms.

[5] For instance, SITC code 84423 "Jackets and blazers of knitted or crocheted textile fabrics, women's or girls'" comprises the following four CN8 classifications: 61043100 "women's or girls' jackets and blazers of wool or fine animal hair, knitted or crocheted (excl. wind-jackets and similar articles), 61043200 "women's or girls' jackets and blazers of cotton, knitted or crocheted (excl. windjackets and similar articles), 61043300 "women's or girls' jackets and blazers of synthetic fibres, knitted or crocheted (excl. wind-jackets and similar articles), 61043900 "women's or girls' jackets and blazers of textile materials, knitted or crocheted, excl. of wool, fine animal hair, cotton or synthetic fibres, wind-jackets and similar articles).

also statistically significant). In the agricultural sector (Panel B) the price coefficient estimated for is slightly higher and, also, significant in 89% of the total 11.288 observations, whereas the coefficients on market share and population are again positive.

The patterns of the aggregate and sectoral export quality indices for manufacturing are depicted in Figures 1 and 2 respectively, which display the aggregate quality estimates in index form and the estimated export quality indices per SITC broad category (5-8), obtained from the residuals of these regressions according to the definition of λ_{ht} and weighted by the shares of annual revenues for each product.[6] Notably, average export quality, which had a slight negative trend over the period 1998-2010 falling by 1% per annum, appears to follow a sharp positive trajectory after 2010, climbing by 13.7% in 2011 and 10.6% in 2012, with the rise mainly driven by SITC categories 5, 6 and 8. Export quality at the sectoral level reveals substantial heterogeneity, with SITC industries 5 (Chemicals and Related Products) and 6 (Manufactured Goods Classified Chiefly by Material) displaying a drop in the estimated export quality after 1998, although a sharp recovery period is observed in years 2003-2005 for SITC 5 and after 2004 for SITC 6. In contrast, SITC industries 7 (Machinery and Transport Equipment) and 8 (Miscellaneous Manufactured Articles) display a stagnant pattern for the whole period. Figures 3 and 4 display the corresponding aggregate and sectoral indices, respectively, for the agricultural sector. Overall, the aggregate index displays a highly cyclical behavior with an upward trend: the average annual rise over the period 1998-2012 amounts to 1.6%. On the other hand, the sectoral indices display more stable patterns. It should be stressed that the results for the agricultural sector should be interpreted with caution due to the small number (13) of SITC product categories used in the estimations.[7]

To assess the robustness of the quality estimates I perform two broad sensitivity tests. First, I estimate the quality of manufacturing products exported to European Union (EU) and Eurozone countries. This analysis is motivated by two main factors. First, intra-EU trade is likely to be oriented to more expensive, and hence higher-quality, products given the higher - and more homogeneous- per capita income levels of the trading partners. Second, the adoption of the Euro eliminated a number of trade barriers in the form of transaction costs and induced transparency in prices, which might have altered the structure of trade towards exporting higher-quality goods to Eurozone countries. To this end, I perform the same exercise by running equation (1) for EU and Eurozone destinations. The corresponding

[6] The average shares over the period 1998-2012 are shown in the last column of Table D1 in the Data Appendix.

[7] Tables A1 and A2 contain the detailed quality estimates per SITC category for the period under consideration.

regression results are given in Panels A and B of Table A3 and the time profiles of the quality estimates are depicted in Figure A1. The estimated quality of exports to EU countries is relatively stable over the sample, whereas the corresponding quality to Eurozone countries exhibits much larger variation. Interestingly, both indices confirm the sharp rise in export quality for 2011 and 2012.

I also test the sensitivity of quality estimates for the agricultural sector by controlling for world prices in agricultural products.[8] More specifically, it is possible that an increase in the quality of agricultural products hides a rise in global agricultural prices, as prices in destination markets increased proportionately across export countries without affecting relative prices and market shares. In other words, if the rise in world prices is not taken into account, a rise in domestic agricultural prices would spuriously leave market shares unaffected indicating higher quality. Panel C in Table A3 presents the estimates from an augmented version of equation (1) that includes world agricultural prices as an additional covariate. World prices enter with a positive sign as expected, whereas the rest of the coefficients retains their signs and magnitudes. The overall picture is confirmed in Figure A2, which plots the corresponding quality index for agricultural products and exhibits a similar pattern with the one obtained in Figure 3, indicating an average annual rise of quality by 0.9% for the period under consideration. This implies that the inclusion of world agricultural prices indeed lowers somewhat the rise in the estimated quality of Greek agricultural products, without however affecting the general trend.

3. Linking product quality with firm characteristics

In this section, I use the quality estimates to study (a) how product quality relates to key aspects of firm characteristics and (b) the interplay between foreign market characteristics and the relationship of product quality and firm characteristics.

3.1. Data and empirical specification

To address the questions posed in the Introduction, I use a newly compiled dataset on Greek exporting firms that merges data from two sources. Trade data at the firm-product-destination level are obtained from the Intrastat databank and firm-level variables are obtained

[8] Source: Food and Agriculture Organization (http://www.fao.org/worldfoodsituation/foodpricesindex/en/).

from the Annual Manufacturing Survey (AMS), both available via the Greek Statistical Agency (ELSTAT).

The Intrastat databank collects information and produces statistics on dispatches and arrivals of goods in European Union countries and replaced customs declarations as the source of trade statistics. In particular, the national authorities collect data on the identification number allocated to the party responsible for providing information, the reference period, the flow (arrival, dispatch), the value and quantity of the goods in net mass (weight excluding packaging) and the supplementary unit (litre, m², number of items, etc.) if relevant, and their destination. Firms whose annual trade amount is above a certain value are responsible for providing information and this threshold value is re-defined so that a minimum amount of data is collected for each trade flow. Each year, national authorities define their thresholds, set in such a way so as to collect data relating to at least 97% of all dispatches.

Export data at the firm level are combined with survey data available through the AMS, which is carried out annually and contains data related to economic activity of medium-scale and large-scale manufacturing firms. The firm survey is collected at the plant level, but export and financial information is recorded at the firm level. Specifically, the survey provides figures on types of expenses and labor force variables (like number of employees and remuneration per type of worker).[9] A key limitation of these data is therefore sample size in some regressions, depending on the number of firms for which data via AMS are available.

Although the AMS data are available for the period 2001-2010, I focus on the relationship between export quality at the product level and firm characteristics in a single year in the panel, 2007. This strategy, also adopted by Manova and Zhang (2012), is motivated by a number of considerations. First, the aim to establish stylized facts that obtain in the cross-section of firms and not in export dynamics. Due to the structure of the survey, there is no information on whether a firm is not included in one or more years because it has exited from the export market, or because it was omitted from the sample. By focusing on a single year I abstract from these issues and, also, concerns on nominal frictions, such as sticky wages and prices, and related firm or sectoral dynamics. Second, I avoid to use data for years 2008 and 2009 due to the global trade crisis that might have affected the nature of exporting in a small open economy like Greece (Behrens et al., 2013). Third, because data for one year

[9] For a more detailed description of the external sector statistics and the Annual Industrial Survey, see Theofilakou and Stournaras (2013) and Tsakanikas and Vassiliadis (2013).

denominated in Euros are examined, and given that as was established in the previous section, the quality estimates of Greek exports remain unaffected when Eurozone destinations are considered, the analysis is not sensitive to possible adjustments in the quality of exports by Greek firms related to the adoption of the Euro in year 2001. Finally, from a technical point of view, when I explore how the interaction of firm and destination market characteristics relates with export quality, time-invariant (bilateral distance) or strongly persistent (GDP, GDP per capita) variables are used. If the outcome variable were at the panel dimension, the standard errors could be misleadingly low because the number of observations would be effectively multiplied without necessarily introducing new information. Also, outliers are likely to be of greater concern in a panel dataset extending over several years, as there is a lot of lumpiness because many firms do not export a given product to a given market in every year.

Formally the estimating equation for year 2007 is given by (time index is omitted):

$$\ln(\lambda_h) = c + \delta_1 \text{ x } \ln(firm\_var_f) + \delta_2 \text{ x } [\ln(firm\_var_f) \text{ x } dest_d] + \theta \text{ x } \ln(W_f) + \varepsilon_{fhd} \qquad (2)$$

The l.h.s. variable, λ_h, denotes quality at the product level obtained through equation (1). On the r.h.s., $firm\_var_f$ denotes the firm characteristic under consideration and parameter δ_1 captures its conditional association with product quality. I consider a number of variables, capturing labor (wage bill, number of persons employed and their wage rates), human capital and innovation (training, R&D expenses and personell), various types of expenses (advertising, export promotion, exhibition, royalties) and export subsidies.[10] The term $\ln(firm\_var_f)$ x $dest_d$ interacts these firm characteristics with destination characteristics, like size, income and distance, proxied by gdp, gdp per capita and bilateral distance respectively.[11] The interaction term between the destination characteristics and the firm variable captures, through parameter δ_2, the extent to which the correlation between product quality and firm characteristics is associated with these characteristics. I also take as regressors a vector of firm characteristics, W_f, that proxy for the various conjectures to explain product quality at the firm level through the parameter θ. In the empirical specification, W_f translates into the (logs of) age and export intensity (measured as exports to total revenues), to account for size and productivity performance, as more productive firms are expected to be more export oriented (Melitz, 2003; Berman et al., 2012). Finally, the term ε_{fhd} denotes the firm-product (or firm-product-destination depending on the specification used) error term.

[10] The detailed description of the variables and their source codes is given in Table D3 of the Data Appendix.

[11] Data on GDP and GDP per capita are obtained from the World Bank's World Development Indicators and bilateral distances is obtained from CEPII.

The primary interest is in the signs and significance levels of δ_1 and δ_2 in each regression, which reflect the conditional correlations between export quality at the product level and characteristics across firms that export the corresponding products. It should be emphasized that δ_1 and δ_2 cannot be given a causal interpretation because product quality and many firm attributes are both affected by unobserved firm characteristics. Moreover, in many recent models of heterogeneous firms they are the joint outcome of firms' profit maximization and, hence, are simultaneously determined (Verhoogen, 2008; Feenstra and Romalis, 2014).

3.2. Results

Table 2 presents the estimates of equation (2) with two regressions run for each firm variable, namely without and with control variables. Turning first to the control variables, they are almost always significant with robust signs: higher-product quality is associated with larger and younger firms.

Concerning the variables of interest, columns (1) and (2) of Table 2 display the coefficients for the wage skill premium, measured by the ratio of the wage bill for skilled to unskilled employees. The former category comprises full and part-time employees on a monthly payroll and the latter category comprises respectively full and part-time employees paid on a daily salary. In both specifications the coefficient turns out positive and significant, indicating that firms that spend relatively more on skilled labor export higher-quality products. In the next four columns the wage bill is decomposed into the number of employees and the wage rate.[12] Specifically, columns (3) and (4) use the ratio of skilled to unskilled workers as a r.h.s. variable and show that firms with relatively more skilled labor export higher-quality products. Interestingly, the conditional correlations of product quality with the wage-bill skill premium and the ratio of skilled to unskilled employees are larger when the regressions control for export intensity and age, which implies that the outcomes do not hide a spurious association of higher-productivity firms producing higher-quality products by spending relatively more on skilled labor or employing relatively more skilled workers. In contrast, the coefficients on the skill premium based on the wage rate do not show any relation with product quality. I therefore conclude that the relative quantity (share) of skilled employees is positively and significantly related to the product quality of exports, whereas the

[12] The wage rate for skilled and unskilled workers is calculated by dividing the corresponding wage bills to the numbers of employees. Denoting the wage bill, employment the wage rate by *wb*, *n* and *w* respectively, we get that $\frac{w^s}{w^u} \equiv \frac{wb^s}{n^s} \quad \frac{wb^u}{n^u} = \frac{wb^s}{wb^u} \quad \frac{n^u}{n^s}$, where *s* and *u* denote skilled and unskilled labor.

relative price of skilled (relative to unskilled) labor is not.

In columns (7) to (12) of Table 2 product quality is regressed on measures related to human capital, namely training expenses, R&D expenses and R&D personnel. I find that there is a negative association of product quality with training expenses, a finding that might be attributed to a negative correlation between the number of skilled to unskilled employees. Indeed in the raw data there is a negative correlation between these variables amounting to -0.19, indicating that firms with a lower share of skilled workers pay more on training expenses and produce lower quality goods. On the other hand, there is a positive correlation with both R&D measures, but survives only in the unconditioned regressions. In light of this and the small number of firms included in this sample, this result should be interpreted as a tentative one that requires further investigation.

In the second part of Table 2 the correlations with various share of expenses are presented. The shares of advertising and promotion expenditures and exhibition expenditures are negatively related to product quality, an effect that persists when the regressions control for export intensity and age. The share of expenditures related to export promotion is positively related to product quality, but the effect becomes insignificant when the specifications includes export intensity and age, indicating that the unconditioned positive relationship is likely to be driven by export-oriented, older firms that have established networks in foreign markets. Finally, the share of expenses paid on royalties is not found to be related to product quality, whereas the coefficient on export subsidies changes sign between the two regressions and relies on a very small number of firms.

As a next step in the analysis of the association between firm characteristics with product quality, Tables 3 to 5 summarize the results from including interaction terms of firm characteristics with destination size, income and distance. Specifically, the first two rows in Table 3 display the direct coefficient of the wage-bill skill premium and its interaction with destination size (gdp). The coefficient on the wage-bill skill premium is now negative and insignificant, whereas the interaction is positive and significant indicating that the positive association with product quality increases for larger destinations. In the next two regressions the effects are decomposed in the ratio of skilled to unskilled employees and the wage rate skill premium. The correlation of the ratio of skilled to unskilled workers with product quality is negative and insignificant, but is significantly positive for larger destinations. The coefficient on the wage rate skill premium is positive and its interaction with size is negative, but both effects are insignificant. The corresponding rows of Table 4, which contain the

specifications with the interactions with destination income (gdp per capita) show that the coefficients on the wage bill skill premium and the ratio of skilled to unskilled workers are negative and significant, whereas the corresponding interactions with destination income are positive and significant. In contrast, these effects become insignificant when the interactions with distance are considered. The wage rate skill premium is positive and its interactions with income and distance are negative, but only marginally significant (see fifth and sixth rows of Tables 4 and 5). The general picture that emerges therefore is that the positive correlations found between product quality and (a) the wage bill ratio, (b) the ratio of skilled to unskilled workers, are mainly driven by large and rich destinations.

Regarding the rest of the estimated correlations, it should be noted that in contrast to the simple model of Table 2, the association of product quality with advertising-promotion and exhibition related expenditures is now positive, whereas the interactions with destination size and income are negative. This finding implies diminishing returns of product quality w.r.t. marketing; higher spending for advertising and exhibitions is associated with higher-quality products, which are presumably more expensive, but the association becomes weaker in larger and richer markets. This conjecture is in line with the assumption put forward in Arkolakis (2010) that the marginal cost of marketing in firm exporting increases with the market size, in the form of number of consumers, reached. I find here a similar pattern for the interactions with destination income, which would imply that the marginal cost of marketing also increases with the income of consumers reached, a finding that provides a potentially fruitful avenue for future research.[13]

4. Conclusions

Empirical research in trade models has consistently found that product quality influences cross-border trade; richer countries consume and export higher quality products than developing countries, with most studies using observable unit prices as proxies for quality. This study estimated the quality of Greek exports based on the premise that a product's quality will rise if its price in a market can rise without losing market share. A specification that relates market shares to prices and other determinants was estimated using

[13] Table 5 also shows that the correlation of R&D expenditures as a share of total expenditures and product quality is positive and significant, whereas the interaction term with distance is negative, which implies that the this association becomes weaker for more distant destinations. However, given the small number of firms with observations for R&D expenditures (25 firms), this result should be interpreted with caution.

Greek export data over the period 1998-2012. Export quality in manufacturing is estimated to have fallen by 1% per year on average for the period 1998-2010, but recovered in 2011 and 2012 when export quality displayed a cumulative rise of 25.7%, yielding a cumulative rise of 9.2% for the entire period 1998-2012. Export quality in agriculture displays a slightly upward trend with the average annual rise over the period 1998-2012 amounting to 1.6%. Linking the quality estimates at the product level in the manufacturing sector with exporting firms shows that skill-intensive firms export higher-quality products, an effect that is more pronounced in large and rich destinations.

Looking ahead, the implications of the findings presented here are relevant from a policy perspective. The promotion of quality as a dimension of international competitiveness is an objective of high-income economies facing price competition from low-wage countries. Given that the treatment of the product-quality related characteristics, like skilled employment, is sensitive to policy parameters, the nexus between export quality and the skilled to unskilled employment ratio should be considered when evaluating the implications of policies that may affect a firm's composition of employment.

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TABLE 1. Export quality estimation results: coefficient estimates of equation (1)

Statistic	Mean	Median
A. Manufacturing		
Price coefficient	-0.612	-0.550
Coefficient on conditional market share	0.718	0.717
Coefficient on population	0.028	0.013
Estimations with statistically significant negative price coefficient at 5% level	68	
Observations with statistically significant negative price coefficient at 5% level	36634	
Total estimations	71	
Total observations across all estimations	37688	
B. Agriculture		
Price coefficient	-1.017	-0.936
Coefficient on conditional market share	0.698	0.669
Coefficient on population	0.076	0.054
Estimations with statistically significant negative price coefficient at 5% level	11	
Observations with statistically significant negative price coefficient at 5% level	10040	
Total estimations	13	
Total observations across all estimations	11288	

Notes: The first three rows in Panels A and B report estimation statistics of running equation (1) separately for each of the 71 SITC5 manufacturing products and the 13 SITC5 agricultural products. respectively.

TABLE 2. Export quality and firm characteristics: 2007 cross section

	dependent variable: product quality											
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
skill premium (wage bill)	0.113*** (0.028)	0.254*** (0.049)										
skilled/unskilled workers			0.101*** (0.029)	0.227*** (0.047)								
skill premium (wage rate)					0.124 (0.083)	0.054 (0.081)						
training expenses							-0.178*** (0.035)	-0.176*** (0.025)				
R&D expenses									0.124* (0.064)	0.044 (0.090)		
R&D personnel											0.445*** (0.123)	-0.034 (0.139)
export intensity		0.225*** (0.035)		0.227*** (0.036)		0.198*** (0.031)		0.216*** (0.035)		0.510*** (0.098)		0.589*** (0.124)
age		-0.213*** (0.051)		-0.187*** (0.048)		-0.242*** (0.049)		-0.175*** (0.059)		-0.026 (0.187)		0.104 (0.200)
R-sq.	0.002	0.122	0.001	0.119	0.001	0.104	0.011	0.109	0.016	0.2071	0.064	0.205
#observations	3699	3106	3680	3087	3680	3087	1958	1724	268	253	266	254
#firms	501	360	499	358	499	358	215	176	30	26	30	27
#destinations	120	109	120	109	120	109	110	99	70	70	70	70

Notes: All variables are in logs. All regressions include a constant term and product fixed effects with destination clustered standard errors (*t*-statistics are in parentheses and * denotes p<.10, ** denotes p<.05, *** denotes p<.01).

TABLE 2. Export quality and firm characteristics: 2007 cross section (continued)

	dependent variable: product quality									
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
advertising and promotion expenses	-0.142*** (0.030)	-0.063*** (0.018)								
export promotion expenses			0.089*** (0.032)	0.005 (0.035)						
exhibition expenses					-0.058*** (0.022)	-0.072*** (0.024)				
royalties expenses							-0.028 (0.028)	-0.028 (0.025)		
export subsidies									0.208* (0.117)	-0.823*** (0.184)
export intensity		0.160*** (0.029)		0.190*** (0.034)		0.177*** (0.033)		0.172*** (0.050)		1.025*** (0.165)
age		-0.201*** (0.044)		-0.195*** (0.061)		-0.239*** (0.062)		-0.256*** (0.094)		0.667* (0.352)
R-sq.	0.029	0.090	0.008	0.080	0.002	0.067	0.000	0.048	0.214	0.445
#observations	3583	2951	1198	1149	2145	1740	1129	955	55	49
#firms	501	359	145	129	263	203	102	77	11	8
#destinations	120	109	86	85	109	95	89	73	16	13

Notes: All variables are in logs. All regressions include a constant term and product fixed effects with destination clustered standard errors (*t*-statistics are in parentheses and * denotes p<.10, ** denotes p<.05, *** denotes p<.01).

TABLE 3. Export quality and interactions of firm characteristics with destination size

	dependent variable: product quality					
	coefficient	(std. error)	R-sq.	# obs.	# firms	# destinations
skill premium (wage bill)	-0.157	(0.151)				
skill premium (wage bill) X size	0.034***	(0.012)	0.124	3035	357	97
skilled/unskilled workers	-0.114	(0.155)				
skilled/unskilled workers X size	0.027**	(0.012)	0.120	3016	355	97
skill premium (wage rate)	0.084	(0.418)				
skill premium (wage rate) X size	-0.001	(0.034)	0.105	3016	355	97
training expenses	-0.090	(0.146)				
training expenses X size	-0.006	(0.012)	0.108	1679	174	90
R&D expenses	0.155	(0.600)				
R&D expenses X size	-0.010	(0.045)	0.196	245	25	67
R&D personnel	-1.315	(0.965)				
R&D personnel X size	0.100	(0.073)	0.168	246	26	67
adv. and promotion expenses	0.362***	(0.125)				
adv. and promotion expenses X size	-0.035***	(0.011)	0.082	2879	356	97
export promotion expenses	-0.243	(0.229)				
export promotion expenses X size	0.019	(0.018)	0.048	1124	129	79
exhibition expenses	0.284*	(0.157)				
exhibition expenses X size	-0.028**	(0.013)	0.054	1685	201	86
royalties expenses	0.081	(0.155)				
royalties expenses X size	-0.009	(0.014)	0.047	943	76	67
export subsidies	-0.807***	(0.105)				
export subsidies X size	-1.193***	(0.385)	0.491	49	8	13

Notes: The regressions are from the 2007 cross section and include logs of export intensity and firm age as control variables. See also Notes to Table2.

TABLE 4. Export quality and interactions of firm characteristics with destination income

	dependent variable: product quality					
	coefficient	(std. error)	R-sq.	# obs.	# firms	# destinations
skill premium (wage bill)	-0.738*	(0.390)				
skill premium (wage bill) X income	0.100**	(0.039)	0.124	3035	357	97
skilled/unskilled workers	-0.782**	(0.378)				
skilled/unskilled workers X income	0.102***	(0.037)	0.120	3016	355	97
skill premium (wage rate)	1.960*	(1.054)				
skill premium (wage rate) X income	-0.190*	(0.108)	0.102	3016	355	97
training expenses	0.200	(0.308)				
training expenses X income	-0.037	(0.031)	0.096	1679	174	90
R&D expenses	0.137	(1.603)				
R&D expenses X income	-0.010	(0.160)	0.204	245	25	67
R&D personnel	-2.509	(1.714)				
R&D personnel X income	0.250	(0.172)	0.153	246	26	67
adv. and promotion expenses	0.962***	(0.243)				
adv. and promotion expenses X income	-0.104***	(0.025)	0.079	2879	356	97
export promotion expenses	0.086	(0.403)				
export promotion expenses X income	-0.008	(0.041)	0.083	1124	129	79
exhibition expenses	0.722**	(0.289)				
exhibition expenses X income	-0.080***	(0.029)	0.046	1685	201	86
royalties expenses	1.128***	(0.411)				
royalties expenses X income	-0.117***	(0.042)	0.037	943	76	67
export subsidies	-0.774***	(0.082)				
export subsidies X income	-2.129***	(0.392)	0.557	49	8	13

Notes: See Table3.

TABLE 5. Export quality and interactions of firm characteristics with destination distance

	dependent variable: product quality					
	coefficient	(std. error)	R-sq.	# obs.	# firms	# destinations
skill premium (wage bill)	-0.304	(0.441)				
skill premium (wage bill) X distance	0.076	(0.062)	0.126	3035	357	97
skilled/unskilled workers	-0.384	(0.407)				
skilled/unskilled workers X distance	0.083	(0.057)	0.120	3016	355	97
skill premium (wage rate)	0.953*	(0.492)				
skill premium (wage rate) X distance	-0.120*	(0.067)	0.100	3016	355	97
training expenses	0.237	(0.193)				
training expenses X distance	-0.056**	(0.027)	0.115	1679	174	90
R&D expenses	1.759**	(0.833)				
R&D expenses X distance	-0.243**	(0.117)	0.077	245	25	67
R&D personnel	-0.356	(1.567)				
R&D personnel X distance	0.038	(0.222)	0.208	246	26	67
adv. and promotion expenses	0.344	(0.224)				
adv. and promotion expenses X distance	-0.056*	(0.033)	0.097	2879	356	97
export promotion expenses	-0.815***	(0.170)				
export promotion expenses X distance	0.110***	(0.021)	0.010	1124	129	79
exhibition expenses	0.428**	(0.182)				
exhibition expenses X distance	-0.069***	(0.025)	0.072	1685	201	86
royalties expenses	0.075	(0.218)				
royalties expenses X distance	-0.014	(0.032)	0.051	943	76	67
export subsidies	-0.852***	(0.107)				
export subsidies X distance	-2.584***	(0.716)	0.558	49	8	13

Notes: See Table3.

FIGURE 1. Quality of Greek Exports, 1998-2012: Manufacturing (aggregate)

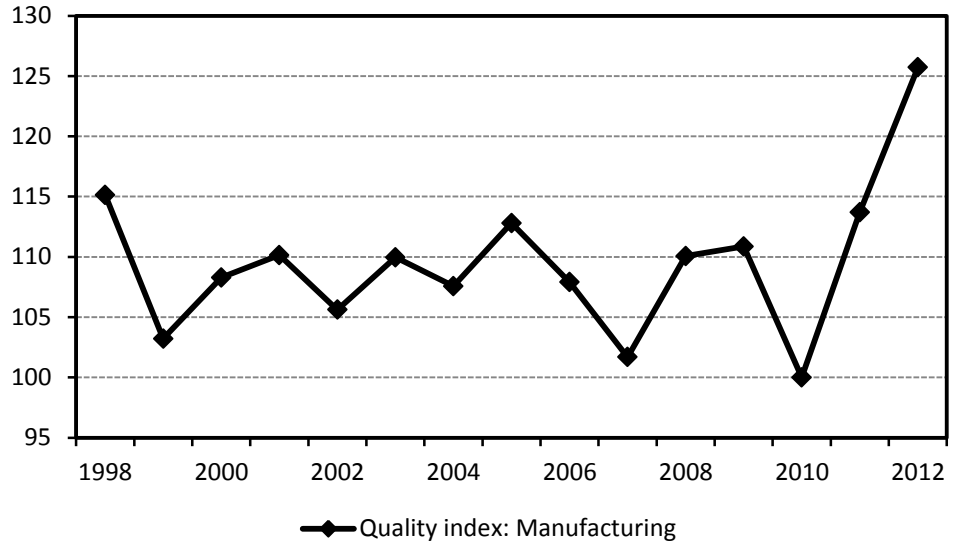


FIGURE 2. Quality of Greek Exports, 1998-2012: Manufacturing (sectoral)

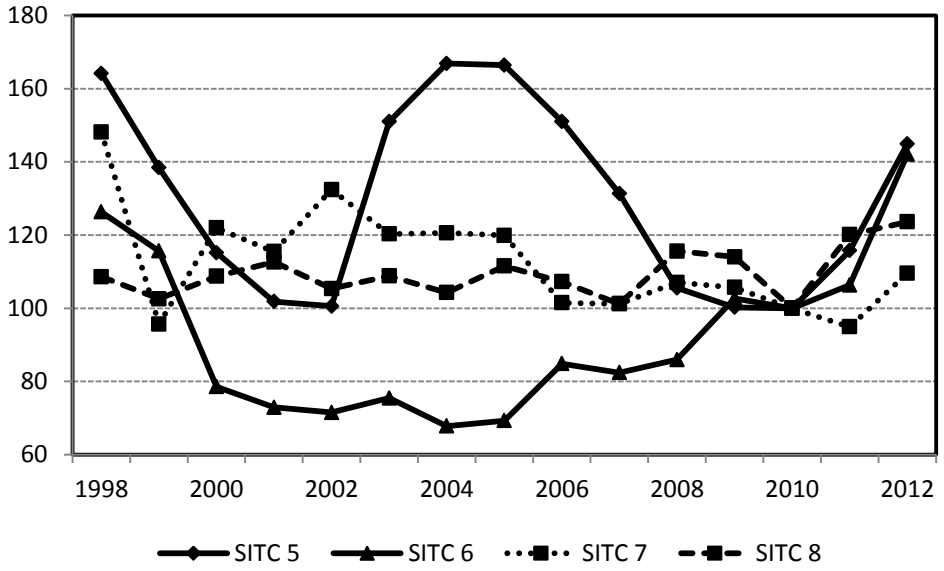


FIGURE 3. Quality of Greek Exports, 1998-2012: Agriculture (aggregate)

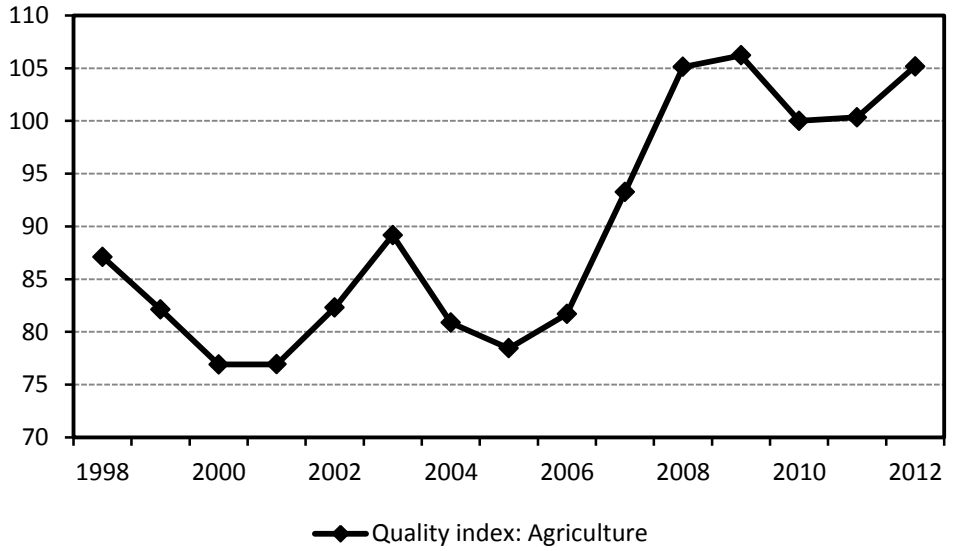


FIGURE 4. Quality of Greek Exports, 1998-2012: Agriculture (sectoral)

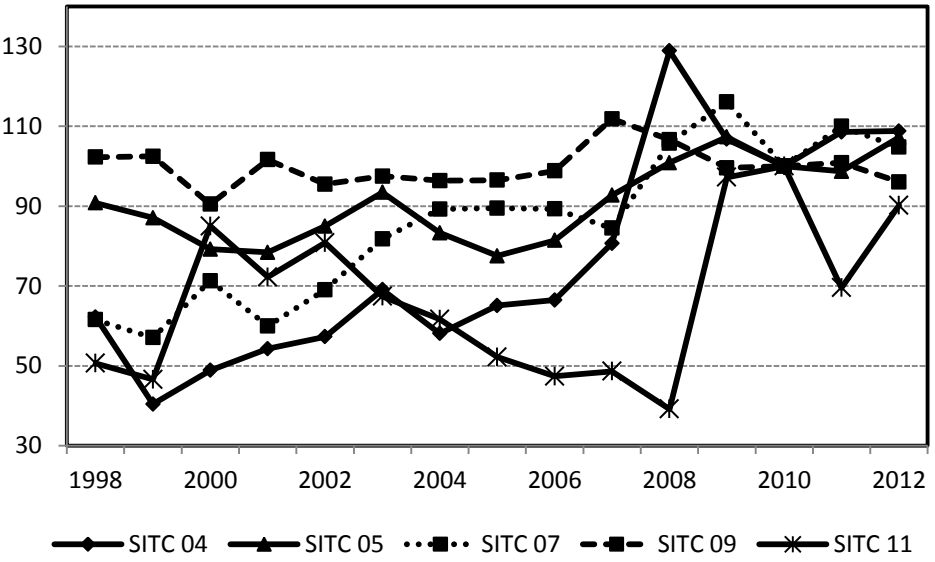


Table A1. Quality indices of Greek manufacturing exports, by SITC1 and total

Year	SITC 5 (4)	SITC 6 (12)	SITC 7 (12)	SITC 8 (43)	Total
			Indices (2010=100)		
1998	164.2	126.3	148.1	108.6	115.1
1999	138.4	115.6	95.6	102.6	103.2
2000	115.2	78.6	121.9	108.7	108.3
2001	101.8	72.9	115.5	112.6	110.1
2002	100.5	71.5	132.4	105.4	105.6
2003	151.0	75.5	120.3	108.8	110.0
2004	166.8	67.8	120.6	104.3	107.6
2005	166.4	69.3	119.9	111.5	112.8
2006	151.0	84.9	101.5	107.2	107.9
2007	131.3	82.4	101.2	101.2	101.7
2008	105.5	86.0	107.0	115.6	110.1
2009	100.3	102.7	105.7	114.0	110.9
2010	100.0	100.0	100.0	100.0	100.0
2011	115.7	106.3	94.9	120.1	113.7
2012	144.9	142.1	109.6	123.6	125.7
			y/y % change		
1999	-26.8	-11.7	-53.5	-7.1	-10.3
2000	-24.2	-38.1	25.3	5.2	4.9
2001	-14.3	-6.6	-7.5	2.9	1.7
2002	-2.3	-2.4	15.9	-8.3	-4.1
2003	49.5	2.9	-13.1	2.5	4.1
2004	14.9	-8.7	-0.7	-5.5	-2.17
2005	-1.5	0.5	-1.7	6.3	4.9
2006	-16.4	14.6	-19.4	-5.3	-4.3
2007	-20.7	-3.4	-1.3	-7.0	-5.7
2008	-26.8	2.6	4.8	13.4	8.2
2009	-6.3	15.7	-2.4	-2.6	0.7
2010	-1.3	-3.7	-6.7	-15.0	-9.8
2011	14.7	5.3	-6.1	19.1	13.7
2012	28.2	34.7	13.7	2.5	10.6

Note: The first line (in bold) denotes the aggregate (SITC1) product classifications and the number of SITC5 products used in each SITC1 category.

Table A2. Quality indices of Greek agricultural exports, by SITC1 and total

Year	SITC 04 (3)	SITC 05 (5)	SITC 07 (2)	SITC 09 (2)	SITC 11 (1)	Total
			Indices (2010=100)			
1998	87.1	62.2	90.8	61.5	102.2	50.6
1999	82.1	40.4	87.1	57.0	102.4	46.6
2000	76.9	48.8	79.2	71.3	90.5	85.0
2001	76.9	54.3	78.4	60.0	101.6	72.2
2002	82.3	57.3	85.0	69.0	95.5	80.8
2003	89.2	69.0	93.4	81.8	97.5	67.4
2004	80.9	58.1	83.3	89.2	96.4	61.6
2005	78.4	65.1	77.5	89.5	96.5	52.2
2006	81.7	66.5	81.4	89.3	98.8	47.4
2007	93.3	80.6	92.7	84.5	111.8	48.6
2008	105.1	128.9	100.8	105.7	106.6	39.2
2009	106.2	106.7	107.3	116.1	99.6	97.2
2010	100.0	100.0	100.0	100.0	100.0	100.0
2011	100.3	108.5	98.7	110.0	100.9	69.5
2012	105.2	108.8	107.2	104.7	96.0	90.2
			y/y % change			
1999	-22.8	-4.7	-5.5	-0.8	-5.1	-5.7
2000	7.5	-8.9	13.2	-13.0	37.4	-6.4
2001	4.4	-1.8	-12.3	10.2	-13.8	0.0
2002	2.0	5.6	8.1	-7.2	7.6	7.0
2003	10.8	7.5	11.7	1.0	-14.4	8.3
2004	-12.0	-11.2	6.5	-2.1	-6.7	-9.3
2005	6.0	-6.8	-0.8	-0.9	-10.5	-3.0
2006	0.3	2.9	-1.2	1.3	-5.8	4.1
2007	13.2	10.3	-5.8	12.0	0.2	14.2
2008	47.2	7.1	20.3	-6.2	-10.5	12.7
2009	-23.1	5.5	9.3	-8.1	57.0	1.0
2010	-7.7	-8.3	-17.1	-0.6	1.8	-5.8
2011	7.5	-2.3	9.0	-0.1	-31.5	0.3
2012	-0.8	7.5	-6.2	-5.8	19.7	4.8

Note: The first line (in bold) denotes the aggregate (SITC1) product classifications and the number of SITC5 products used in each SITC1 category.

TABLE A3. Sensitivity analysis of coefficient estimates of equation (1)

Statistic	Mean	Median
A. Eurozone (manufacturing products)		
Price coefficient	-0.592	-0.560
Coefficient on conditional market share	0.720	0.717
Coefficient on population	0.014	0.012
Estimations with statistically significant negative price coefficient at 5% level	68	
Observations with statistically significant negative price coefficient at 5% level	11965	
Total estimations	71	
Total observations across all estimations	12397	
B. European Union (manufacturing products)		
Price coefficient	-0.596	-0.560
Coefficient on conditional market share	0.721	0.723
Coefficient on population	0.019	0.012
Estimations with statistically significant negative price coefficient at 5% level	68	
Observations with statistically significant negative price coefficient at 5% level	21886	
Total estimations	71	
Total observations across all estimations	22671	
C. Controlling for world agricultural prices		
Price coefficient	-1.077	-0.818
Coefficient on conditional market share	0.696	0.685
Coefficient on population	0.078	0.053
Coefficient on world agricultural price index	0.192	0.213
Estimations with statistically significant negative price coefficient at 5% level	11	
Observations with statistically significant negative price coefficient at 5% level	10037	
Total estimations	13	
Total observations across all estimations	11288	

Notes: See Table 1.

FIGURE A1. Quality of Greek Exports to EU and Eurozone countries, 1998-2012: Manufacturing (aggregate)

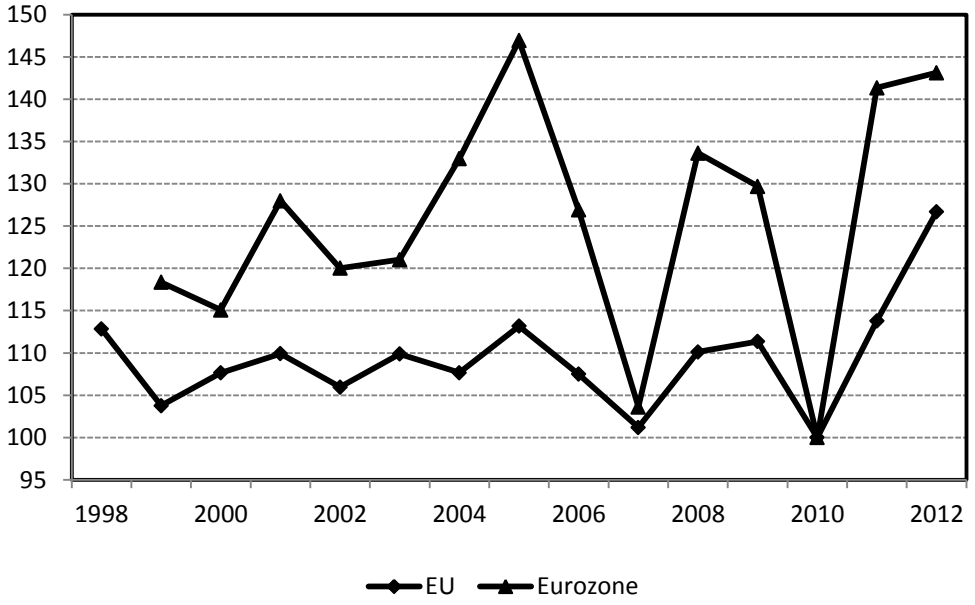
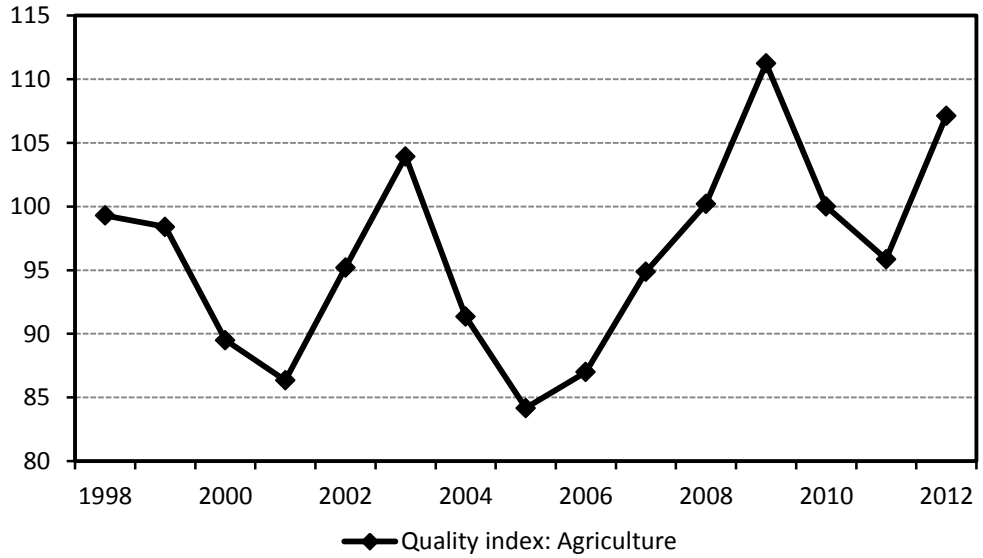


FIGURE A2. Quality of Greek Exports, 1998-2012: Agriculture (aggregate) after controlling for world prices



DATA APPENDIX

TABLE D1. Manufacturing sector: product categories used in the estimation (description, SITC code and number of CN8 codes within SITC)

SECTOR (SITC1 code)	SITC5 (# CN8)	Average Weight
Chemicals and Related Products, n.e.s. (5)		
Paints & varnishes (including enamels & lacquers) based on synthetic polymers/chemically modified natural polymers, dispersed/dissolved in a non-aqueous medium; plastics in solution	53342 (5)	0,037
Glaziers' putty, grafting putty, resin cement, caulking compounds and other mastics, painters' fillings, nonrefractory surfacing preparations	53354 (3)	0,005
Wadding, gauze, bandages etc. impregnated/coated with pharmaceutical products or in retail packages for medical/dental/veterinary use, n.e.s.	54191 (3)	0,007
Organic surface-active agents, put-up for retail, sale or not	55421 (3)	0,008
Manufactured Goods Classified Chiefly by Material (6)		
Conveyor belts/belting	62922 (3)	0,039
Narrow woven fabrics, n.e.s.	65613 (3)	0,001
Other embroidery	65659 (5)	0,005
Textile fabrics impregnated, coated, covered/laminated with plastics, other than those of heading	65732 (4)	0,002
Twine, cordage, ropes & cables, whether/not plaited/braided & whether/not impregnated, coated, covered/sheathed with rubber/plastics	65751 (4)	0,005
Textile wadding materials and articles thereof, textile fibers not over 5mm in length (flock), textile dust and mill neps	65771 (4)	0,011
Furnishing articles, n.e.s. of textile materials	65859 (3)	0,001
Articles of plaster or of composition based on plaster	66331 (3)	0,004
Wire cloth, grill, netting and fencing, and expanded metal, of iron/steel	69350 (3)	0,002
Screws, bolts, nuts, screw hooks, rivets, washers and similar articles, threaded, of iron/steel	69421 (4)	0,001
Clasps, buckles, hooks, eyes, etc. of base metal for clothing, handbags, awnings, etc. base metal tubular etc. rivets, base metal	69933 (3)	0,002

beds and spangles		
Stoppers, caps, lids, etc., capsules for bottles, threaded bungs, bung covers, seals, etc., of base metal	69953 (3)	0,020
Machinery and Transport Equipment (7)		
Textile machinery for washing, wringing, pressing, dyeing, coating etc., textile yarn, fabric/articles, textile machinery, n.e.s.	72474 (3)	0,008
Machinery, n.e.s., for the industrial preparation/manufacture of food/drink	72722 (5)	0,008
Agricultural/horticultural appliances for projecting, dispersing, or spraying liquids/powders	74564 (3)	0,017
Taps, cocks, valves and similar appliances, n.e.s.	74780 (8)	0,013
Apparatus for protecting electrical circuits, n.e.s., not exceeding 1.000 volts	77253 (3)	0,006
Switches for electrical apparatus, n.e.s., for voltages not exceeding 1.000 volts	77255 (3)	0,002
Household/laundry type washing machines, each of a dry linen capacity not exceeding 10kg	77511 (3)	0,005
Refrigerators, household-type (electric/other), whether/not containing a deep-freeze compartment	77521 (3)	0,006
Electrics space heating and electrics soil heating apparatus	77582 (3)	0,002
Microwave ovens; other ovens; cookers, cooking plates, boiling rings, grillers & roasters	77586 (5)	0,026
Motors vehicles for the transport of persons (other than public), n.e.s.	78120 (4)	0,020
Motor vehicles for the transport of goods, n.e.s.	78219 (3)	0,004
Miscellaneous Manufactured Articles (8)		
Electric lamps and lightning fittings, n.e.s.	81315 (3)	0,002
Furniture, n.e.s., of wood, of a kind used in offices	82151 (3)	0,002
Furniture, n.e.s., of wood, n.e.s.	82159 (3)	0,009
Articles of a kind normally carried in the pocket or handbag	83191 (3)	0,000
Other travel goods, handbags & similar containers	83199 (4)	0,002
Overcoats, raincoats, carcoats, capes and similar articles, of woven textile materials other than wool or fine animal hair, men’s/boys’	84112 (5)	0,003
Anoraks, windbreakers and similar articles of woven textile	84119 (4)	0,003

materials, men’s/boys’		
Suits of woven textile materials other than wool or fine animal hair, men’s/boys’	84122 (3)	0,002
Ensembles of woven textile materials, men’s/boys’	84123 (3)	0,002
Jackets and blazers of woven textile materials, men’s/boys’	84130 (4)	0,006
Trousers, bib & brace overalls, breeches & shorts, men's/boys', of textile materials, not knitted/crocheted	84140 (10)	0,036
Overcoats, raincoats, capes, cloaks and similar articles of woven textile fabrics, women’s/girls’	84211 (6)	0,003
Anoraks, windbreakers and similar articles of woven textile fabrics, women’s/girls’	84219 (3)	0,001
Suits of woven textile fabrics, women’s/girls’	84221 (4)	0,006
Ensembles of woven textile fabrics, women’s/girls’	84222 (3)	0,007
Jackets of woven textile fabrics, women’s/girls’	84230 (5)	0,007
Dresses, women's/girls', of textile materials, not knitted/crocheted	84240 (4)	0,012
Skirts & divided skirts, women's/girls', of textile materials, not knitted/crocheted	84250 (5)	0,010
Trousers, bib & brace overalls, breeches & shorts, women's/girls', of textile materials, not knitted/crocheted	84260 (9)	0,026
Blouses, shirts & shirt-blouses, women's/girls', of textile materials, not knitted/crocheted	84270 (6)	0,042
Overcoats, carcoats, capes, anoraks, cloaks, etc., knitted/crocheted fabric, women’s/girls’	84410 (3)	0,001
Jackets & blazers, women's/girls', knitted/crocheted of textile materials	84423 (4)	0,018
Dresses, women's/girls', knitted/crocheted of textile materials	84424 (4)	0,020
Skirts & divided skirts, women's/girls', knitted/crocheted of textile materials	84425 (4)	0,007
Blouses, shirts & shirt-blouses, women's/girls', knitted/crocheted of textile materials	84470 (4)	0,371
Jerseys, pullovers, cardigans, waistcoats & similar articles, knitted/crocheted	84530 (7)	0,031
Griddles, corsets, braces, suspenders, garters and similar articles, whether/not knitted/crocheted	84552 (3)	0,002
Articles of apparel, men's/boys', n.e.s., not knitted/crocheted	84587 (4)	0,001

Garments, knitted/crocheted, n.e.s.	84599 (3)	0,010
Shawls, scarves, mufflers, mantillas, vales and the like, not knitted/crocheted	84612 (3)	0,000
Ties, bow ties and cravats, not knitted/crocheted	84613 (3)	0,000
Hosiery, n.e.s.	84692 (3)	0,000
Footwear, n.e.s., with outer soles and uppers of rubber/plastics, n.e.s.	85132 (3)	0,004
Footwear, n.e.s., with outer soles of leather and uppers of leather/composition leather	85148 (16)	0.016
Spectacles, goggles and the like, corrective, protective or other	88423 (3)	0.002
Paper/paperboard labels of all kinds, whether/not printed	89281 (4)	0,004
Sacks and bags of plastics	89311 (3)	0,010
Articles for the conveyance/packing of goods, n.e.s., of plastics, stoppers, lids, caps and other closures, of plastics	89319 (6)	0,028
Baths, shower baths, washbasins, bidets, lavatory pans, seats and covers, flushing cisterns and similar sanitary ware, of plastics	89321 (3)	0,003
Other builders' ware of plastics	89329 (5)	0,019
Brooms, brushes, mops and feather dusters, prepared knots and tufts, paint pads etc.	89972 (5)	0,002
Press-fasteners, snap-fasteners and press-studs and parts thereof, button	89983 (4)	0,006
Combs, hair-slides and the like, hairpins, curling pins, curling grips, hair curlers and the like (except electric), and parts thereof	89989 (3)	0,000

Notes: Lines in bold denote the aggregate (SITC1) product classifications. The rest of the lines denote disaggregated (SITC5) product classifications. The last column indicates the share of revenues for the corresponding SITC code, averaged over the period 1998-2012.

TABLE D2. Agricultural sector: product categories used in the estimation (description, SITC code and number of CN8 codes within SITC)

SECTOR (SITC1 code)	SITC5 (# CN8)	Average Weight
Food and live animals (0)		
Flour of wheat or of meslin	04610 (3)	0,024
Macaroni spaghetti and similar products	04830 (3)	0,056
Bakers' wares, n.e.s., communion wafers, empty cachets for pharmaceutical use, sealing wafers, rice, paper, etc.	04849 (4)	0,048
Vegetables, fruit, nuts and other edible parts of plants, prepared or preserved by vinegar or acetic acid	05671 (3)	0,102
Tomatoes, prepared or preserved otherwise than by vinegar or acetic acid, n.e.s.	05673 (6)	0,122
Jams, fruit jellies, marmalades, fruit or nut puree and pastes, being cooked preparations, not including homogenized preparations	05810 (4)	0,014
Nuts, groundnuts and other seeds, prepared or preserved, n.e.s., whether/not containing added sugar or other sweeting matter or spirit	05892 (6)	0,017
Apricots, cherries and peaches, prepared or preserved, n.e.s., whether/not containing added sugar or other sweetening matter or spirit	05895 (9)	0,457
Food preparations, n.e.s., containing cocoa, in blocks/snaps/bars	07330 (3)	0,006
Food preparations, containing cocoa, n.e.s.	07390 (5)	0,013
Yeasts, other single-shell microorganisms, dead, prepared baking powders	09860 (3)	0,003
Food preparations, n.e.s.	09899 (5)	0,121
Beverages and tobacco (1)		
Waters, including natural/artificial mineral waters and aerated waters, not containing added sugar or other sweetening matter, ice and snow	11101 (3)	0,017

Notes: Lines in bold denote the aggregate (SITC1) product classifications. The rest of the lines denote disaggregated (SITC5) product classifications. The last column indicates the share of revenues for the corresponding SITC code, averaged over the period 1998-2012.

TABLE D3. Variables from Annual Manufacturing Survey used in Tables 2-5

Variable name	Description	Variable code in AMS
skill premium (wage bill)	total wages paid to workers on a monthly salary / total wages paid to workers on a daily salary	201/202
skilled/unskilled workers	workers on a monthly salary / workers on a daily salary	(102+103)/(104+105)
skill premium (wage rate)	wage per worker on a monthly salary / wages per worker on a daily salary	V201*(V104+V105)/V202*(V102+V103)
training expenses	training expenses (% of labor expenses)	206/(201+202+203+204+206 +207+208+209+211)
R&D expenses	R&D expenses (% of total expenses)	367/(Γ1_Γ10)
R&D personnel	R&D personnel (% of total personnel)	366/100
advertising and promotion expenses	advertising-promotion expenses (% of total expenses)	326/(Γ1_Γ10)
export promotion expenses	expenses for export promotion (% of total expenses)	337/(Γ1_Γ10)
exhibition expenses	exhibition expenses (% of total expenses)	339/(Γ1_Γ10)
royalties expenses	royalties expenses (% of total expenses)	332/(Γ1_Γ10)
export subsidies	export subsidies (% of total revenues)	403/(401+402+403+404+405+406+407 +408+412+413+414+416+417+418+419)
export intensity	exports (% of total revenues)	621/(401+402+403+404+405+406+407 +408+412+413+414+416+417+418+419)

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