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FACTOR CONTENT OF AGRICULTURAL TRADE IN A GENERALIZED THREE FACTOR MODEL[1]

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Abstract

The present paper studies the factor content of agricultural trade in a in a generalised three factor model. Using the trade and technology data for the EU, we test the Heckscher-Ohlin hypothesis of the relative factor abundance. We propose a generalised three factor model, which on the one hand relaxes the assumption of factor price equalisation and, on the other hand includes land among the primary factors in addition to labour and capital. Our empirical findings suggest that the Heckscher-Ohlin model performs better in the full EU-25 sample than in the CEE-8 transition country trade, which are less diversified and face soviet-planning distortions of factor prices. We also find that the Heckscher-Ohlin model performs considerable better when relaxing the assumption of factor price equalisation between countries. These results strongly support the generalised three factor version of the Heckscher-Ohlin model.

Keywords: Heckscher-Ohlin, Generalised Three-Factor Model, Factor Content of Trade, Factor Abundance.

1. Introduction

According to general equilibrium models of international trade, countries trade with each other because of their differences or due to increasing returns in production. Ricardian model of international trade states that differences in technology between trading partners determine trade pattern while Heckscher-Ohlin (HO) model asserts that countries trade because of differences in relative factor endowments. According to the new trade theory, countries with equal endowments and technology may still benefit from trade, if they

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specialise in different varieties of the same product. In this case trade is driven by increasing returns in production and product differentiation.

Among the general equilibrium models of international trade, the relative factor endowment models continue to play a particularly prominent role in international trade literature (*Accinelli et al* 2010, *Martins* 2010). The commodity version of the HO model, often called Heckscher-Ohlin-Samuelson model, predicts that a country will export those goods which require intensive use of the country's abundant factors, i.e., a relatively capital abundant country will export capital intensive goods while a relatively labour abundant country will export relatively labour intensive goods. The factor-content version of the HO theory, Heckscher-Ohlin-Vanek model, on the other hand deals with the factor content of trade rather than with the trade pattern of individual products. Produced goods contain labour, capital or land services and export of goods involves also export of services of factors of production. Heckscher-Ohlin-Vanek theory states that countries will export the services of their abundant factors. This implies that in capital abundant country capital labour ratio will be higher in production than in consumption, i.e. capital abundant country exports capital services while labour abundant country exports labour services (*Leamer* 1980).

There are two principal reasons why one of the key objectives of the international economic research has been to account for the factor content of trade. The first is that economists want to trace the effects of international influences on relative and absolute factor prices within a country. In this context the HO model and its variants, with their emphasis on trade arising from differences in the availability of productive factors, provide a natural setting for such investigations (*Davis* and *Weinstein* 2001; *Debaere* 2003).

The second reason for the focus on the factor content of trade is that it provides a precise prediction against which to measure how well do trade models work. The relative factor endowment models are extraordinary in their ambition. They propose to describe, with a few parameters and in a unified constellation, the endowments, technologies, production, absorption, and trade of all countries in the world. This juxtaposition of extraordinary ambition and parsimonious specification have made these theories irresistible to empirical researchers (*Davis* and *Weinstein* 2001; *Debaere* 2003).

The present study contributes to both strands of the relative factor endowment literature. On the one hand, we indirectly examine the effects of the central planning and market restructuring influences on relative and absolute factor prices in the CEE-8 transition countries (*Kancs* and *Weber* 2001).[2] Hence, unlike the most other studies on the relative factor abundance, which usually test the factor intensities in the developed country manufacturing trade (*Deardorff* 1984), the present study examines the factor content of the EU agricultural trade. On the other hand, we test the performance of two different versions of the HO model. In addition to the standard HO setup, we also examine the role of the relative factor abundance in a generalised three factor model,

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[2] In the present study Central and Eastern Europe (CEE-8) refers to Czech Republic, Estonia, Hungary, Latvia, Lithuania, Poland, Slovakia and Slovenia.

which relaxes the assumption of factor price equalisation and, in addition to labour and capital, includes also land among the primary factors.

Hence, complementing the previous research of *Schluter* and *Lee* (1978); *Lee*, *Wills* and *Schluter* (1988); *Kancs* and *Ciaian* (2010); *Ciaian, Kancs and Pokrivcak (2010)*, the present study makes three contributions to the existing literature: (i) it assesses the performance of two alternative versions of the HO model - the standard and a more general; (ii) it extends the empirical literature on the factor content of agricultural trade, and as in *Leamer* (1987) includes land among the primary factors; (iii) it provides empirical evidence of the factor price distortions in the the post-communist transition country trade, which we compare with the developed EU countries.

In the empirical analysis we use data for 2004. The agricultural trade data is extracted from the COMEXT trade data base (*Eurostat* 2007), which provides data for Member States of the European Union on external trade with each other and with non-member countries. Factor endowments are extracted from the GTAP data base (version 7). The technology coefficients are calculated from the Farm Accountancy Data Network (FADN) firm-level data.

The paper is organised as follows. Section 2 presents the relative factor endowments in the CEE agriculture. Section 3 introduces the theoretical framework for examining the factor content of trade. Section 3.1 presents the standard Heckscher-Ohlin-Vanek (HOV) setup, where countries trade because of differences in their relative factor endowments. Section 3.2 extends the general framework by allowing for factor price variation across countries. In section 4 we examine factor intensities of the CEE-8 agricultural trade and test the HO hypothesis in both setting. Section 5 concludes and outlines avenues for future research.

2. Relative Factor Endowments in the CEE Agriculture

2.1. Factor Endowments in CEE

CEE countries differ significantly in agricultural factor endowments (table 1). In table 1 land endowments are measured in hectares of agricultural land per capita while capital endowments are measured in thousands of Euros of capital per agricultural worker. Agricultural labor force endowment is proxied by the share of agricultural employment in the total employment in 1990. We use this proxy for agricultural labor force for two reasons: (i) it is highly correlated with the unobservable agricultural labor endowment;[3] and (ii) it is exogenous, i.e. it is not determined by farm labor demand in 2004.[4] Moreover, those workers which worked in agriculture until the nineties of the last century are experienced, many of them have agricultural education and, most importantly, they

[3] In the context of the present study the agricultural labor force captures both the size of agricultural workers and the size of agricultural employment seekers.

[4] We perform sensitivity analyses using alternatives measures of rural labor endowment (rural population density, rural unemployment rate and rural-urban wage gap). Given that the use of alternative proxies does not change the presented results significantly, they are not reported here for the sake of brevity.

live in rural areas as their competitiveness for manufacturing jobs in cities is limited (*Kancs* and *Weber* 2001).[5]

Of all CEE in our sample Lithuania and Latvia are the most land abundant countries with 0.76 and 0.71 hectares of agricultural land per capita respectively. Slovenia is the least land abundant country with only 0.25 hectares of agricultural land per capita.

The lowest ratio of capital per agricultural worker is in Lithuania (2929 Euro/capita); the highest in Slovenia (6540 Euro/capita). Countries with higher GDP per capita have higher capital/labour ratios (*Davis* and *Weinstein* 2001). Slovenia was the most developed country in our sample in terms of GDP per capita and GDP in Slovenia is almost two times higher than in Lithuania.

Table 1. CEE Country Factor Endowment Ratios

	Land/Labour land/capita, ha	**Capital/Labour euro/capita**	**Agricultural labour % of total employment**
Czech Republic	0.36	4078	9.6
Estonia	0.57	3411	16.3
Latvia	0.71	3283	19.5
Lithuania	0.76	2929	18.0
Hungary	0.58	4060	17.5
Poland	0.43	4364	25.8
Slovenia	0.25	6540	8.4
Slovakia	0.36	3952	10.7
CEE	0.50	4077	15.7

Source: Authors' calculations based on Eurostat (2007) and FAO (2008) data.

The absolute labour endowment in terms of agricultural employment share in total employment is reported in column 4 of the table 1. The smallest agricultural employment share in total employment in 1990 was in Slovenia - 8.4%. Also in the Czech Republic and Slovakia agricultural labour force was relatively small compared to the rest of the CEE. The most farm labour abundant country was Poland, where in 1990 more than one quarter of all economically active workers was employed in agriculture.

To obtain the country's relative factor abundance we compute a share of the country's factor endowment to the factor endowment in all CEE countries and a share of the country's gross agricultural output (GAO) to the GAO in all CEE. The relative factor endowment is then the ratio of the share of the country's factor endowment and the share of the country's GAO. If country r's endowment of factor f relative to the CEE endowment of that factor exceeds country r's share in the CEE's GAO, i.e. $\frac{V_{fr}}{V_{fw}} > s_r$, then

[5] Although, a certain share of them has left the rural regions, worker decision to leave is an endogenous process largely driven by wage differences and employment opportunities. Hence, the current agricultural employment share cannot be considered as a measure of exogenous comparative advantages.

country r is abundant in factor f. The GAO and factor endowment shares by country are reported in table 2.

Table 2. Individual CEE Country Endowment with Land, Capital and Labour Relative to All CEE Countries

	GAO share	Labour share	Land share	Capital share
Czech Republic	0.131	0.065	0.132	0.088
Estonia	0.014	0.010	0.030	0.014
Hungary	0.157	0.079	0.156	0.109
Lithuania	0.036	0.051	0.080	0.039
Latvia	0.022	0.026	0.045	0.024
Poland	0.572	0.696	0.467	0.680
Slovakia	0.047	0.036	0.074	0.028
Slovenia	0.021	0.037	0.017	0.017
Total CEE	1.000	1.000	1.000	1.000

Source: Authors' calculations based on FADN (2008) and Eurostat (2008) data. Notes: GAO-Gross Agricultural Output.

The Czech Republic and Estonia are relatively abundant in land. Hungary is relatively scarce in all three factors - labour, land and capital. In contrast, Lithuania and Latvia are relatively abundant in all three factors - labour, land and capital. Poland is relatively abundant in labour and capital. Slovakia is relatively abundant in land and Slovenia is relatively abundant in labour but relatively scarce in land and capital. These estimates are roughly in line with the factor endowment ratios reported in table 1.

2.2. Relative Factor Intensities of Agricultural Production in CEE

The relative factor endowment differences across countries are especially an important source of comparative advantages if there are sizeable differences in factor intensities among agricultural activities (commodities). Figure 1 shows the differences between various agricultural activities in the relative labour intensity across CEE. Labour content in percent is measured on the vertical axis and the seven agricultural activities on the horizontal axis. Dots in the figure 1 represent the eight CEE countries. The average values for each sector with the corresponding standard deviations are reported next to the columns.

As shown on figure 1, labour intensity significantly differs between agricultural activities (commodities) in CEE. For example the pig and poultry production (14.6% labour content in agricultural production) is on average 2.4 times more labour extensive than horticulture (34.6% of labour content in agricultural production). Similarly, cereal and oilseed production (17.1% labour content) requires almost two times less labour than permanent crops (33.9%). Hence, the existing differences in the relative factor intensities suggest that there are potential gains from international specialisation in agricultural production and trade.

Considering Heckscher-Ohlin theory, several predictions about production and trade specialisation in CEE countries can be made. First, labour abundant Latvia and Lithuania would produce and export products with relatively high land content, and import products with relatively low land content. Slovenia has the lowest land endowment per capita, which would suggest the opposite pattern of factor content of agricultural trade. Second, farm labour abundant countries, such as Poland, which has three times higher agricultural labour endowment than other comparable CEE economies, e.g. Slovenia, would specialise in production and export of relatively labour intensive products relative to their agricultural imports. On the other hand, if other things were equal, agricultural labour scarce countries - the Czech Republic, Slovenia and Slovakia - would import relatively labour intensive goods and export labour extensive agricultural commodities.

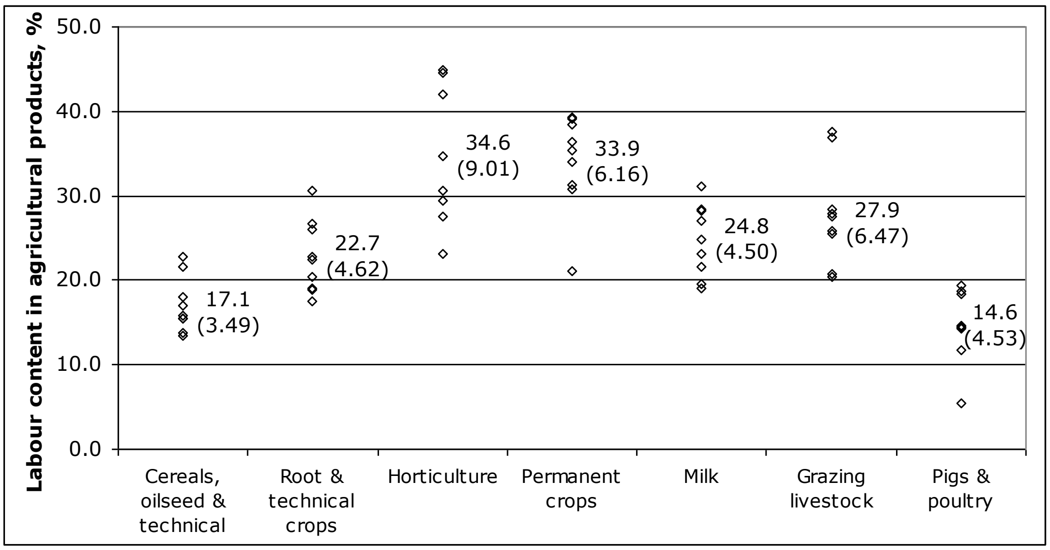

Figure 1. Labour Content in Agricultural Products in CEE Countries.

2.3. Factor Content of CEE Agricultural Trade

Here we analyse agricultural exports from CEE to the rest of the world (RoW) (most of which go to the countries of the EU) and imports from the rest of the world (most of which originate from the EU) to CEE. Second, we examine the factor content hypothesis relating the relative country endowments to factor content of agricultural trade. Given that CEE countries and old EU countries are very different, the key underlying assumptions of the HOV theory (equal factor prices, identical technologies, etc.) are not satisfied. Hence, factor content of agricultural trade between these two groups of countries cannot be analysed in the standard HOV framework. We therefore proceed as follows: (i) we analyse factor content of the CEE – rest of the world (RoW) agricultural trade relying on qualitative analysis; and (ii) we calculate not only value of factor content of trade but also quantity ratios, which may reveal the role of factor price differences between the CEE and RoW play.

The content of factor services in the gross agricultural trade flows at a disaggregated level are reported in tables 3 and 4. In both tables columns 2-4 report factor content in agricultural imports to CEE from the RoW; and columns 5-7 report factor content in agricultural exports from CEE to RoW. We use EU-25 factor intensities in production to obtain factor shares of CEE imports in tables 3 and 4. This is a good approximation given that the most of the CEE trade is with the EU (more than 75%). For exports we use factor intensities in production of CEE countries themselves.[6] Given that agricultural trade is not balanced for all countries in our sample, the factor content is calculated per unit of exports and imports.

Table 3. Factor Ratios of Agricultural Trade in 2004 (In Quantities)

	Factor ratios in imports			Factor ratios in exports		
	L/A	***L/K***	***K/A***	***L/A***	***L/K***	***K/A***
Czech Republic	13.10	0.87	15.06	7.04	0.90	7.81
Estonia	10.68	0.85	12.54	6.79	1.34	5.07
Latvia	12.54	0.82	15.23	8.40	1.90	4.42
Lithuania	11.39	0.84	13.57	8.74	2.87	3.05
Hungary	11.28	0.76	14.78	9.58	0.82	11.62
Poland	12.26	0.87	14.07	23.36	2.10	11.10
Slovenia	9.65	0.81	11.92	17.58	1.53	11.46
Slovakia	10.58	0.76	13.92	5.92	0.97	6.11
CEE	11.35	0.82	13.80	9.25	1.40	6.60

Source: Authors' calculations based on Eurostat (2007), FADN (2008) and GTAP (2008) data. Notes: *A*-land, *L*-labour, *K*-capital.

There are differences in factor content ratios computed for exports and imports. On average, the CEE tend to have higher labour content relative to capital content in exports than in imports. Additionally CEE exports possess higher land content relative to capital and relative to labour than CEE imports. These facts are as predicted by the HOV theory because CEE countries are abundant in labour and land relative to EU-25.

For imports factor content ratios differ insignificantly between the countries. Relatively stronger cross country variation is observed for factor content ratios in exports. In particular Poland and Slovenia have high labour/capital (low capital/labour) content ratio in exports, while the opposite holds for the Czech Republic and Slovakia. The Czech Republic, Hungary and Slovakia have low labour/capital ratio (high capital/labour ratio) in exports compared to other countries. According to the HOV theory, the countries with relatively high *K*/*L* endowments (Slovenia, Poland in table 2) should have high relative *K*/*L* content in exports. This is not true as Slovenia and Poland have relatively low *K*/*L* ratio in exports (table 3). On the other hand high *K*/*L* ratio in exports is observed

[6] The only exception is the Czech Republic. Due to unreliable factor price data we use Slovak factor intensities for the Czech Republic. However, given that both countries shared the same history until 1993, and have similar farm structure in 2004, using Slovak coefficients should not cause major differences in the factor content of trade data.

for Slovakia and the Czech Republic and these countries do not possess the relatively high *K*/*L* endowments.

In both exports and imports capital represents the largest factor share, which on average accounts for 58.5% and 49.1% of export and import value, respectively (table 4). Agricultural imports of the CEE countries have higher labour content than exports (45.8% and 39.5%), whereas agricultural exports from CEE contain more capital than imports to CEE (58.5% and 49.1%). The third primary production factor land accounts on average for only 2.0% (5.1%) of export (import) value.

In contrast to the results reported in table 3, where we account only for relative factor quantities, in table 4, where we account for both relative factor quantities and factor prices, capital/labour ratio is higher in CEE agricultural exports than in CEE agricultural imports (labour/capital ratio is lower for exports than for imports). More expensive capital relative to labour in CEE as compared to old EU member states reverts the ratio of capital to other factors in trade, when factor content of trade is calculated in values. This finding is in contradiction to HOV theory predictions.

According to table 4, the variation of factor content in imports is rather small across the CEE countries. Similar to table 3, a stronger variation is observed for exports. Slovakia, the Czech Republic and Slovenia have the highest share of capital content in exports, whereas labour is the largest component of agricultural exports in Estonia, Lithuania and Poland.

Table 4. Factor Content Shares of Agricultural Trade in 2004 (In Values)

	Factor shares in imports			**Factor shares in exports**		
	Land	**Labour**	**Capital**	**Land**	**Labour**	**Capital**
Czech Republic	4.68	47.65	47.66	1.50	28.64	69.86
Estonia	5.43	46.12	48.46	0.67	56.09	43.24
Latvia	4.70	46.40	48.89	1.21	42.00	56.79
Lithuania	5.24	46.44	48.31	2.36	46.82	50.81
Hungary	4.96	44.13	50.90	1.99	37.01	61.00
Poland	5.04	47.41	47.56	3.05	46.84	50.11
Slovenia	5.68	44.80	49.52	3.83	30.80	65.37
Slovakia	5.31	43.06	51.63	1.67	27.46	70.88
CEE	5.13	45.75	49.12	2.03	39.46	58.51

Source: Authors' calculations based on Eurostat (2007), FADN (2008) and GTAP (2008) data. Notes: For each countries the sum of shares normalised to 1.

On average, the exported goods are more capital intensive than agricultural goods produced domestically (58.5% and 51.7%). In contrast, locally produced agricultural goods are more labour intensive than exported goods (45.9% and 39.5%). The average land content is slightly higher in the aggregate farm output compared to agricultural exports. Slovakia, Slovenia and Estonia have the largest differences in factor content between farm output and agricultural exports, which raises important questions about differences in the drivers of factor content in agricultural trade.

Summarising findings we may conclude that the HOV theory poorly predicts factor content of agricultural trade of the CEE countries. Agricultural imports of the CEE countries have higher labour content than exports (45.8% and 39.5%), whereas agricultural exports from CEE contain more capital than imports to CEE (58.5% and 49.1%). This is surprising given the fact that the major trading partner for the CEE countries is the EU-25 which is relatively labour and land scarce and capital abundant.

Also relatively capital abundant countries in the context of CEE are observed to export low capital/labour ratio (Slovenia and Poland) while relatively labour abundant countries are observed to export high capital/labour content as measured in quantities (Slovakia). When measured in value terms again Slovakia, the Czech Republic and Slovenia have the highest share of capital content in exports, whereas labour is the largest component of agricultural exports in Estonia, Lithuania and Poland. These findings do not confirm the HOV theory.

Many reasons are identified in the literature why HO theory does not provide good predictions about international trade. In the next section we argue that the key underlying assumptions (equal factor prices, identical technologies, etc.) of the HOV theory are not satisfied. A special attention is paid to differences in technologies stemming from the organisation of farm production in CEE.

3. Theoretical Framework

3.1. The Heckscher-Ohlin-Vanek model

The standard multifactor, multicommodity, and multicountry model for predicting factor content of trade is the HOV model, which relates the factor content of trade to the relative country endowment with production factors. The key assumptions are identical technologies and identical and homothetical preferences across countries, homogenous factors, differences in factor endowment, and trade in goods and services. The HOV model predicts that if all countries would have their endowments within their cone of diversification, then factor prices were equalised across countries.

Assume that $r = 1,..,o,..,d,..,w,..,R$ index countries, $i = 1,...,I$ are industries; and $f = 1,..,f,..,g,..,F$ index factors. Let a_{io} be the amount of production factors used to produce one unit in each industry. Let Y_o be output in o, and let D_o be the demand in origin country o. The net export vector of goods, E_o, originating from country o can then be written as:

$$E_o = Y_o - D_o \tag{1}$$

The factor content of trade, A_o, i.e. the $F \times 1$ vector of trade in factor services, can then be defined as:

$$A_o = a_o E_o \tag{2}$$

where a_o is the amount of production factors used to produce one unit of output in country o. Identical technologies across countries and factor price equalisation imply that $a_o = a$, which makes the interpretation of $A_o = aE_o$ straightforward: a positive value of an element in A_o indicates that the factor is exported and a negative value indicates that the factor is imported.

The factor content of trade can be calculated either for trade with the rest of the world or between country pairs. In the former case country o's consumption, D_o, must be proportional to the total world consumption, D_w:

$$D_o = s_o D_w \tag{3}$$

where s_o is o's share in the world demand, D_w. Assuming that the world production is equal to the world consumption we obtain:

$$aD_o = s_o aD_w = s_o aY_w = s_o F_w \tag{4}$$

Assuming full employment of all primary factors we can write $aY_o = F_o$, where F_o is the factor endowment in country o. Together with the expressions for aE_o and aD_o yields the standard HO hypothesis:

$$A_o \equiv aE_o = F_o - s_o F_w \tag{5}$$

The left hand side of equation (146) captures the production side of the HOV theorem and is often labelled as the measured factor content of trade. The right hand side of equation (146) captures the consumption/demand and is referred to as the predicted factor content of trade.

For factor f the HO hypothesis can be rewritten as:

$$A_o^f = F_o^f - s_o F_w^f \tag{6}$$

where F_o^f and F_w^f are factors f's endowments of country o and the world w. Equation 0 relates country o's factor f's net content of trade to its own and the world's endowments. This world version of the HO hypothesis 0 has been tested in many previous studies yielding both supporting and rejecting results (*Bowen*, *Leamer* and *Sveikauskus* 1987; *Trefler* 1995).

According to *Davis* and *Weinstein* (2001), the world version has several conceptual disadvantages over the country pair version for assessing the success of the HO hypothesis. First, in the country pair version, one does not have to employ and construct endowment data for the whole world. This is important because the world endowment figures are wrong as soon as countries are missing, or as soon as the data for a particular country are unreliable. Second, and more importantly, the two-country version requires that the specific HO assumptions hold only for the two countries considered (*Brecher* and *Choudri* 1988). This is important, because as soon as the assumptions of the HO do not hold for the world as a whole, relying on the world endowments is not correct.

As shown in *Kancs* and *Ciaian* (2008, 2010), the country pair version of the HO hypothesis can be expressed as follows:

$$\left(F_d^g / F_d^f - F_o^g / F_o^f\right)\left(A_{od}^f / A_{od}^g - A_{do}^f / A_{do}^g\right) \geq 0 \tag{7}$$

where A_{od}^f is factor f 's content of trade from o to d. Inequality 0 suggests that if country d is more abundant in g than country o, i.e. $F_d^g / F_d^f > F_o^g / F_o^f$, then the g/f ratio embodied in country d 's exports to country o cannot be lower than the g/f ratio embodied in country o 's exports to d, i.e. $A_{do}^g / A_{do}^f \geq A_{od}^g / A_{od}^f$.

3.2. The Augmented HOV Framework

Several authors argue that the unrealistic assumptions of the HOV model is one reason why the HO hypothesis has often been rejected (*Leamer* 1980; *Schott* 2003). In particular, the factor price equalisation is often questioned in the recent literature.

In order to account for the cross-country differences in the relative factor prices, we extend the theoretical framework by following *Brecher* and *Choudhri* (1982); *Helpman* (1984), who consider a trade equilibrium in which factor prices are allowed to differ across countries.[7]

Let w_o be the vector of factor prices in country o. With constant-returns to scale technology, the unit cost, c_{io}, of producing good i in country o is given by

$$c_{io} = w_o a_{io} \tag{8}$$

[7] Choi and Krishna (2004) are the first to note the implications of these relaxed assumptions for HO testing. Using a sample of 8 OECD countries they test the theoretical predictions of Helpman (1984) and find strong evidence supporting the 'augmented' HO hypothesi

Perfect competition implies zero profits on exports of good i from origin country o to destination country d. Hence, $c_{io} = p_{io}$ where p_{io} is good i's output price in country o. Under free trade $p_{io} = p_i$ implying that

$$p_i = w_o a_{io} \tag{9}$$

For importing country d, unit profits on good i must be non-positive:

$$p_i \leq w_d a_{id} \tag{10}$$

With constant returns to scale technology and homogenous firms within industries, equation 0 holds for all industry i's firms in importing country d. Combining equations 0 and 0 yields the relationship of unit costs in exporting country, o, and hypothetical unit costs in importing country, d:[8]

$$w_o a_{io} \leq w_d a_{io} \tag{11}$$

Equation 0 describes the predicted relationship between the direct factor requirements, a_{ir}, and factor prices, w_r, for industry i in the trade equilibrium. According to equation 0, direct factor requirement, a_{io}, in exporting country may differ from the direct factor requirement, a_{id}, in importing country due to differences in factor prices, $w_o \neq w_d$.

The aggregate amount, A_{iod}, of factors that is used to produce one unit of sector i's exports from o to d is derived by aggregating 0 over i using industry-level trade volume shares as weights $A_{iod} \equiv a_{io}\left(\frac{E_{iod}}{\sum_i E_{iod}}\right)$:

$$\sum_i w_o A_{iod} \leq \sum_i w_d A_{iod} \tag{12}$$

Alternatively, for importing country d:

$$\sum_i w_d A_{ido} \leq \sum_i w_o A_{ido} \tag{13}$$

[8] These results are identical with those of free trade in intermediates and uniform technology. For the implications of costly trade of intermediate inputs see Staiger (1986).

where E_{iod} denotes the volume of gross exports of good i from origin country o to destination country d and A_{iod} denotes the vector of weighted factors required directly to produce each unit of E_{iod}. Equations 0 and 0 predict the factor content of bilateral trade between o and d.

As shown in *Kancs* and *Ciaian* (2008, 2010), equations 0 and 0 can be rearranged to derive the HO hypothesis of the extended HOV model:

$$\left(w_d^f / w_d^g - w_o^f / w_o^g\right)\left(A_{do}^g / A_{do}^f - A_{od}^g / = A_{od}^f\right) \geq 0 \tag{14}$$

Equation 0 implies that if country d has a higher f / g factor price ratio than country o, ($w_d^f / w_d^g > w_o^f / w_o^g$), then the f / g ratio embodied in country d's exports to o cannot be higher than the f / g ratio embodied in country o's exports to d ($A_{do}^g / A_{do}^f \geq A_{od}^g / A_{od}^f$).

Several issues need to be noted about equation 0. First, it allows for (although it does not require) cross-country differences in factor prices, $w_o \neq w_d$. Hence we are able to account for the empirically observed variation in factor prices across countries. Second, equation 0 can be used to directly compare factor content of bilateral trade. However, according to *Staiger* (1986), it is not valid for comparing the indirect factor content of bilateral trade. Third, given that all variables are observable in the data, equation 0 can be tested empirically.

4. Empirical Results

4.1. Factor Content of Trade under Factor Price Equalisation

We test two versions of the HO hypothesis: the world version and the country-pair version. For the world version we rewrite equation 0 as a difference between the observed and the predicted factor content of trade. As a result, we obtain testable HO hypothesis for the *world version* of the HOV model:

$$HO_{fo} \equiv A_{od}^f - \left(F_o^f - s_o F_w^f\right) = 0 \tag{15}$$

We estimate equation 0 for two groups of EU countries instead of the whole world.[9] This allows us to avoid constructing and employing endowment data for the world as a whole, which is not available for agricultural activities at a reasonable confidence level.

[9] The CEE-8 group includes the eight Central and Eastern European economies. The EU-25 group contains the 25 countries (including the CEE-8) which were EU Member States by the end of 2004.

In addition, by restricting trade within the EU, we hope that the HO model's theoretical requirements would be satisfied at least approximately.

We test the HO hypothesis using the sign and rank tests. The sign test asks whether the sign of the measured factor content of trade, A_r^f , is the same as that of the predicted factor content of trade, $F_r^f - s_r F_w^f$. Strength of the sign test is that large outliers are unlikely to affect the results. A weakness of the sign test is that countries with small predicted factor content of trade may have many sign errors (weak test performance) without it indicating a major problem for the theory. Rank test puts a little more structure on the data by asking whether countries that are predicted to be large exporters/importers of a factor are measured to do so.

Given that agricultural trade is not balanced between the EU countries, we calculate the observed factor content of agricultural trade and the predicted factor content of agricultural trade per unit of trade flow. The HO test results obtained estimating equation 0 are reported in Table.

According to the test results reported in Table, the average HO test performance is rather poor. However, there is a significant variation in the HO test performance between countries and factors. Generally, the HO test performance is higher in the case of full sample (EU-25). This is true both for the sign and rank tests and for all three factors. On average, the rank test performance is higher than the sign test performance. As noted above, this might be due to the fact that in the sign test countries with small predicted factor content of trade may have many sign errors (weak test performance). This is corrected for in the rank test.

Table 5. HO test results for the net agricultural trade in the EU

	Test	$HO_{CEE-8} \geq 0$	$HO_{EU25} \geq 0$
		(1)	**(2)**
Labour	Sign	0.63	0.71
	Rank	0.75	0.79
Land	Sign	0.50	0.53
	Rank	0.66	0.67
Capital	Sign	0.75	0.82
	Rank	0.73	0.77
No of observations		24 (8 × 3)	75 (25 × 3)

Notes: Both sign and rank tests are calculated using equation 0 and are based on input value per one unit of the net agricultural trade in 2004. The unweighted averages are calculated as a percentage of the respective maximum values.

The sign test results reported in Table suggest that in the case of labour the hypothesis $HO_{fo} = 0$ is satisfied in trade flows of approximately two thirds of countries (63% of the CEE-8 and 71% of the EU-25). The rank test results for labour are even better (75% and 79%, respectively). According to the sign test, the hypothesis $HO_{fo} = 0$

is most often satisfied for the capital content of agricultural trade (75% for the CEE-8 and 82% for the EU-25). The rank test confirms the sign test's results that the HO prediction for capital 0 is satisfied in roughly three-fourth country's agricultural trade. The sign test's performance is relatively poor for land - only half of the tested CEE-8 countries and just above the half (53%) of the EU-25 countries match the predicted import/export content of land with the observed import/export content of land. The relatively poor HO performance for land is also confirmed by the rank test - it has the highest average rank deviation (34% and 33% for the CEE-8 and EU-25, respectively). One way how to interpret these results is that they provide an indirect evidence of transaction costs and market imperfections, which are particularly high for land compared to the mobile factors labour and capital (*Kancs* and *Ciaian* 2010; *Ciaian, Kancs and Pokrivcak* 2010).[10]

Second, we test the *country-pair version* of the HO hypothesis, which is derived from equation 0:

$$HO_{od} \equiv \left(F_d^g / F_d^f - F_o^g / F_o^f\right)\left(A_{od}^f / A_{od}^g - A_{do}^f / A_{do}^g\right) \geq 0 \qquad (16)$$

Hypothesis $HO_{od} \geq 0$ predicts that if country d is more factor g abundant than country o, i.e. $F_d^g / F_d^f > F_o^g / F_o^f$, then the g/f factor ratio embodied in country d's exports to country o cannot be lower than the g/f factor ratio embodied in country o's exports to d, i.e. $A_{do}^g / A_{do}^f \geq A_{od}^g / A_{od}^f$.

In the case of three factors the hypothesis $HO_{od} \geq 0$ allows for testing of three unique factor ratio hypothesis: capital-labour, capital-land and land-labour. The test results for the CEE-8 and EU-25 are reported in Table.

According to the sign statistics reported in Table, the HO test performance is rather weak. On average, just more than half of all country pairs satisfy the hypothesis $HO_{od} \geq 0$. Compared to the hypothesis $HO_{fo} = 0$ (Table), the HO test performance is poorer for the bilateral trade (Table). However, as above, there is a significant variation in the HO test performance between countries and factors. Generally, the HO test performance is higher in the case of full sample (EU-25). This is true for all three factor ratios reported in Table.

The sign statistics reported in Table suggests that for the labour/capital ratio the hypothesis $HO_{od} \geq 0$ is satisfied for 57% of bilateral trade flows between CEE-8

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[10] As a robustness check, we test the hypothesis $HO_{fo} = 0$ with respect to the factor content of the total trade (not per unit). This alternative evaluation allows us to assess the magnitude of the deviations across factors. Again, the HO test results suggest significant discrepancies between the predicted and observed factor content of aggregate trade in CEE-8. As an additional robustness check, we also perform the HO sign and rank tests for factor quantities of agricultural trade. The quantity tests yield qualitatively similar results, though the magnitudes of both the predicted and observed factor content of trade change. Therefore, the results presented above are not repeated.

countries and 69% EU-25 countries. The $p-$ value of the sign test are 0.10 and 0.03, which means that the probability of having $HO_{od} \geq 0$ for more than 57% and 69% of the time is about 10% and 3%. According to the third row in Table, the test statistics is lower for the land/labour ratio, where the hypothesis $HO_{od} \geq 0$ is satisfied for 46% (CEE-8) and 57% (EU-25) of bilateral trade flows of agricultural goods. The hypothesis $HO_{od} \geq 0$ cannot be rejected at the 17% and 8% significance level, respectively. The test performance is slightly higher for the capital/land ratio. For the CEE-8 the hypothesis $HO_{od} \geq 0$ is satisfied for 53% and for EU-25 for 61% of bilateral trade flows. However, the results are less significant. Hence, the sign statistics reported in Table also suggests that the best test performance (69%) is for labour/capital content of the bilateral trade between the EU-25 countries.

Table 6. HO test results for the bilateral trade in the EU

	$HO_{CEE-8} \geq 0$	$HO_{EU25} \geq 0$
	(1)	**(2)**
Labour/Capital	0.57	0.69
	(0.10)	(0.03)
Land/Labour	0.46	0.57
	(0.17)	(0.08)
Capital/Land	0.53	0.61
	(0.19)	(0.13)
No of observations	84 (28 × 3)	900 (300 × 3)

Notes: Sign test results based on equations 0; p-values in parenthesis.

Generally, the results reported in Table and 2 are in line with the previous studies on the factor content of agricultural trade in the USA (*Schluter* and *Lee* 1978; *Lee*, *Wills* and *Schluter* 1988). In particular, the average HO test performance of the three studies is of the same order of magnitude as the EU-25 in Table and 2. Our estimates for the CEE-8 are somewhat lower than those in the previous literature. This may be explained by the factor price distortions in the post-centrally planned CEE-8 transition economies.

4.2. Factor Content of Trade without Factor Price Equalisation

In this section we test the HO hypothesis of the extended model, which was given in equation 0:

$$HO_{od} \equiv \left(w_d^f / w_d^g - w_o^f / w_o^g\right)\left(A_{do}^g / A_{do}^f - A_{od}^g / A_{od}^f\right) \geq 0 \tag{17}$$

Hypothesis 0 implies that if country d has a higher f/g factor price ratio than country o, ($w_d^f / w_d^g > w_o^f / w_o^g$), then the f/g ratio embodied in country d's exports to o cannot be higher than the f/g ratio embodied in country o's exports to d ($A_{do}^g / A_{do}^f \geq A_{od}^g / A_{od}^f$).

As above, in the case of three factors the hypothesis $HO_{od} \geq 0$ allows for testing of three unique factor ratio hypothesis: capital-labour, capital-land and land-labour. The test results for the CEE-8 and EU-25 are reported in Table 1.

According to the sign statistics reported in Table 1, the average test performance is reasonable and most of the $p-$ values reasonably small. On average, about two-thirds of all country pairs satisfy the hypothesis $HO_{od} \geq 0$. Compared to Table, the HO test performance has increased in Table 1. These results are in line with HO models without factor price equalisation (*Helpman* 1984 and *Staiger* 1986). However, as above, there is a significant variation in the HO test performance between countries and factors. Again, the HO test performance is higher in the case of full sample (EU-25). This is true for all three factor ratios reported in Table 1.

Table 1. Augmented HO test results for the bilateral trade in the EU

	$HO_{CEE-8} \geq 0$	$HO_{EU25} \geq 0$
	(1)	**(2)**
Labour/Capital	0.62	0.78
	(0.08)	(0.02)
Land/Labour	0.55	0.67
	(0.14)	(0.05)
Capital/Land	0.64	0.70
	(0.11)	(0.09)
No of observations	84 (28 × 3)	900 (300 × 3)

Notes: Sign test results based on equations 0; p-values in parenthesis.

The sign statistics reported in Table 1 suggests that for the labour/capital ratio the hypothesis $HO_{od} \geq 0$ is satisfied for 62% of bilateral trade flows between the CEE-8 countries and 78% between the EU-25 countries. Both values have increased compared to Table, suggesting that relaxing the assumption of factor price equalisation increases the HO test performance. The p^{-1} value of the sign test are 0.08 and 0.02 suggesting that the statistical significance of the results has increased in the augmented HO model (without factor price equalisation). As in Table, the test statistics is lower for the land/labour ratio, where the hypothesis $HO_{od} \geq 0$ is satisfied for 55% (CEE-8) and 67% (EU-25) of bilateral trade flows of agricultural goods. Note, however, that in the augmented model the test statistics has improved for both groups of countries. The hypothesis $HO_{od} \geq 0$

cannot be rejected at the 14% and 5% significance level, respectively, which is an improvement compared to the standard HO model. The capital/land test performance is between the labour/capital and land/labour test performances. For the CEE-8 the hypothesis $HO_{od} \geq 0$ is satisfied for 64% and for EU-25 for 70% of bilateral trade flows, which is an improvement of about 10% compared to hypothesis 0. Also the significance of the results has improved - the $p-$ value of the sign tests decreased from 0.19 to 0.11 and from 0.13 to 0.09 for the CEE-8 and EU-25 country pairs, respectively.

Generally, we may conclude that the test statistics reported in Tables 1-3 is robust with respect to two alternative specifications: (i) factor content of net trade (world version); and (ii) factor content of bilateral trade (country pair version). Second, the group of EU-25 countries perform better than the group of CEE-8 countries. Third, the observed labour and capital content of agricultural trade is more consistent with the predicted factor content of trade than land. One way how to interpret these results are transaction costs and market imperfections, which are considerably higher for agricultural land than the mobile factors labour and capital (*Ciaian* and *Swinnen* 2006). On the other hand, the assumption of homogenous factors is particularly critical for land, the quality of which is highly heterogenous across the EU (*Kancs* 2007). Fourth, the sign statistics of the augmented HO model is considerably better than of the standard HO model. This in turn implies that, at least in the agricultural trade, factor price equalisation is a limiting assumption which distorts empirical results of the relative factor endowment theory. These results are in line with previous studies testing a generalised version of the HO model (*Choi* and *Krishna* 2004; *Kancs* and *Ciaian* 2010).

5. Conclusions

The present paper studies the factor content of agricultural trade in the EU. We examine the relative abundance for labour, capital and land in two sets of countries (the post-centrally planned CEE-8 transition economies and EU-25), and test the Heckscher-Ohlin (HO) hypothesis in two different models: the classical and a more general. A unique firm-level panel data for the EU-25 allows us to calculate input-output coefficients for different agricultural sub-sectors, which combined with detailed trade data from the Comext data base allows us to estimate factor content of activity-specific agricultural trade.

Complementing the previous work of *Schluter* and *Lee* (1978); *Lee*, *Wills* and *Schluter* (1988); *Kancs* and *Ciaian* (2010), our empirical findings suggest that the results are robust with respect to two alternative specifications: (i) factor content of net trade (world version); and (ii) factor content of bilateral trade (country pair version). Comparing the two sets of tested countries we may conclude that the group of EU-25 perform better than the group of CEE-8 countries, which include only the post-centrally planned Central and Eastern European transition economies. The worse test performance for the CEE-8 may be driven by two factors: (i) factor price bias from the central-planning period; and (ii) lower diversification compared to the EU-25 sample. Third, the observed labour and capital content of agricultural trade is more consistent with the predicted factor content of trade than land. On the one hand, these results can be related to transaction costs and market imperfections, which are considerably higher for agricultural land than the mobile factors labour and capital (*Ciaian* and *Swinnen* 2006). On the other hand, the assumption of homogenous factors is particularly critical for land, the quality of which is highly heterogenous across the EU. Fourth, the augmented HO model performs considerably better than of the standard HO model, which implies that factor price equalisation is a limiting assumption, which distorts empirical results of the relative factor endowment theory. These results are in line with previous studies testing the generalised version of the HO model (*Choi* and *Krishna* 2004; *Kancs* and *Ciaian* 2010).

Data Appendix

In the empirical analysis we use data for 2004. The agricultural trade data is extracted from the COMEXT trade data base, which is maintained by the *Eurostat*. The COMEXT data base provides data for Member States of the European Union on external trade with each other and with non-member countries. It contains data on external trade collected and processed by all EU Member States and more than 100 trade partners, including U.S.A., Japan and the EFTA countries. The factor endowments for the analysed countries are extracted from the GTAP data base version 7. The base year of the GTAP v. 7 data base is 2004.

The technology coefficients are calculated from the Farm Accountancy Data Network (FADN) firm-level data. The FADN is a European system of sample surveys that take place each year and collect structural and accountancy data on the farms. In total there is information about 150 variables on farm structure and yield, output, costs, subsidies and taxes, income, balance sheet, and financial indicators. The annual sample of FADN covers approximately 80.000 agricultural farms. In 2004 they represented a population of about 5.000.000 farms in the 25 Member States, covering approximately 90% of the total utilised agricultural area (UAA) and accounting for more than 90% of the total agricultural production of the EU. Farm-level data are confidential and, for the purposes of this study, accessed under a special agreement.

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"TRADES LIKE CHICKEN? THREE REPRESENTATIONS OF CHICKEN TRADE FOR POLICY AND MARKET ANALYSIS"

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Abstract

Quantitative policy analysis can be based on any of several representations of market structure. We add to the literature by representing chicken trade in three ways: one homogeneous good, two homogeneous co-products, and heterogeneous goods differentiated by country of origin. Each representation is characterized by trade equations, and certain data and elasticities. Key supplies and demands are changed as little as possible among representations for consistency, so differences in results only come from the fundamentally different assumptions about what 'chicken' is. We simulate the effects of liberalization of US and Mexican chicken imports, US export support, and external shocks to supply and demand. We find that chicken trade policy analysis results in particular depend on market structure, but effects of shocks to underlying supply and demand are less sensitive to the structure.

Keywords: chicken, chicken trade, product aggregation, exotic Newcastle disease

Introduction

Analysts' decisions about how to represent markets may be motivated by the costs and benefits of different representations. One way to reduce the cost is to use a model structure that minimizes data processing, potentially leading analysts to favor model structures whose input data correspond as closely as possible to published data. In the case of chicken meat, for example, publicly available data are most suitable to two particular representations, as one homogeneous commodity or as commodities differentiated by country of origin. Other approaches requires costly data processing. But

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the choice of one representation over the others has implications for analytical results that typically are not noted, let alone identified quantitatively.

One opportunity for chicken trade policy analysis arises from China's complaint that U.S. constraints on chicken imports serve as a non-tariff barrier to trade:

> Washington has refused entry to China's chicken products on health grounds since 2007. The extension of the ban was made explicit in March, when US President Barack Obama signed into law a federal budget that included a line, in Section 727, that specifically forbids imports of Chinese poultry products. The clause drew a harsh response from Chinese trade officials, who denounced the ongoing ban as clearly discriminatory. (Bridges, 2009a)

China requested that a panel be formed at the World Trade Organization to rule on this import prohibition (Bridges, 2009b). This action puts a point to more general questions about the effects of US rules limiting chicken imports for phytosanitary reasons and the implications of using available data and economic representations to answer this question.

We apply three representations of chicken meat markets to test how this choice affects market and policy analysis. We use the models to assess the effects of US and Mexico chicken meat import restrictions, US export subsidies, and external shocks. Our results address two questions: (1) how sensitive is chicken trade policy analysis to the choice of model structure; and (2) how sensitive is analysis of certain external shocks to chicken model structure. The trade policy simulation results are sensitive to trade specification, leading in particular to different outcomes in the event of greater US imports, but the external shock effects are roughly similar among these representations of trade.

Representations of Chicken

Chicken policy analysis is not new. This may be a surprise given that chicken trade and support policy has historically been viewed as having a lower support than for many other commodities (OECD, 2007). More recent support estimates that focus on single-commodity transfers, payments that are tied to only one activity, suggest that poultry producers has been 10-18% of the gross poultry production receipts for OECD members in aggregate (OECD, 2010). According to this source, poultry has moved from 13 out of 16 commodities in terms of its share of gross receipts caused single-commodity transfers in 1986-88 to 5th highest share in 2007-09, with this change following from policy changes that reduced tied support for other commodities. Canadian supply control, including restrictions on domestic production and imports, represents a more striking exception, with the OECD estimating that the share of gross farm value attributable to single-commodity support rising from 12% in 1986-88 to 18% in 2007-09. The OECD estimates that EU support to poultry also increase as a share of gross receipts, rising from 13% in 1986-88 to 36% in 2007-09. The OECD (2010) estimates that in 2007-09 Mexico's single-commodity support to poultry production accounts for only 12% of gross receipts and that there is no single-commodity support to poultry production in the US. The OECD data do not include any restrictions to trade related to sanitary and phytosanitary barriers, such as efforts to prevent the spread of avian diseases. The U.S. exports a large amount of chicken meat and imports almost none, possibly owing to measures to prevent imports of goods with exotic Newcastle disease from affecting the domestic flock (Orden et al., 2002; USDA-APHIS, 2008).

Databases relating to production and consumption often treat a country's chicken as a single aggregate, sometimes as part of a larger aggregate (FAOSTAT, PSD, GTAP). Possibly as a consequence of the definition of these data, several large-scale agricultural commodity models appear to represent chicken as a single homogeneous good. Agriculture and Agri-Food Canada, USDA-ERS, FAPRI, and OECD-FAO baseline data represent chicken meat as a single good in production, consumption, and trade. Country-of-origin product differentiation is another important representation. By exploiting data that report quantities and values of bilateral trade, a researcher could implement this representation largely based on available data. Country-of-origin differentiation is one characteristic of the GTAP general equilibrium model, but chicken is part of a broader aggregate (non-ruminants) in the base data of the GTAP model (Gehlhar et al., 1997; GTAP, 2008).

A third approach is to differentiate chicken meat by cut or into white and dark meat. Quantity data relating to these two markets are not readily available, but some sources indicate that such a disaggregation is warranted. The retail prices of whole chickens, breasts, and legs can be used in farm-to-retail poultry price margins (Reed, Elitzak, and Wohlgenant, 2002). U.S. consumer price index calculations reflect the potential for prices of varieties within broad aggregates to move in different directions, such as chicken breast price and chicken leg price (Reinsdorf, 1998). As for trade, the U.S. typically exports dark meat and very little white meat. During NAFTA implementation, the U.S. exported dark and mechanically deboned meat to Mexico, but not white meat despite the absence of barriers (Hahn et al., 2005). Preferences for white and dark meat likely vary. For example, whereas U.S. consumers seem to prefer white meat, consumers in India prefer dark meat (Landes, Persaud, and Dyck, 2004). Cheney et al. (2001) advise caution when using a broad poultry demand aggregate in the course of endogeneity tests.

Chicken market representation in policy analysis apart from large-scale models has varied. Gervais et al. (2007) summarize the literature addressing Canadian chicken policies such as supply control. Rude and Gervais (2006), for example, assess steps toward trade liberalization in the face of variable world prices based on a representation of chicken as one good with farm-level supply and demand. In the course of updating chicken tariff equivalent calculations by Moschini and Meilke (1991), Huff et al. (2000) assume a homogeneous good but find that trade statistics suggest that chicken should not be viewed as a homogeneous good. They propose differentiation by cut as an area for further research.

Chicken policies of other countries have also been subject to analysis. Alston and Scobie (1987) assess how changes in the European Union's Common Agricultural Policy would affect poultry trade and the results of countering US poultry export subsidies. In a rare instance that compares model based on different definitions of the good, they find small differences between an homogeneous single-good representation and one based on differentiation by country of origin. A single model with disaggregated high- and low-value cuts of chicken, which are viewed as largely synonymous with white and dark meat, and a country-of-origin differentiation within each of these types has also been explored in the context of sanitary measures (IFPRI, 2004; Peterson and Orden, 2005). An earlier version of this model also used a representation of chicken differentiated into high- and low-value cuts, but then treated the cuts as homogeneous goods rather than using country-of-origin differentiation within cut trade (Orden et al., 2002). There, authors take into account the influence of trade barriers relating to phytosanitary and sanitary measures by disallowing certain bilateral flows. However, apart from Alston and Scobie (1987) who apply two structures, authors typically assume a single representation and do not explore alternative representations.

The problem of product definition is not unique to the commodity we choose to examine. Alston (2005) lists three dimensions of aggregation that cause data relating to markets for fundamentally homogeneous goods to take on some properties of heterogeneous goods, particularly in trade data. First is form: different types of a commodity or products along the chain of production might be traded among countries. For example, one type of wheat might be exported from a country even as it imports another type of wheat, so a modeler working with a single aggregate of wheat will struggle to represent these flows. The second is space: national average data may obscure differences. Even if it is cheaper in one part of Canada for pork to be imported from the US, another part of Canada might be producing pork competitively, but these regional differences would not be easily represented in a model based on aggregate pork data for Canada. The third is time: seasonal production patterns lead to seasonal trade flows that might be misinterpreted by models that operate over only annual data. A soybean importer might buy from the US when it harvests soybeans and then buy from South America when Brazil and Argentina harvest soybeans, but a model built from annual data might not capture well the seasonal switch between export suppliers. Alston's first dimension of aggregation, form, is explored here by simulating the effects chicken trade policy changes and external shocks using three representations of chicken trade.

Our contribution is to explore the implications of modeling chicken trade in three different ways, any one of which might be judged acceptable *a priori* and each with its particular costs, in contrast to almost all previous studies. We shock the three model frameworks with trade policy changes and external factors to compare the results directly. This paper can in a sense be seen as both update to and extension of Alston and Scobie (1987) and an alternative to studies that assume one approach, which is the case for the vast majority of research. As such, our results shed light on the appropriateness of the standard analysis to modeling chicken markets, namely using a single approach without testing alternatives. We also recognize the costs of the different options in terms of the required data and elasticities.

Models: Data and Equations

We build three representations of chicken markets, each based on a different assumption about product homogeneity and heterogeneity:

- One-good: chicken is a single good no matter where it is produced and consumed, or what type of cut.
- Two-good: white meat and dark meat are co-products that are distinct goods, but white meat is one homogeneous good and dark meat is another homogeneous good regardless of the production location.
- Country-good: chicken is distinct based on where it is produced, but not by cut.

Our data and parameters are based on those used in an existing model, where possible. Data and parameters cannot be exactly constant among the models; each model requires some changes from the basic data of the one-good case. For example, the total consumption of the one-good model must be disaggregated between dark and white meat in the two-good model and by country of origin in the country-good model. This decomposition of aggregate chicken demand relative to the one-good model also requires additional elasticities governing cross-price effects. However, we minimize these adjustments so the differences in output reflect differences in structure instead of alternative values for key parameters. The data and model details are reported in an appendix that is available on request.

Model Data

Data represent some of the key players in the international chicken markets in 2004, namely Brazil, Japan, Mexico, and the U.S., plus trade of the rest of the world (ROW) (Table 1). Domestic price data are from national sources in all cases. For the one-good case, data for chicken prices at farm and aggregated chicken production and trade (exports and imports) are from the AGLINK-COSIMO data base of the OECD and FAO. Stocks are ignored in this and both of the other representations. Chicken consumption data are the market residual in the one-good case.

The one-good model data are not sufficient for the country-good model. Bilateral trade shares are drawn from the FAO. For each country, we assume that at least 10% of imports must come from the US and at least 10% from Brazil. As a way to handle instances of zero initial trade, “obvious *ad hoc* solutions are replacing zero trade flows with small numbers and/or increasing the substitution elasticity between imported goods or aggregating regions or products”, but these are not the only approaches and not always successful ones if the goal is to reconcile expected large changes with small results that follow from small initial values (Komorovska et al., 2007). We return to this point later, but in practice the largest volume effect of these minimums is on Mexico’s imports of chicken from Brazil, and the bilateral trade shares between US and Brazil also rise.

Bilateral trade shares multiplied with total trade data of the one-good model so that the total import data of the country-good and one-good models are the same.

In the country-good case, consumption of imported chicken equals chicken imports. Consumption of domestic chicken equals the total consumption (from the one-good case) minus imported chicken consumption. The domestic market clearing identity determines exports of the domestically produced good (e.g. production less consumption of the domestic good equals exports). Exports to the rest of the world is the residual of total exports less the bilateral trade to other modeled countries.

Table 1. Model data for base year 2004

	Model	Brazil	Japan	Mexico	U.S.	ROW
Quantities		(thousand tons)				
Production, total	all three models	8241	1239	2245	15451	-
White	two good	4450	669	1212	8343	-
Dark	two good	3791	570	1033	7107	-
Consumption, total	one good	5805	1577	2542	13305	-
White	two good	3268	1011	1212	8280	-
Dark	two good	2538	566	1330	5025	-
Domestic	country good	5805	1235	2240	13288	-
Imported	country good	0	342	302	16	-
Imports net, total	one good, country good	0	342	302	16	3946
White meat imports	two good	0	342	0	16	904
Dark meat imports	two good	0	0	302	0	3042
Imports from Brazil	country good	-	279	30	3	2125
Imports from Japan	country good	0	-	0	0	3
Imports from Mexico	country good	0	0	-	0	4
Imports from U.S.	country good	0	28	298	-	1836
Imports from ROW	country good	0	34	3	15	-
Prices		(USD per 100 kg)				
Domestic producer	one good, country good	87	390	152	151	117
White	two good	92	223	202	217	122
Dark	two good	81	587	93	73	111
Import	country good	102	213	61	151	117

Notes: data from OECD and FAO, with calculations as described in the text. At least 10% of imports are assumed to come from Brazil and the US regardless of base data.

Data for the two-good case are more complicated because chicken production, trade, and consumption by cut data are not readily available. Chicken production is separated into white (breasts and wings) and dark (legs and back) meat based on assumed chicken cut-out rates, much as Rude et al. (2007) applied in the case of cattle. In this case, a 54%-to-46% distribution between white and dark meats is applied for all countries.

White and dark meat trade data for the two-good model are constructed as follows. The initial step is to choose a benchmark world price for each of the two homogeneous goods. The world price indicators are the average Brazilian wholesale price of chilled bone-in breast and wings for white meat and Brazilian wholesale price of chilled legs, plus an assumed transportation cost (equal to USD 30 per 100 kg in 2004). The second step is to compare average unit values of exports and imports to these benchmark prices (all expressed in USD) and draw conclusions about how much is white meat and how much is dark meat. For exports, for example, there are three possibilities: (1) if the average unit value of exports is less than the world white meat price and greater than the world dark meat price, then the shares are calculated so that the weighted average of white and dark meat prices equals the average unit value; (2) if the average unit value is greater than the white meat price, then all exports are assumed to be white meat; and (3) if the average unit value is lower than the dark meat price, then all exports are assumed to be dark meat. A similar comparison of average unit value of imports to world white and dark meat prices is used to calculate the shares of imports that are white and dark meat.

All chicken trade does not take the form of either of two strictly homogenous products. The first problem is the trade of whole birds which is still important in some cases, such as that of Brazil, although a small part of trade overall. Whole bird trade could be treated separately, making the two-good model a three-good model, but because the quantities are not large overall, we subsume whole bird trade into parts trade. Whole bird trade is separated from total trade and is not allocated in the manner described above. Instead, whole bird trade is allocated into white and dark meats on the basis of the production chicken cut-out rates (54% and 46%). The second problem is that chicken trade is comprised of more than two forms. Chicken products include frozen, fresh, bone-in, boneless, skinless, meat from spent fowls, and so on. It is not surprising that the unit import or export price can be above both of the world indicator prices of white and dark meat or below both of the world indicator prices. As noted earlier, it is assumed that if the traded price was above the world indicator price of white meat then all trade was white meat, and if the traded price was below the world indicator price of dark meat then all trade was dark meat. This fix should not obscure the fundamental problem that unit values might be misleading in this context. However, the likely alternative, the harmonized system, does not break chicken trade according to the different cuts for all countries. Because one goal of this exercise was to explore the potential to disaggregate many countries' trade, our inability to use the harmonized system in all cases was a serious limitation.

Market-clearing identities are used to calculate certain numbers in the two-good case. Consumption data for each modeled country are calculated as the residual of the market-clearing balance (e.g. white meat consumption equals domestic production plus imports less exports). Rest of world net trade is the residual of world market-clearing identities (e.g. ROW net white meat exports equals the negative of the sum of all other countries' net white meat exports).

The base year data are summarized (table 1) and available in appendix material available from the authors. The table indicates which data are used for which model, but the data calculations are intended to minimize these differences. A consequence is an occasional mismatch of data. For example, in order to use total import data from AGLINK-COSIMO in all three representations, the bilateral trade data necessary for the country-good model are calculated from FAO shares multiplied with this total instead of using FAO trade totals directly. Thus, although different data are required for different representations, the data are as similar as possible so that results are as comparable as possible.

Model Equations

Structure and elasticities are the same for all models to make the results comparable, unless the assumption about the composition of the good requires otherwise. The elasticities are chosen with a view to represent a medium-term adjustment period. Chicken demand elasticities in the one-good case and aggregate chicken demand in the country-good case are taken from the AGLINK-COSIMO model maintained by the OECD and FAO. The own- and cross-price demand elasticities for the two-good case are chosen so the change in total consumption if dark and white meat prices both increase is the same as the change in total consumption in the one-good case. ROW import demand is assumed to take the same form as domestic chicken demand of modeled countries, so a domestic ROW market is not fully elaborated. Supply elasticities are less clearly defined by reference to existing models, outlook models typically focus on short-term effects and general equilibrium representations do not depend on a single supply elasticity, leaving some uncertainty about what to assume for this key parameter. Alston and Scobie (1987) argue that long-run chicken supply is very elastic despite estimates of lower levels for short-run values. Rude and Gervais (2006) use 0.8 based on Chavas (1978). Orden et al. (2002) consider excess supply and demand elasticities, not supply elasticities, but expect that the long-run response is ten times greater than the short-run response. We choose 2.5 for the own-price elasticity of supply, which is on the order of ten times the short-run elasticities in AGLINK-COSIMO and in line with the recommendation of Alston and Scobie (1987).

We do not have good information about price links. The one-good style AGLINK-COSIMO representation suggests using a fixed wedge for transportation costs for model whereas other representations might assume that price transmission is linearized in percent changes. Here, we assume that a 1% change in world price causes a 1.1% change in the price of an exporting country and a 0.9% change in the price of an importing country, thus still capturing to a certain extent the potential for fixed elements in the margins. This assumption may understate costs at least for some trade routes in that the AGLINK-COSIMO model assumption would suggest a slightly weaker relationship between prices in Brazil and in the average importer (0.75 as opposed to 0.82 here), but we exclude here many countries that we expect to have lower price transmission. For the one-good and two-good models, the initial world price is based on Brazilian chicken price(s) plus USD 30 per 100kg for transportation. This calculated world price of a good is used for initial calibration and the starting point for the world market-clearing price of the model in simulation.

The two-good case uses the same single chicken supply as a function of the chicken price as the other cases. This chicken supply is separated into white and dark meat supplies according to the fixed shares (54% and 46%). The change in the domestic chicken price is the share weighted average of changes in white and dark meat prices. Price transmission parameters are used to link domestic white and dark meat prices to world prices, but not all countries trade in both meat types. Thus, domestic market-clearing is assumed for dark meat in Japan and white meat in Mexico and US.

The country-good case elasticities of production and total consumption are the same as in the one-good case. But the consumption is decomposed into the share that is sourced from domestic production at domestic price and the share that is sourced from foreign production at import prices. Following the constant elasticity Armington approach, domestic consumption is divided into domestically produced and imported goods, then imported goods are further divided by country-of-origin. This two-stage differentiation reflects the assumption that chicken made in a different country is a different good. The constant elasticity for all countries at the lower stage (among import sources) is 8.8, which is an estimated elasticity relevant for a broader meat aggregate that includes chicken, and is twice as high as the GTAP v5 elasticity (Hertel et al., 2007). Using the "rule of two" in the same way as those authors, we assume the first-stage elasticity is half of the second stage elasticity.

One structural difference is in the representation of policy. The US barrier to imports is represented as a price wedge in the one-good and country-good model, and by domestic-clearing with exogenous trade for the white meat market in the two-good model. A hypothetical US subsidy on exports is on total exports in the one-good model, dark meat exports in the two-good model, and the price of US exports in bilateral trade in the country-good model. Thus, policy incorporation is consistent with the alternative representations of markets, and this is a potential cause for differences in results shown in the next section.

Results: Trade Policy and External Shocks

We conduct experiments to test how the three different representations of the chicken market respond to different shocks. First, the case of allowing imports into the U.S. and Mexico is shown. This highlights the case with the greatest differences among models, as shown below, and is also relevant to China's complaint about US policy. We represent this hypothetical case by assuming that the difference between a foreign or world price and the comparable domestic price equals transportation costs. In the case of the one-good model, the domestic prices are set equal to the world price directly. For the two-good representation, the domestic white meat price of each of these two countries is set equal to the world price. In the country-good case, the import price of Brazilian and ROW chicken are set equal to prices of Brazil and ROW plus a fixed transportation cost.

The results vary substantially by model (table 2). In the one-good case, the U.S. and Mexico prices of chicken fall 12% and 13%, respectively, leading to large changes in domestic consumption and production. Mexican imports almost triple and the US reverses its trade position completely. In the absence of behavioral trade equations or any differentiation between domestic and exported good, this model can generate meaningfully only a net trade number which, in the case of the US results of this scenario, imply that the U.S. imports after the policy change are greater than the volume exported before imports were allowed.

The two-good case results also show the U.S. becoming a net importer of chicken meat that, in this representation, is the sum of lower dark meat exports and much greater white meat imports. The elimination of the barrier to white meat imports causes the domestic white meat price to fall by 17%, inducing 10% more consumption. The status of white and dark meats as co-products in this representation is also apparent. The surge of white meat imports into the U.S. in the absence of any gap between world and domestic white meat prices leads to falling domestic chicken price and 30% less production. The lower production of chicken leads to lower supplied quantities of both co-products. Because the U.S. competes in world dark meat markets, the world market-clearing dark meat price rises, leading to higher dark meat prices in the U.S., Mexico, Brazil, and elsewhere. The net effects in Mexico include a lower white meat price and higher dark meat price, consumption shifting towards white meat, lower production, and greater imports of both types.

Table 2. US and Mexico chicken imports increase

	United States		Mexico		Brazil	
	Change from base		Change from base		Change from base	
	Absolute	Relative	Absolute	Relative	Absolute	Relative
One good						
Production	-4563	-29.5%	-714	-31.8%	3068	37.2%
Consumption	788	5.9%	162	6.4%	-536	-9.2%
Price	-18	-11.8%	-19	-12.7%	13	14.9%
Two good						
Production	-4618	-29.9%	-380	-16.9%	3401	41.3%
Consumption, white	813	9.8%	120	9.9%	-607	-18.6%
Consumption, dark	-318	-6.3%	-82	-6.1%	27	1.1%
Price, producer	-18	-12.0%	-10	-6.8%	14	16.5%
Price, white	-37	-17.0%	-23	-11.2%	23	24.6%
Price, dark	4	5.6%	4	4.6%	5	5.6%
Country good						
Production	1	0.0%	-184	-8.2%	201	2.4%
Consumption, domestic	-24	-0.2%	-185	-8.3%	-35	-0.6%
Consumption, imports	34	205.5%	343	113.8%	0	3.6%
Price, domestic	0	0.0%	-5	-3.3%	1	1.0%
Price, imports	-103	-46.8%	-31	-32.5%	0	0.0%

Country-of-origin differentiation based on an Armington structure results in smaller changes than the other two representations. The imposed non-zero initial share of trade between the U.S. and Brazil notwithstanding, the share of overall US imports in total US consumption is so small that even its doubling has little effect. In this case, there is hardly any change at all in domestic production or consumption of the domestically-made good despite the large relative change in the US import price and a doubling in the consumption of imported chicken. The effects on Mexico's chicken market would be limited because the US is the main source of imports. However, the assumption of non-zero trade share with Brazil causes there to be a strong effect in this experiment. As Brazil's share increases ten-fold and total imports double, competition between foreign and domestic chicken results leads to 8% less chicken production. If Mexico's trade share data were not adjusted, and given that the trade barrier is represented by a price wedge and the Armington structure we use, then the small initial share of imports from Brazil and ROW would preclude any substantial effect on Mexico – no matter the ten-fold increase in Brazil's share of the total the small initial value would remain small.

The results of US and Mexico import simulations raise the question of model appropriateness, but perhaps too strongly. This case is intended to highlight the potential differences of these representations. A series of tests simulate the three models for shocks such as milder trade policy changes and external shocks (table 3). The results are compared for chicken price, and for quantities of production, consumption, and trade that are summed over different types of chicken in the two-good and country-good representations.

Table 3. Results of various shocks to world chicken market, by model

	US export subsidy			Feed cost			Demand growth		
	One good	Two good	Country	One good	Two good	Country	One good	Two good	Country
US									
Production	3.1%	0.9%	1.6%	-2.0%	-1.4%	-2.0%	7.3%	8.1%	7.3%
Consumption	-0.6%	-0.7%	-0.3%	-1.1%	-1.1%	-1.1%	8.5%	8.5%	8.5%
Exports	26.1%	10.7%	13.6%	-7.6%	-2.8%	-7.4%	-0.1%	5.7%	0.0%
Price	1.2%	0.3%	0.6%	2.2%	2.5%	2.2%	2.9%	3.3%	2.9%
Brazil									
Production	-3.0%	-0.9%	-0.8%	-2.0%	-2.8%	-2.6%	7.3%	6.4%	6.6%
Consumption	0.7%	0.2%	0.2%	-1.4%	-1.2%	-1.2%	8.2%	8.4%	8.4%
Exports	-11.8%	-3.6%	-3.3%	-3.5%	-6.6%	-5.7%	5.3%	1.5%	2.4%
Price	-1.2%	-0.4%	-0.3%	2.2%	1.9%	2.0%	2.9%	2.5%	2.6%

Note: US export subsidy is represented as a USD 100 million subsidy on exports; feed cost is a -7.5% reduction in supply of modeled countries; and demand growth is a 10% shift in consumption of modeled countries and import demand of the rest of the world.

A hypothetical USD 100 million subsidy on US exports is represented as a wedge between domestic and comparable traded price. The wedge equals to the expenditure amount divided by the quantity of exports. In the one-good case, this gap drives higher the US price for the single good, chicken. US production is 3% higher, consumption falls by less than 1%, and US exports are 26% higher.

For the two-good case, the export subsidy (price gap) is assumed to target only dark meat exports. In this case, the subsidy raises the domestic dark meat price, leading to higher production of chicken overall. Co-product price movements offset one another somewhat in this case: the US white meat market clears domestically, assuming imports are not able to increase, so the domestic white meat price falls. US production rises by not quite 1% and exports are 11% higher.

In the country-good case, the lower US export price encourages greater sales in all bilateral trade flows. Imperfect substitution implies that the cheaper US exports do not displace foreign-made chicken at a one-for-one rate, but the high elasticities of substitution assumed here nevertheless lead to noteworthy changes. Total US exports are 14% higher, and the export subsidy results in almost 2% more production.

The results of the export subsidy scenario for Brazil are similar for all quantities and prices shown except for trade and production in the one-good case. Changes in the other variable shown differ by no more than 1% of the base value. For example, Brazilian price effects are -1.2% in the one-good case, -0.4% in the two-good case, and -0.3% in the country-good case. However, for analysis focusing on production or trade, the differences in the outcomes of these three models are more important, with the percent change of one model being as much as four times the percent change of another. This is true even before considering the disparity in disaggregated consumption, trade, and price effects based on the fundamental differences in these models.

The results of the two trade policy shocks are sensitive to the model structure, but model responses are more similar in the wake of two other shocks that are not tied directly to trade. A 10% increase in feed costs is represented as a 7.5% negative shift in supply of the modeled countries, but without any change to rest of world supply. Demand growth is represented as an outward shift in all demands of 10%, including rest of world import demand. In the U.S. and Brazil, the results for production, consumption, and prices are very similar for all models. For both the feed and income scenarios, price effects are quite similar among the three models, with differences of less than half a percent of the base value. Production changes and the aggregate effect on chicken consumption (adding up different types in the two-good and country-good cases) are also very similar among models.

There are greater differences in the trade results, although not as much as in the two trade policy scenarios. The feed cost scenario results in 3-8% lower US exports and Brazilian exports are 4-7% lower. A 10% shift in world-wide chicken demand causes very different results for US exports. There is no increase in US exports according to the one-good and country-good models, but dark meat exports surge in the two-good model. This scenario has disparate results for Brazilian exports, too, but in each case the estimate is for an increase.

These results do not indicate that definition of the commodity and consequent differences in model structure, particularly trade, is the only element of model construction that matters. For example, we assume the elasticity of supply to be 2.5 in the results shown so far, but we also calculate results if the supply elasticities of all countries are lower (1) or higher (5) than the initial value (Figure 1). Different supply elasticities affect the results of the two shocks shown: a shock causes smaller effects for the US domestic price if the supply response is high as compared to a less elastic supply. Consistent with our findings so far, the assumption about market structure causes more variation in the results of a US export subsidy than the assumptions about the supply elasticity that we explore. Also consistent with our findings so far, the choice of supply elasticity causes more variation in the US domestic price effects of a world-wide income shock than the market structure assumption does. While this is only a partial sensitivity analysis, the results reinforce the point that commodity market representation matters more for trade shocks than for non-trade shocks.

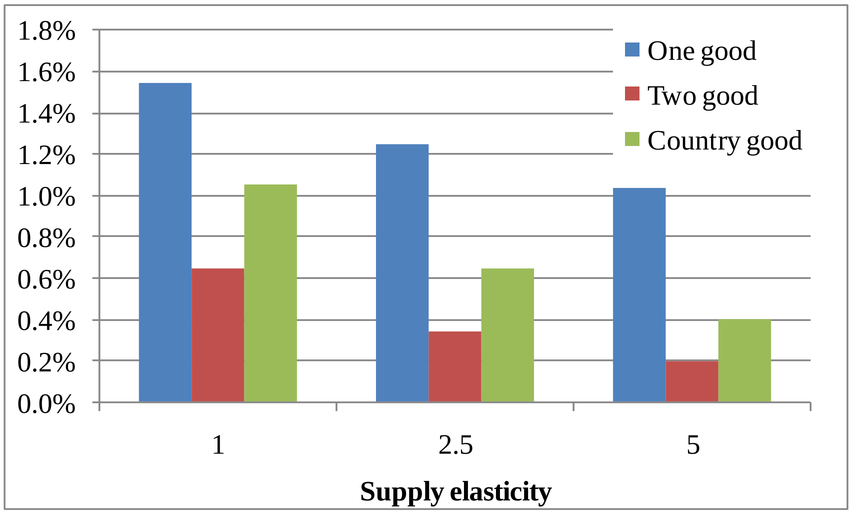

Figure 1A. US export subsidy effects on US domestic price (percent change from base), by supply elasticity.

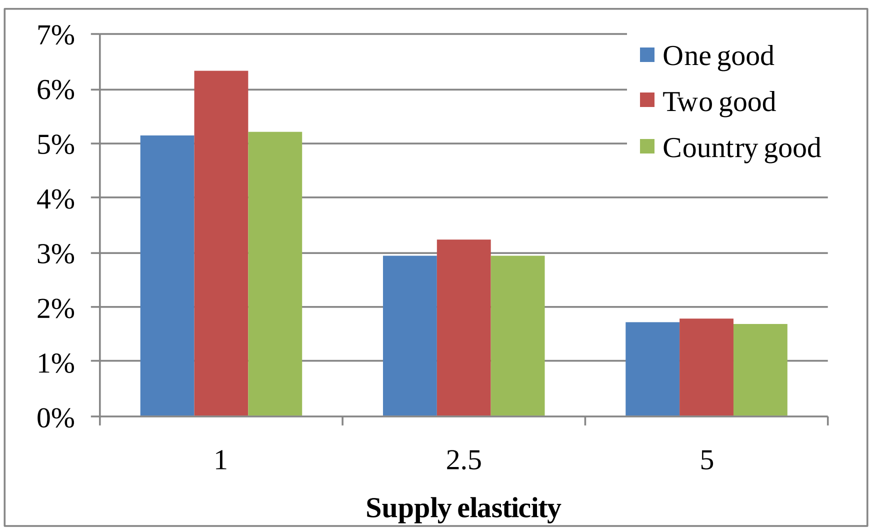

Figure 1B. World income shock effects on US domestic price (percent change from base), by supply elasticity.

Conclusions

In applied model building, the cost of accumulating data and building equations is certainly relevant to the decision of how to represent the chicken market, or any other market. But the level of detail and investment should also take into account the purposes of the model. This balance is difficult to strike, as noted by, for example, Hertel and

Tsigas (1997) in the context of database construction and model building for a global general equilibrium modeling. Orden et al. (2002) likewise recognize the obstacle of identifying a representation that allows an analyst to study the policies of interest "…but does not impose an unrealistic data requirement" (p 148). In the case of chicken markets, for example, researchers only very rarely make direct comparisons among approaches, as we do here, to identify how definition of the good affects policy and market analysis.

The exercises described here highlight the implications of assumed market structure on model outcomes. The results of our exercises may be reassuring. The responses in chicken production, consumption, and prices are similar among the models when the shocks are external to this particular market, such as assessing how chicken production responds to a feed price shock or how chicken markets adjust to changes in income or competing good prices. The similarity may be taken as support for minimizing data cost and model complexity when the purpose is to estimate responses to external factors. Setting aside some larger differences in trade results, one might draw the same conclusion from the similar results that Alston and Scobie (1987) generated whether modeling poultry as one homogeneous good or by country-of-origin differentiation.

The similarities in results begin to evaporate when considering a policy scenario that focuses on chicken trade. The three assumptions about the definition of the commodity are most apparent in the representation of trade. Data requirements, numbers of equations, and even functional forms for trade can be completely different among the three models, so it is not surprising that trade policy shocks tend to highlight the fundamental differences in the nature of chicken. Thus, these results are somewhat less supportive of model building that is defined by the limitations of the data when the research question revolves around trade policy. In the extreme case, we strawman some representations in our choice of an experiment to eliminate a key import barrier. In the country-of-origin treatment, the bilateral quantities cannot budge from zero and the one-good model can generate negative exports. These sorts of results are evident in the case that chicken imports are allowed to flow into the US and Mexico. Depending on model choice, US production falls by as much as 30% or hardly at all, and the producer prices changes range from almost nothing to a 12% decrease.

An applied economist could address these problems by implementing the experiment differently or by altering the model in some more fundamental way. But that is our point. The choice of model should reflect the objectives of the exercise not only the cost. This judgment takes on greater importance as trading partners renew their objections to chicken import policies of the U.S. and decision makers turn to agricultural economists for answers.

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DO RETAIL COFFEE PRICES RAISE FASTER THAN THEY FALL? ASYMMETRIC PRICE TRANSMISSION IN FRANCE, GERMANY AND THE UNITED STATES

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Abstract

We use monthly data spanning the period 1990-2006 to construct error correction representation models to examine price transmission asymmetries between international coffee prices and retail coffee prices in the United States, France and Germany. We find no evidence of long-run price transmission asymmetries. However, we provide evidence of short-run asymmetries with substantial differences among countries. For example, in Germany, decreases in international prices are transmitted faster to retail prices than increases are. Conversely, in the United States increases in international prices are transmitted faster to retail prices than decreases are. In France we find only modest evidence of price transmission asymmetries. We discuss our findings in the context of the differences in supply structures among the three countries.

Keywords: Asymmetric Price Transmission; Roasted Coffee Market; Germany; United States; France; Error Correction Model.

Introduction

There is evidence in the applied economics literature of price transmission asymmetry (PTA) in supply chains for agricultural commodities. Such asymmetries have been generally explained in terms of market power as well as high cost of inventory adjustment (Meyer and von Cramon-Taubadel 2004; Peltzman 2000; Ward 1982). Various empirical studies focusing on food products find that increases in factor prices are often transmitted more quickly to end consumers than decreases in factor prices (Lass 2005; Meyer and von Cramon-Taubadel 2004; Serra and Goodwin 2003). This observed behavior is particularly relevant to the study of marketing margins in the food industry

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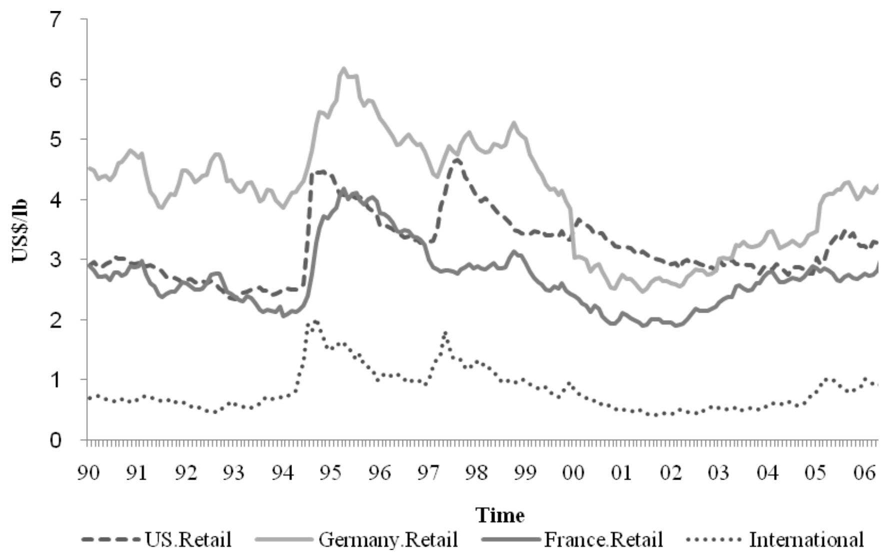
given the rapid concentration in food processing and retailing worldwide, in particular during the 1990s and early 2000s (McLaughlin 2006). Identifying the occurrence of PTAs is relevant to market practitioners in the design of international supply chain strategy. In addition, the study of PTAs is relevant to policy makers concerned about possible anti-competitive practices in global food supply chains.

PTAs may occur in downstream segments of international supply chains for roasted coffee. Figure 1 shows monthly international commodity and retail coffee prices in the three largest coffee importing countries (France, Germany and the United States) during the period 1990-2006. The Figure suggests that coffee retail prices in these countries tend to respond differently to changes in international coffee prices. For instance, the 1994 international price increase resulted in a contemporaneous increase in US retail prices. In contrast, retail prices in France and Germany increased at a slower pace that in the United States. Moreover, during the period 1999-2002 of declining international prices, retail prices in Germany decreased faster than retail prices in France and the United States.



Source: International Coffee Organization. International price is the mean of the weighted average of daily prices for selected coffees of the Other Mild, Arabicas and Robusta varieties, calculated by the International Coffee Organization.

Figure 1. Monthly International Coffee Prices and Retail Prices for Coffee in France, Germany and the United States, 1990-2006.

We test PTAs between international and retail coffee prices in France, Germany and the United States using monthly data on for the period January/1990 to December/2006. We employ an Error Correction Model representation to measure the significance and the magnitude of these asymmetries. We find significant differences in short-run PTAs among the three countries. In Germany, decreases in international prices are transmitted faster to retail prices than increases are. In the United States, in contrast, increases in international prices are transmitted faster to retail prices than decreases are; and we find modest evidence of PTAs in France. Following Meyer and von Cramon-Taubadel (2004), we interpret our results in light of differences in coffee supply chains across the three importing countries. We contribute to the literature by considering PTAs in downstream coffee markets (between international and retail prices in importing countries) focusing on the post-International Coffee Agreement period. Testing for PTAs is important because they may affect all members of the supply chain including coffee growers in developing countries that became more integrated in the market after the elimination of the export quota system in the early 1990s.

Price Transmission Asymmetries and the Coffee Market

Interest in the study of price transmission mechanisms goes back to Keynesian economics postulates explaining the process of wage and prices adjustment over time. A number of empirical studies identified the presence of PTAs in aggregate price adjustments and led economists to develop theories explaining them (Mankiw and Romer 1991; Peltzman 2000). On the one hand, PTAs are viewed as the result of microeconomic price setting frictions such as costs associated with price adjustments as well as the staggered timing of price changes and inventory management (Levy et al. 1997). On the other hand, at a more aggregate level, PTAs are regarded as the consequence of imperfect competition, including demand externalities and coordination failures (Borenstein et al. 1997; Neumark and Sharpe 1992). These principles have been widely employed to construct testable models of PTAs in vertical and spatial price transmission for markets of agricultural commodities and food products (Ward 1982; Kinnucan and Forker 1987; Bailey and Brorsen 1989; Azzam 1999; Xia 2009).

Econometric methods employed in the study of PTAs have changed over time. Earlier empirical procedures developed by Wolffram (1971) and later improved by Houck (1977) focused on differences in responses of aggregate supply functions to positive and negative changes in prices. Many assessments of PTAs in the food system adopted these methodologies to the study of price transmission with mixed results (Kinnucan and Forker 1987; Boyd and Brorsen 1988; Appel 1992; Hansmire and Willett 1992; Zhang et al. 1995). Nevertheless, von Cramon-Taubadel (1998) points out that these studies may be biased because they disregard the time series properties of the data. Specifically, ignoring that prices at different levels of the supply chain are often co-integrated may lead to spurious regression results.

More recently, attention turned to empirical procedures based on the model developed by Engle and Granger (1987) and extended by Granger and Lee (1989) to test for PTA behavior. The authors develop a formal model showing that when two price series are co-integrated, there exists an error correction (EC) representation that describes their short- and long-run relationship as well as the inherent price transmission mechanism. Indeed, the second half of the 1990s saw an increasing interest in EC models to study PTAs in several contexts, including gasoline prices (Borenstein, Cameron and Gilbert 1997; Balke, Brown and Yücel 1998), interest rates (Frost and Bowden 1999), and consumer products (Peltzman 2000).

Von Cramon-Taubadel and Loy (1996) pioneered the application of EC models to examine PTAs in markets for agricultural commodities and challenge methods utilized to discuss price asymmetry in the international wheat markets. The advantages of EC models to investigate PTAs when price series are co-integrated are formalized later in von Cramon-Taubadel and Loy (1999). Subsequent studies employ EC models to examine PTAs primarily in markets for meats (Ben-Kaabia, Gil and Ameur 2005; Sanjuan and Gil 200l; Miller and Hayenga 2001; Goodwin and Holt 1999; von Cramon-Taubadel 1998) and dairy products (Lass, 2005; Serra and Goodwin 2003; Romain, Doyon and Frigon 2002). These studies provide evidence of short-run price asymmetries along supply chains for agricultural commodities.

Researchers have studied price transmission in the international coffee supply chains, primarily in the context of international trade policies. Before 1990, most coffee exporting countries were part of the International Coffee Agreement (ICA) which fixed a system of export quotas to meet a target price above competitive prices (Bates 1997). Importing countries supported the ICA because they saw it as an efficient way to provide assistance to developing countries, particularly during the cold war (Bohman, Jarvis, and Barichello 1996). In 1990, however, the ICA was eliminated and exporters relied on competition to maintain or gain market share in international markets.

This dramatic policy change generated a stream of studies regarding the impact of the International Coffee Agreement on coffee markets and the implications for the members of the international coffee supply chain (Bohman, Jarvis, and Barichello 1996; Buccola and McCandlish 1999; Boratav 2001) and on price transmission at various levels (Krivonos 2004; Mehta and Chavas; 2008; Fafchamps and Vargas 2008). Krivonos (2004) conducts a co-integration analysis showing that the rate of price transmission between farm and international prices increased during the post-ICA period. However, the study finds evidence of price transmission asymmetries that favor coffee exporters. Fafchamps and Vargas (2008) employ data from growers, traders and exporters in Ghana to examine price transmission from international to prices received by coffee growers. They find that traders enter the market to benefit from higher international prices without transmitting these higher prices to coffee growers. Most recently, Mehta and Chavas (2008) study the impact of the ICA on the relationship between farm prices in exporting countries, international prices, and retail prices in importing countries. Their results suggest that coffee roasters and retailers benefited from price asymmetries between international and retail prices during the ICA period.

This study extends research on price transmission in coffee markets by testing PTAs between international and retail prices in France, Germany, and the United States, the three largest coffee importing countries. In addition, we follow Meyer and von Cramon-Taubadel (2004) to discuss our findings in the context of differences in the coffee supply chains across the three countries.

An Empirical Model of Asymmetric Price Transmission

PTAs can occur in the short- and long-runs, depending on the stochastic process governing prices. Consider, for instance, two price series that are believed to be interdependent. If these time series are integrated, but not co-integrated, then long-run asymmetries yield incomplete price transmission. The differences between positive and negative changes accumulate over time leading to a non-stable long-run equilibrium. In contrast, if two time series are integrated and co-integrated, long-run PTA is inconsistent with theory and only short-run asymmetries are possible (von Cramon-Taubadel and Loy 1996). On the other hand, PTAs can occur in the short-run, as the speed of adjustment toward the long-run equilibrium depends on the sign of the price change.

To address long- and short-run asymmetries, consider a distributed lag model with two non-stationary time series (y_t and x_t) and two lags:

$$y_t = \alpha_0 + \alpha_1 y_{t-1} + \alpha_2 y_{t-2} + \alpha_3 x_t + \alpha_4 x_{t-1} + a_5 x_{t-2} + \varepsilon_t \tag{1}$$

Assuming that y_t and x_t are co-integrated and re-rearranging (1), the general model of an EC representation yields

$$\Delta y_t = \alpha_0 + \left(\alpha_1 + \alpha_2 - 1\right)\left[y_{t-1} + \frac{\alpha_3 + \alpha_4 + \alpha_5}{\alpha_1 + \alpha_2 - 1} x_{t-1} \right] - \alpha_2 \Delta y_{t-1} + \alpha_3 \Delta x_t - \alpha_5 \Delta x_{t-1} + \varepsilon_t \tag{2}$$

where the long-run relationship (co-integration equation) between y_t and x_t is $y_t = \beta_0 + \beta_1 x_t + u_t$. The second term in brackets on the right hand side is the error correction term (ECT) representing the deviation from the equilibrium in the previous period:

$$ECT_{t-1} = v_{t-1} = y_{t-1} - \rho_0 - \rho_1 x_{t-1} \tag{3}$$

Depending on the extent of the deviation, the ECT corrects the dependent variable in the following period toward the long-run equilibrium (Banerjee et al. 1993). Thus PTAs can take place in the deviation from equilibrium as well as in the 'short-run dynamics' (first and second differences on the right hand side). Following Wolffram (1971) and Houck (1977), these deviations can be segmented into positive and negative deviations from the long-run equilibrium, namely ECT^{+}_{t-1} and ECT^{-}_{t-1} respectively. For example, ECT^{+}_{t-1} equals ECT_{t-1} when the latter is positive and zero otherwise. Therefore, adding up the segmented vectors ECT^{+}_{t-1} and ECT^{-}_{t-1} yields the original vector ECT_{t-1}. The same can be done for the variables expressed as first-differences to explore short-run asymmetries. Equation (2) can be modified into its asymmetric representation as follows:

$$\Delta y_t = \alpha_0 + \bar{\alpha}^{+} ECT^{+}_{t-1} + \bar{\alpha}^{-} ECT^{-}_{t-1} - \alpha_2 \Delta\ y_{t-1} + \alpha_3^{+} \Delta^{+} x_t + \alpha_3^{-} \Delta^{-} x_t - \alpha_5^{+} \Delta^{+} x_{t-1} - \alpha_5^{-} \Delta^{-} x_{t-1} + \varepsilon_t \tag{4}$$

where $\overline{\alpha} = \alpha_1 + \alpha_2 - 1$. Long-run asymmetry tests can be utilized to determine whether or not the coefficients of the segmented variables ECT^{+}_{t-1} and ECT^{-}_{t-1} are equal. If $\overline{\alpha}^{+} = \overline{\alpha}^{-}$ PTA is rejected and prices adjust equally for positive and negative changes from the long-run equilibrium. The same holds for the estimated parameters of the variables expressed in differences.

Hitherto the discussion assumes an unidirectional relationship between y_t and x_t. However, it is possible that these two variables are determined simultaneously. Consequently, we conduct weak exogeneity tests to examine whether the co-integrating equation influences both variables. Identification of the short-run dynamics in our model needs at least one restriction on each equation. A simultaneous representation of equations yields

$$\Delta y_t = \alpha_0 + \overline{\alpha}^{+} ECT_{t-1} + \overline{\alpha}^{-} ECT_{t-1} - \alpha_2 \Delta\, y_{t-1} + \alpha_3^{+} \Delta^{+} x_t + \alpha_3^{-} \Delta^{-} x_t - \alpha_5^{+} \Delta^{+} x_{t-1} - \alpha_5^{-} \Delta^{-} x_{t-1} + \alpha_6 \Delta\, z_t - \alpha_7 \Delta\, z_{t-1} + \varepsilon_{1t} \quad (5a)$$

$$\Delta x_t = \beta_0 + \overline{\beta}^{+} ECT_{t-1} + \overline{\beta}^{-} ECT_{t-1} - \beta_2 \Delta\, x_{t-1} + \beta_3^{+} \Delta^{+} y_t + \beta_3^{-} \Delta^{-} y_t - \beta_5^{+} \Delta^{+} y_{t-1} - \beta_5^{-} \Delta^{-} y_{t-1} + \beta_6 \Delta\, z'_t - \beta_7 \Delta\, z'_{t-1} + \varepsilon_{2t} \quad (5b)$$

where Δz_t and $\Delta z'_t$ are the identifying variables for the short-run parameters. We employ the system of equations (5a-b) to examine long- and short-run asymmetries between international and retail price transmission asymmetries in France, Germany and the United States.

Data

We employ monthly data on international coffee prices and retail coffee prices in France, Germany and the United States during the period January/1990 to December/2006. We compile national retail prices of roasted coffee and international prices of green coffee from the International Coffee Organization (ICO). Retail prices of roasted coffee are in US dollars per pound and international prices are a composite from different coffee varieties, expressed in US-Dollars.[11] We use monthly exchange rates of the Franc and the German Mark to the US dollar from the Federal Reserve Bank (2010) as well as the as the Import Price Index in the United States from the Bureau of Labor Statistics (2010) to identify the retail price equations. We apply the conversion factor between the Franc, the German Mark and the Euro after adoption of the common currency in January/2002.[12] We use the monthly average precipitation in Fortaleza, Brazil to identify the short run

[11] The indicator price is the arithmetical mean of the weighted average of daily prices for selected coffees of the *Other Mild Arabicas* and *Robusta* groups, calculated in accordance with procedures established under the *International Coffee Agreement*. The weighting reflects the participation of the groups in world trade. The prices are compiled daily from quotations for prompt shipment obtained from various major coffee markets (New York, Bremen/Hamburg and Le Havre/Marseilles) and are weighted to reflect the participation of the various coffees in world trade (ICO, 2010).

[12] 1 Euro = 1.95583 German Marks; and 1 Euro = 6.55957 French Francs.

dynamics of the international price equation because weather patterns affect international prices (National Centre for Atmospheric Research 2010). We provide descriptive statistics of these data in Table 1.

Table 1. Descriptive statistics of the estimating sample, 1990-2006.

	Mean	Ste. Dev	Max	Min
International price	0.829	0.340	2.024	0.412
Retail price in France	2.703	0.523	4.179	1.904
Retail price in Germany	4.115	0.897	6.179	2.473
Retail price in the US	3.217	0.528	4.669	2.352
Exchange Rate (Franc/US Dollar)	5.799	0.731	7.694	4.831
Exchange Rate (Mark/US Dollar)	1.718	0.225	2.294	1.381
Import Price Index, Foods, Feeds, and Beverages[a]	1.026	0.079	1.226	0.885
Precipitation (100mm)	1.292	1.508	6.680	0

[a] Index 2000 = 1.

Tests of Integration, Co-integration and Weak Exogeneity

Integration

Most tests of integration assume non-stationarity under the null hypothesis and often fail its rejection. The Augmented Dickey-Fuller (ADF) and the Phillips-Perron tests are examples of this approach. However, simulations have shown that in small samples both tests show lower diagnostic power than the DF-GLS-test (Elliott, Rothenberg, and Stock 1996; Elliott 1999). Therefore, we test for stationarity under the null and under the alternative hypothesis. The most commonly used test under the null of stationarity is the Lagrange-Multiplier-test of Kwiatowski et al. (1992), known as the KPSS-test.

We construct ADF and DF-GLS tests with non-stationarity under the null hypothesis and KPSS tests with stationarity under the null hypothesis. Test results in Table 2 are robust to the alternative specifications as well as to deterministic processes (i.e. deterministic trends and constants). Our results suggest that all retail price series as well as the international price series contain unit roots with or without constant and trend. However, the null hypotheses for the price series in first differences are rejected (not rejected in the case of the KPSS test) indicating that all time series are *I(1)* without deterministic trends.

Co-integration

Johansen (1992a, 1992b, 1995) as well as Johansen and Juselius (1992) proposed tests to determine whether two *I(1)* time series are co-integrated. The procedures identify the number of equations that determine the co-integration relationship between the two series. The tests are based on the matrix of canonical correlations. One method is the *trace* test (Johansen 1988), which is a likelihood ratio test defined by

$trace = -T\sum_{i=r+1}^{n}\log\left(1-\hat{\lambda}_i\right)$, where T is the number of observations, r is the number of co-integration relations and $\hat{\lambda}_i$ is the eigenvalue. The principle is to determine how many eigenvalues equal one and the test is carried out until the null hypothesis cannot be rejected. The second approach, the λ_{max} test, addresses the significance of the estimated eigenvalues, where $\lambda_{\max} = -T\log\left(1-\hat{\lambda}_i\right)$. Critical values for this test are reported in Osterwald-Lenum (1992).

Table 2. Tests of integration in levels and in first differences

Variables in Levels			Critical Value[a]	Retail Price France	Retail Price Germany	Retail Price US	International Price
ADF-t	$H_0: \sim I(1)$		-2.88	-1.83	-1.47	-2.59	-2.49
	$H_0: \sim I(1)$	no constant	-1.95	0.001	-0.25	-0.317	-0.71
DF-GLS	$H_0: \sim I(1)$		-2.93	-1.82	-1.46	-2.43	-2.36
	$H_0: \sim I(1)$	no linear trend	-2.03	-1.83	-1.33	-2.40	-2.25
KPSS	$H_0: \sim I(0)$	no constant	1.66	13.73	14.49	13.54	12.83
	$H_0: \sim I(0)$	no linear trend	0.463	0.469	1.54	0.5	0.56
Variables in First Differences			**Critical Value**	**Δ Retail Price France**	**Δ Retail Price in Germany**	**Δ Retail Price in US**	**Δ International Price**
ADF-t	$H_0: \sim I(1)$		-2.88	-8.33	-9.67	-9.42	-12.11
	$H_0: \sim I(1)$	no constant	-1.95	-8.35	-9.70	-9.45	-12.13
DF-GLS	$H_0: \sim I(1)$		-2.93	-5.35	-7.11	-6.28	-6.64
	$H_0: \sim I(1)$	no linear trend	-2.03	-4.15	-6.92	-5.87	-6.59
KPSS	$H_0: \sim I(0)$	no constant	1.66	0.09	0.15	0.06	0.06
	$H_0: \sim I(0)$	no linear trend	0.463	0.12	0.14	0.05	0.07

[a] At the 10% level of significance.

Tests of co-integration are sensitive to the structure of the data generating process - the underlying deterministic process such as constant and trend. Johansen and Juselius (1990) and Osterwald-Lenum (1992) consider three possible cases: (i) intercept restricted to the co-integration space, (ii) intercept in the short-run model (which corresponds to a model with drift) and (iii) linear trend in the co-integration vector (i.e., the co-integrating relationship includes time as trend-stationary variable). Johansen (1992b) suggests testing the joint hypothesis of both rank order and deterministic components. Consequently, our strategy is to move from the most restrictive model (i) to the least restrictive model (iii).

At each stage the test statistics are compared to their critical values. These tests are conducted as long as the null hypothesis is rejected. For each country we conducted λ_{max} as well as *trace* tests for each national retail price with respect to the international price. These results are reported in Table 3, where *r* is the number of co-integrating vectors.

According to the tests, all countries have one co-integrating vector. The tests also indicate that the model should include an intercept in the error correction term in France and Germany. In contrast, the tests indicate that in the United States the error correction term should include an intercept and a linear trend. The fact that retail prices in the three countries are co-integrated with international prices rules out the existence of long-run PTAs. As a result, asymmetric transmission can only take place in the short-run, as prices adjust towards the long-run equilibrium.

Table 3. Test of co-integration (*Johansen*-test), 2 lags

Critical Value	**H_0:r**	**intercept in long-run model**	**intercept in short-run model**	**linear trend in long-run model**
λmax	0	11.44	14.07	19.67
	1	3.84	3.76	9.24
trace	0	12.53	15.41	19.96
	1	3.84	3.76	9.42
France	**H_0:r**	**intercept in long-run model**	**intercept in short-run model**	**linear trend in long-run model**
λmax	0	13.680	19.528	19.574
	1	0.004	3.704	3.788
trace	0	13.685	23.232	23.361
	1	0.004	3.704	3.788
Germany	**H_0:r**	**intercept in long-run model**	**intercept in short-run model**	**linear trend in long-run model**
λmax	0	12.542	15.289	15.319
	1	0.039	2.658	2.695
trace	0	12.581	17.937	18.014
	1	0.039	2.648	2.695
United States	**H_0:r**	**intercept in long-run model**	**intercept in short-run model**	**linear trend in long-run model**
λmax	0	10.652	25.444	25.446
	1	0.135	8.944	9.031
trace	0	10.787	34.387	34.477

Weak Exogeneity and Long-run Price Transmission Asymmetry

First, we estimate the equation (5a) and (5b) using Zellner's (1962) Seemingly Unrelated Regressions (SUR) because the error terms in the system are likely to be correlated. For the France and Germany equations (5a) we create a dummy variable that equals 1 during the Euro period and zero otherwise. We employ this specification to test for long-run asymmetry in the error correction term and for weak exogeneity in the price series (Table

4). We first examine whether the magnitude of the estimated coefficient of the positive deviation-vector (ECT^{+}_{t-1}) equals its negative counterpart (ECT^{-}_{t-1}). Table 4 suggests that the null hypothesis (symmetry) cannot be rejected in any country. This means that asymmetry can take place only in the short-run dynamics of the price relationship (i.e. asymmetry in the first-differences variables).

We present the weak exogeneity tests corresponding to the bivariate ECM in equations (5a) and (5b) in Table 4. Test results indicate that the international price is weak exogenous in the bivariate model for France and the United States, but not for Germany. In France and the United States, weak exogeneity of the international price implies that deviations from the equilibrium cause price adjustments in retail prices only. In contrast, test results for Germany suggest feedback between retail and international prices.

Table 4. Tests of long-run asymmetry and weak exogeneity

	$\chi^2(1)$ **Critical value at 5%**	**France**	**Germany**	**United States**
Long-run Asymmetry Test ($H_0 : \bar{\alpha}^{+} = \bar{\alpha}^{-}$)	3.84	0.00	0.02	0.68
Weak Exogeneity Test (H_0: co-integrating vector has no influence on endogenous variable)				
Retail price as endogenous variable (5a)	3.84	13.71***	9.59***	17.00***
International price as endogenous variable (5b)	3.84	3.08	10.79***	0.22

There are several strategies to estimate the ECM. Engle and Granger (1987) suggest a two-stage method based on the asymptotic independence between the co-integrating relationship and the short-run dynamics. This method is appropriate if the long-run relationship shows asymmetries in the error correction term and is generally applied to large samples. An alternative, particularly in small samples, is to use a one-stage model in which the components of the error correction term are employed directly in the estimating equation. Based tests presented in Table 4, we modify equations (5a) and (5b) and estimate the following model for each country:

$$\Delta RP^{i}_{t} = \alpha_0 + \bar{\alpha} RP^{i}_{t-1} + \bar{\bar{\alpha}} IP_{t-1} - \alpha_2 \Delta\, RP^{i}_{t-1} + \alpha^{+}_{3} \Delta^{+} IP_t + \alpha^{-}_{3} \Delta^{-} IP_t - \alpha^{+}_{5} \Delta^{+} IP_{t-1} - \alpha^{-}_{5} \Delta^{-} IP_{t-1} + \alpha_6 \Delta\, z_t - \alpha_7 \Delta\, z_{t-1} + \varepsilon_{1t} \quad (6a)$$

$$\Delta IP_t = \beta_0 - \beta_2 \Delta\, IP_{t-1} + \beta^{+}_{3} \Delta^{+} RP^{i}_{t} + \beta^{-}_{3} \Delta^{-} RP^{i}_{t} - \beta^{+}_{5} \Delta^{+} RP^{i}_{t-1} - \beta^{-}_{5} \Delta^{-} RP^{i}_{t-1} + \beta_6 \Delta\, z'_t - \beta_7 \Delta\, z'_{t-1} + \varepsilon_{2t} \quad (6b)$$

where RP^{i}_{t} is the retail price of coffee in country *i* in month *t*; IP_t is the international price of coffee in month *t*; $\bar{\alpha} = \alpha_1 + \alpha_2 - 1$, $\bar{\beta} = \beta_1 + \beta_2 - 1$; $\bar{\bar{\alpha}} = \alpha_3 + \alpha_4 + \alpha_5$; and $\bar{\bar{\beta}} = \beta_3 + \beta_4 + \beta_5$. Equation (6a) includes a trend in the error correction term in the US model; and equation (6b) includes the error correction term as explanatory variable in the

German model. Statistical inference requires identification of the short run dynamics, captured by z_t and z_t^r. For the retail equation, we employ the exchange rate between the domestic currency and the US dollar, EX_t^f, EX_t^g in France and Germany, respectively; and for the United States we employ the monthly import price index for food and beverage products (IPI_t^{us}). The identifying restriction on the international price equation (6b) is the monthly average precipitation in Fortaleza, Brazil ($RAIN_t$).

Results

Table 5 presents Seemingly Unrelated Regression (SUR) parameter estimates of the system (6a) and (6b) for each country. The retail price equations explain about 77, 60 and 58 percent of the variation in retail prices in France, Germany and the United States, respectively. Similarly, the international price equations explain 18, 19 and 15 percent of the variability in international coffee prices. The relatively lower explanatory power of the international price models may be due to the fact that factors other than trade (e.g., future prices in the stock market) generate speculative investments which we cannot model within this framework. Durbin-Watson statistics indicate no autocorrelation in the error terms. Our discussion below focuses primarily on the retail price equations, given that our objective is to examine asymmetries in price transmission from international to retail prices.

Long-Run Equilibrium between International and Retail Prices

The estimated coefficient of IP_{t-1} describes the long run relationship between international and retail prices and the estimated coefficient of RP_{t-1} indicates the speed of adjustment towards the long-run equilibrium following a change in international prices. The parameters estimates of IP_{t-1} are positive in all three countries, as predicted by theory, although the United States coefficient is statistically insignificant. In Germany (France), a $1 increase in international coffee price leads to a $0.14 ($0.08) in retail price; but this adjustment takes place at a rate on 0.039 (0.043) per month. In the United States, international prices may have only short-term effects on retail prices and these effects do not persist in the future; and the trend coefficient suggests that the price spread between international and retail price increased at a modest significant rate of $0.0002 per pound per month during the period of analysis. These results suggest differences between the three countries: the long-run relationship between international and retail prices is stronger in Germany than in France, yet the speed of adjustment is similar in these two countries. In the United Sates, our results do not provide evidence of a long-run equilibrium between international and retail prices.

Table 5. Estimation results

Retail price equation (5a)	France	Germany	U.S.
Constant	0.047** (0.018)	0.043 (0.031)	0.181*** (0.050)
Trend	-	-	0.0002* (0.0001)
RP^i_{t-1}	-0.043*** (0.010)	-0.039*** (0.011)	-0.094*** (0.024)
IP_{t-1}	0.078*** (0.021)	0.142*** (0.038)	0.044 (0.041)
ΔRP^i_{t-1}	0.411*** (0.059)	0.174*** (0.066)	0.123** (0.051)
$\Delta^+ IP_t$	0.038 (0.057)	0.226** (0.109)	0.445*** (0.106)
$\Delta^- IP_t$	0.231** (0.099)	0.681*** (0.192)	-0.180 (0.181)
$\Delta^+ IP_{t-1}$	0.174*** (0.066)	0.109 (0.124)	1.120*** (0.126)
$\Delta^- IP_{t-1}$	-0.173* (0.092)	-0.286 (0.180)	-0.708*** (0.174)
Δz_t	-0.433*** (0.025)	-1.996*** (0.164)	0.261 (1.471)
Δz_{t-1}	0.148*** (0.037)	-0.021 (0.218)	0.943 (1.479)
$D \cdot \Delta z_t$	0.003 (0.023)	-0.275* (0.154)	-
$D \cdot \Delta z_{t-1}$	0.009 (0.024)	-0.146 (0.156)	-
R^2	0.749	0.573	0.571
Constant	-0.005 (0.009)	-0.005 (0.027)	0.008 (0.013)
Trend	-	-	0.00002 (0.0001)
IP_{t-1}	-	-0.074*** (0.026)	-
RP^i_{t-1}	-	0.014 (0.009)	-
ΔIP_{t-1}	0.051** (0.066)	0.173** (0.068)	0.061 (0.082)
$\Delta^+ RP_t$	0.483*** (0.115)	0.403*** (0.081)	0.132* (0.072)
$\Delta^- RP_t$	-0.090 (0.134)	0.054 (0.068)	0.160 (0.136)
$\Delta^+ RP^i_{t-1}$	-0.361*** (0.114)	-0.127 (0.083)	0.061 (0.060)
$\Delta^- RP^i_{t-1}$	-0.022 (0.134)	-0.006 (0.067)	-0.180 (0.135)
$\Delta^+ Rain_t$	0.003 (0.004)	-0.003 (0.004)	-0.003 (0.004)
$\Delta^+ Rain_{t-1}$	0.016*** (0.004)	0.015*** (0.004)	0.016*** (0.004)
R^2	0.148	0.186	0.103

[a] Standard errors in parenthesis; *** significant at 1% level; ** significant at 5% level.

Short-Run Asymmetries between International and Retail Prices

In Table 6, we present tests results for short-run asymmetries regarding the impact of contemporaneous and lagged changes in international prices (ΔIP_t and ΔIP_{t-1}) on changes in retail prices (ΔRP_t). Test results suggest differences in short-run dynamics across countries. In Germany, there is evidence that negative changes in international prices have a larger effect on retail prices than positive changes: a \$1 decrease (increase) in international price is associated with a \$0.68 (\$0.23) contemporaneous decrease (increase) in retail prices. Asymmetry tests in Table 6 suggest that negative changes have significantly larger impacts than their positive counterparts. Lagged changes in international prices in the previous month, either positive or negative, do not affect current changes in retail prices. Our German results are in sharp contrast with parameter estimates for the United States, in which positive changes in international prices appear to have a greater effect on retail prices than do negative changes. Specifically, for the United States, our results suggest that while a \$1 increase in international price leads to a \$0.45 contemporaneous increase in retail prices, negative changes in international prices do not affect retail prices. Moreover, a \$1 increase in lagged international prices is associated with a \$1.12 increase in retail prices; and, contrary to expectations, a \$1 decrease leads to a \$0.78 increase in retail prices. These results provide evidence that in the United States changes in retail prices are much more sensitive to positive than to negative changes in international prices (Table 6).

Table 6. Tests of asymmetric adjustment

Retail price equation				
Null hypothesis: $\alpha_j^+ = \alpha_j^-, \forall j$	$\chi^2(1)$ **Critical value, 10%**	**France**	**Germany**	**U.S.**
$\Delta^+ IP_t$ and $\Delta^- IP_t$	3.84	2.08 (0.15)[a]	3.14 (0.08)	5.85 (0.02)
$\Delta^+ IP_{t-1}$ and $\Delta^- IP_{t-1}$	3.84	6.63 (0.01)	2.35 (0.12)	54.52 (0.00)
International price equation				
Null hypothesis: $\beta_j^+ = \beta_j^-, \forall j$	$\chi^2(1)$ **Critical value at 5%**	**France**	**Germany**	**U.S.**
$\Delta^+ RP_t^i$ and $\Delta^- RP_t^i$	3.84	6.74 (0.01)	8.37 (0.00)	0.02 (0.88)
$\Delta^+ RP_{t-1}^i$ and $\Delta^- RP_{t-1}^i$	3.84	2.81 (0.09)	0.97 (0.32)	2.31 (0.13)

[a] Probability > *Chi* square in parenthesis.

Results in Table 5 and Table 6 suggest further differences in the French coffee supply chain in comparison to Germany and the United States. In France, our results indicate asymmetries on the lagged changes in international prices (ΔIP_{t-1}): a \$1 increase in lagged changes international prices leads to a \$0.23 increase in retail prices while a \$1 decrease does not result in lower retail prices. In fact, of the coefficient of negative changes is unexpected (0.17) because it suggests that negative changes in international prices lead to positive changes in retail prices. Nevertheless, the segmented coefficients of contemporaneous changes in international prices (ΔIP_t) correct this apparent inconsistency: a $1 negative contemporaneous change in international coffee prices results in a $0.23 decline in coffee retail prices, whereas positive contemporaneous changes in international prices do not influence changes in retail prices.

The variables employed for identification of short-run dynamics are significant in France and Germany but not in the United States. As expected, changes in the exchange rate are negative and significant given that retail prices are converted into US dollars. There are modest differences in Germany during the common currency period, as reflected by the interaction coefficient Δz_t. In the United States, the price index of imported food and beverages is used for identification and its coefficient is positive but statistically insignificant.

Short-Run Dynamics of the International Price Equation

The parameter estimates suggest that international prices are influenced by increases of retail prices in all three countries. If retail prices were to increase $1 in each importing country then the international price would increase $0.48, $0.40 and $0.13 in France, Germany and the United States, respectively. In contrast our results suggest that negative changes in retail prices do not have an effect on international prices in the three countries. Although Table 4 suggests feedback effects from retail to international prices in Germany, the estimated coefficient of lagged retail price, which represents the long-term effect that retail prices have on international prices, is statistically insignificant. Consequently, our results suggest that such effects take place only in the short-run. Lagged changes in precipitation levels in Fortaleza-Brazil, the variable employed for identification, are positive and significant in the three models. This suggests that short run weather patterns, as well as changes in harvest expectations, are important determinants of international prices.

Summary of Findings

Our findings reject the hypothesis of long-run asymmetries in price transmission between international and retail coffee prices. In contrast, we find asymmetric price behavior in the short run with marked differences across the three countries. In Germany, reductions in international prices produce faster adjustments of retail prices than do increases in international prices. In contrast, in the United States, positive changes in international prices produce immediate increases in retail prices and negative changes do not affect retail prices in the short-run. In France, our results suggest modest evidence of price transmission asymmetries: contemporaneous and lagged changes in international prices exhibit asymmetries of comparable magnitudes in opposite directions.

Short Run Price Asymmetries and Market Structure

The observed differences in short-run price transmission behavior can be discussed in the context of differences in coffee supply chains among the three importing countries. In Table 7 we present selected characteristics of the coffee supply chain in each country relevant to our period of analysis. The United States coffee market is the largest, even though the US per capita consumption is substantially smaller than in France and Germany. The coffee processing sector is slightly more concentrated in the United States than in France and Germany. The share of private label coffee brands in Germany (31.1 percent) is much larger than in France (14.4 percent) and the United States (7.8 percent). The degree of concentration of food retailing in the European countries is substantially higher than in the United States; and the primary difference between the food retailing sectors in France and Germany is the high market share of hard discounters (e.g. Aldi, Lidl) in the latter (7.8 and 34.0 percent, in France and Germany, respectively). In the US, on the other hand, the share of hard discounters was less than 2 percent during the period of analysis. Hard discounters offer a limited assortment of products (typically five to six thousand stock keeping units, compared to forty-five thousand stock keeping units in traditional supermarkets) in large quantities, which allow them to operate extremely low-cost supply chains.

Table 7. Selected characteristics of coffee supply chains

	France	Germany	United States
Per Capita Consumption[a]	5.39	7.10	4.10
Roasted coffee retail sales (Million US Dollars)[b]	1,174	2,297	4,145
Brand Manufacturers[b,c]			
Share of leading brand (%)	27.0	28.5	34.7
Share of three leading brands (%)	66.8	63.1	70.2
Share of private label brands (%)	14.4	31.1	8.1
Supermarket Sector[b]			
Share of five leading supermarkets (%)	76.4	61.8	35.5[d]
Share of hard-discount retailers (%)	7.8	34.0	< 2.0%[e]

[a] Averages for years 1995, 2000 and 2005, from *Tropical Products: World Markets and Trade,* Foreign Agricultural Service, United States Department of Agriculture.
[b] Averages for years 2001 and 2003, from Mintel's Market Intelligence.
[c] Data for the United States is from *Grocery Headquarters State of the Industry Almanac* (2002 and 2004).
[d] Average for years 1998-2003, from the *Food Industry Management Program*, Cornell University.
[e] Estimates from the *Food Industry Management Program*, Cornell University.

We argue that country differences in Table 7 can be discussed in the context of PTAs identified in the econometric model. In Germany, for example, the large market share of hard-discount retailers, as well as the large market share of private label coffee brands, may explain that reductions in international coffee prices are transmitted faster than are price increases. Hard discounters often employ aggressive competitive strategies based on low prices relative to competitors. Large market share of private label brands increases the ability of food retailers to control their pricing strategies. Indeed, a number of academic and industry studies document price wars in the German retail sector in general and in the coffee product category in particular, mostly during the late 1990s and early 2000s (e.g. Koerner 2002; McLaughlin 2006). The Aldi coffee brand is the market leader in Germany, the company owns coffee roasting plants and buys green coffee directly from international commodity exchanges. Therefore, Aldi may have the ability to control the supply chain and to pass lower international prices on to the end consumer.

In France, both the market concentration at the processing and retail levels, as well as the share of private label brands in the coffee category are comparable to Germany. However, the market share of hard-discount retailers in France is substantially smaller than in Germany. Furthermore, a unique feature of the French market is the role of public policies in regulating the pricing behavior along the food supply chain. A report by Dobson Consulting (1999), for example, states that the French coffee market was heading to a price war in the early 1990s, similar to its German counterpart. Nevertheless, price promotions were restricted substantially after the Government passed the Galland Law in 1996. This law is intended to avoid conflicts and imbalances in the relationship between large retailers and their suppliers as well as with small retailers. The law prevents processors and retailers from selling at a loss and retailers cannot reduce prices to take advantage of volume discounts and other promotions offered by coffee processors.[13] This regulation, together with the smaller participation of hard discounters in the French market and the similar market concentration between processors and retailers, may explain the modest evidence of price transmission asymmetries in France.

In the United States, the coffee supply chain exhibits considerable differences with respect to its European counterparts. Consider the following unique characteristics of the supply chain in this country: 1) high concentration in the coffee processing sector; 2) moderate concentration in food retailing; 3) small share of private label brands in the coffee product category; and 4) less than two percent market share of hard-discount retailers. In addition, US government regulation regarding price promotion is less strict than in France. Therefore, coffee processors in the United States may have more ability to coordinate the supply chain than do their European counterparts. Our econometric estimates show that negative changes in international prices are not passed on to consumers as fast as are positive changes, suggesting a certain degree of oligopoly power of coffee processors. This conjecture, however, should be interpreted with caution because a formal analysis of market power is beyond the scope of the study.

Conclusion

Price transmission asymmetries can provide valuable information for private and public decision makers about supply chain behavior. We develop error correction models to statistically test for long- and short-run PTAs in France, Germany and the United States, during the post International Coffee Agreement period (1990-2006). The analysis focuses

[13] The Franch Government passed an amendment in 2005 to make the Galland Law less restrictive, but the primary principles of the law are still in in place.

on the impact of changes in international coffee prices on retail prices and also on the links between PTA econometric estimates and coffee supply chain structures.

Our analysis provides evidence of asymmetric price transmission behavior only in the short-run with important differences between Germany, France and the United States. In Germany, negative changes in international prices have higher impacts on retail prices than do positive changes. Large share of hard-discount retailers may drive this asymmetric behavior. Price transmission behavior is opposite in the United States: positive changes in international prices produce immediate positive changes in retail prices while negative changes do not affect retail prices. The characteristics of the coffee supply chain may allow coffee processors to obtain economic rents in the short-run. Finally, we find modest evidence of asymmetric price transmission behavior in France. Public policies aimed at regulating relationships among supply chain members may contribute to small price asymmetries in the French coffee market. We note that our discussion of links between parameters estimates and market structure is conjectural and should be interpreted with caution.

While our study provides insights regarding PTAs and market structures in coffee importing countries, several areas call for further research. Our approach assumes that price transmission is independent of the magnitude of changes in international prices. This assumption may lead to underestimation of asymmetries in price transmission (Goodwin and Holt 1999; Goodwin and Piggott 2001). Future research should employ threshold error correction models to assess price transmission asymmetries from international to retail coffee prices. This extension may require the use of higher data frequency (e.g. weekly) to increase the sample size. In addition, future research should take into consideration differences in consumer preferences across countries, primarily between *robusta* and *arabica* variety types. Such level of disaggregation would provide more precise estimates of price transmission asymmetries given the high level of product differentiation in the coffee product category in high income countries. Finally, more research on formal models to assess market structure and conduct is required to assess the welfare implications of the elimination of the International Coffee Agreement.

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OPTIMAL AGRICULTURAL POLICY AND PSE MEASUREMENT: AN ASSESSMENT AND APPLICATION TO NORWAY

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Abstract

Among the general public the producer support estimate calculated by the OECD is widely viewed to be an indicator of distortions created by agricultural policies. When considering conventional agricultural policy grounded on production subsidies, the relative (percentage) PSE and inefficiencies are indeed highly correlated. However, we demonstrate that this is not necessarily the case if policy is targeted to correcting externalities associated with agricultural activity. In particular, a welfare-enhancing reform involving a shift from production subsidies to payments for the supply of public goods may result in a lower absolute PSE and lower trade distortions, but a higher relative PSE.

Keywords: PSE, policy reform, trade distortions

1. Introduction

The producer support estimate (PSE) is a measure of monetary transfers from consumers and taxpayers to producers through agricultural policies. Its conceptual basis is as an equivalent subsidy of the incidence of government policies (Corden, 1971). Josling (1973 and 1975) applied the concept to agricultural policies and coined the term “producer subsidy equivalent”.

Since the mid 1980s the OECD has published data on the PSE for its members and for some non-member countries. The OECD’s PSE incorporates a wide range of forms of assistance to agriculture and has subsequently been renamed the “producer support estimate”. The OECD’s annual estimates provide the only readily available, timely and

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consistent source of internationally comparable information on government support for agriculture in developed countries. Cahill and Legg (1989-90) and Legg (2003) provide an overview of definitions and use of the OECD's support measurements.

The publication of internationally comparable PSE figures has increased transparency on the nature and incidence of agricultural policies in OECD countries. The PSE concept also contributed to establishing a base for internationally binding commitments on domestic support through the Aggregate Measure of Support (AMS) in the Uruguay Round of trade negotiations of the World Trade Organization (WTO). A major difference between the AMS and the PSE is that the former uses fixed international reference prices derived from a specific base period in calculating market price support (MPS), while the latter uses current international reference prices. The WTO's MPS is a negotiated construct while the OECD measure is an economic one. Furthermore, the AMS excludes WTO green and blue box categories of support and support that is judged sufficiently small to be counted under the *de minimis* provision of the Agreement on Agriculture. Hence, the PSE provides a more comprehensive accounting of forms of government support. This, in combination with the regularity and accessibility of the data, has made it an extremely popular measure among those interested in agricultural policies.

Given the prominence of the OECD and the WTO connection, it is not surprising that PSE estimates have attracted much public attention and received wide media coverage. Even if the PSE was never intended to provide an indicator of the impact of policies on welfare or trade, but merely to serve as an indicator of monetary transfers to farmers from consumers and taxpayers (Legg, 2003; Tangermann, 2005 and 2006), the concept has been widely used in the international debate on agricultural policies as a yardstick of policy misconduct. The higher a country's relative (percentage) PSE, the more likely that its agricultural policy will be criticized for being inefficient and trade distorting. As Haniotis and Bascou (2003, p.1) have observed: "the generalized association and implicit acceptance of PSE as a measurement of the trade distorting impact of agricultural policies continues (and) policy makers are often left to believe not only that they have a measure reflecting grade policy distortions, but also an indicator reflecting the potentially positive impact if these policy distortions are removed."

When considering conventional agricultural policy based on production subsidies, the percentage PSE and inefficiencies tend to go hand in hand. High relative PSEs tend to be associated with high levels of price support, which creates distortions in both production and consumption (OECD, 2007). Reductions in price support would result in a lower relative PSE and reduced distortions. However, this is not necessarily the case if agricultural policy is targeted towards correcting externalities related to agricultural activity, e.g., if price support and other production subsidies are replaced by direct payments designed to promote the supply of environmental services from agriculture.

In this paper we investigate the impact of welfare-improving policy reform on the relative PSE under different assumptions with respect to the willingness to pay for public goods supplied by agriculture. We do not examine how the results relate to WTO domestic support disciplines since the AMS and the PSE, though related, are different constructs. Current WTO disciplines on domestic support are relatively weak and rarely constrain policy choice (Orden et al., forthcoming). Even for countries that provide high levels of support, such as Norway, proposed changes in the Doha Round of WTO negotiations are likely to have only a limited impact on the ability of countries to provide output-linked support for agriculture (Blandford et al., forthcoming).

In this paper we show that a policy that is targeted to the supply of environmental services and is less distorting for production and trade may result in an increase in the relative PSE. As an example we compare output subsidies and land payments, respectively, as means for achieving a given environmental service objective which is assumed to be a function of land in use by agriculture. The output subsidy case is a proxy for current agricultural policies which are inferior in comparison to land payments with respect to this particular objective. The land subsidy policy is a proxy for agri-environmental programs whose primary aim is to keep land in agriculture in order to preserve positive externalities associated with agricultural usage. We recognize that, in reality, policy objectives and instruments are typically more complicated than these simple examples, but this does not detract from the substance of our analysis. While the absolute PSE and trade distortions are largest in the output subsidy case, we show both analytically and through simulations of an agricultural sector model for Norway that a higher relative PSE may well result from a welfare-enhancing reform of agricultural policy.

2. Agricultural Support, Welfare and Trade Distortions

It is widely accepted that there are externalities and public goods related to agricultural activity. Emissions of nitrate, ammonia and greenhouse gases are examples of negative externalities. Cited examples of positive externalities are environmental benefits, such as contributions to biodiversity, but others include the amenity value of the landscape, food security, and the preservation of rural communities and rural lifestyle (for a summary, see OECD, 2001). An important issue is the extent to which positive externalities and the provision of public goods is linked to resource use, methods of production, or the level of output (Blandford and Boisvert, 2002). The implications of public goods for agricultural policy are controversial, in particular, whether support can be justified to ensure provision of non-commodity outputs, and what policy instruments are efficient in achieving the desired supply of public goods. In the Doha round of WTO negotiations, for example, some high-cost importing countries have used alleged non-commodity outputs (the so-called “multifunctionality” of agriculture) to argue for the maintenance of import protection. Low-cost exporting countries reject this argument. Their view is supported by studies that demonstrate that efficient policies for multifunctional agriculture do not depend on import protection (e.g., Chang et al., 2005; Peterson et al., 2002).

Pigouvian subsidies (taxes) equal to marginal benefits (costs) should be used whenever agricultural activities, through production or input use, affect the supply of public goods and have positive (negative) externalities (Blandford and Boisvert, 2002). Consider the case of no subsidies and no trade restrictions, and consequently a PSE equal to zero. With positive externalities this would clearly be suboptimal, since agricultural activity would fall short of the optimal level. Correcting this through Pigouvian subsidies would not only enhance welfare but also create a positive PSE. If the environmental service were initially provided by a suboptimal output subsidy policy, the switch to an optimal policy might well result in a reduction in the absolute PSE since the level of subsidy and, most likely, the total value of production would decline. However, the relative PSE might be unchanged or even increase.

To illuminate how the relative PSE could be affected by policies targeted towards externalities, we use a simple partial model. We restrict the example to a positive externality in the form of an environmental service (e.g., cultural landscape) which is assumed to be a function of land in use. The first assumption makes the analytical derivations tractable. Negative externalities, such as pollution, which are excluded, tend to be negatively correlated with landscape amenity values because negative external effects are primarily tied to the degree of capital intensity (including the use of fertilizer and pesticides). Normally, if the policy mechanism changes from output to land subsidies, capital intensity will decrease and so will pollution. So a land subsidy can be used to generate positive external effects as well as mitigate negative effects, i.e. it is a preferred policy. With respect to the second assumption, the amenity value of the cultural landscape depends on how the land is managed. Existing studies (e.g., Drake, 1992) suggest that attributes that enhance the value of the landscape are biodiversity, variation, grazing animals, openness and environmental benefits, and that cultural landscape is a spatial public good (Dillman and Bergstrom 1991). This suggests that land subsidies should be differentiated with respect to region, land type, and the intensity of land use. The simplification made here is, however, not decisive for our conclusions. In addition, the empirical model employed in the paper allows for differentiation between land types.

We assume the following production function for agriculture:

$$Y = L^{\alpha} K^{\beta} , \qquad \alpha + \beta < 1 , \tag{1}$$

where Y is agricultural production, L is land, and K is an aggregate of other factors of production, which for simplicity we refer to as capital. The Cobb-Douglas function is chosen mainly for expositional clarity. In Appendix 1 we provide derivations for the more general Constant Elasticity of Substitution (CES) case. Later in this section, in connection with Figure 1, we discuss how various CES functions affect our analysis.

Producer surplus as defined by the profit function is:

$$\Pi = pY - wL - rK, \tag{2}$$

where p is the price of the agricultural good and w and r are the prices of land and capital, respectively. Assuming the small country, small sector case output and factor prices are given. We further assume that there are no trade barriers so that p is the world market price. Subsequently, the empirical model used in the paper incorporates difference grades of land each with limited supply, such that land prices are endogenous whenever the ceiling on available land is binding.

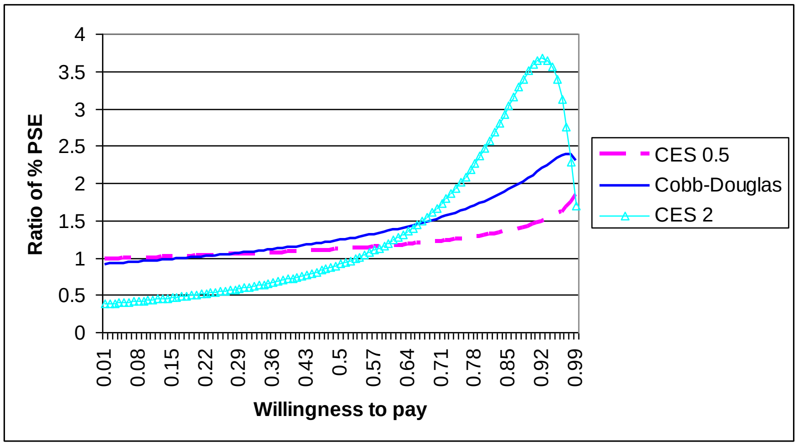

Figure 1. Relative percentage PSE for optimal land subsidies compared to product subsidies yielding the same land input.

Maximizing profit yields the following supply and factor demand functions under the assumption of perfect competition:

$$Y = \left[\alpha^{\alpha} \beta^{\beta} \frac{p^{\alpha+\beta}}{w^{\alpha} r^{\beta}} \right]^{\frac{1}{1\text{-}\alpha\text{-}\beta}},$$

$$L = \left[\alpha^{1-\beta} \beta^{\beta} \frac{p}{w^{1-\beta} r^{\beta}} \right]^{\frac{1}{1\text{-}\alpha\text{-}\beta}},$$

$$K = \left[\alpha^{\alpha} \beta^{1-\alpha} \frac{p}{w^{\alpha} r^{1-\alpha}} \right]^{\frac{1}{1\text{-}\alpha\text{-}\beta}}. \tag{3}$$

Now let us assume that there are amenity benefits attached to the use of land in agriculture, for which society has a constant marginal willingness to pay. A study by Lopez et al. (1994) indicates that the marginal willingness to pay decreases strongly with a rising supply of cultural landscape. The simplifying assumption of a constant marginal willingness to pay does not prevent a unique solution since we assume decreasing returns to scale. However, in our empirical analysis we employ a function characterized by decreasing marginal willingness to pay with respect to land use. With a constant marginal willingness to pay, the social optimum can be found by maximizing the following welfare function:

$$W = \Pi + CS + \gamma L, \tag{4}$$

where γ is the constant marginal willingness to pay for landscape amenity. *CS* is consumer surplus, which is independent of domestic production since the agricultural good can be freely imported or exported at the world market price *p*.

Assuming for simplicity that $p = w = r = 1$, we use the competitive, free trade, no-subsidy case as a point of reference:

$$\Pi_{MAX} \qquad \begin{aligned} &Y' = \left[\alpha^{\alpha}\beta^{\beta}\right]^{\frac{1}{1-\alpha-\beta}} \\ &L' = \left[\alpha^{1-\beta}\beta^{\beta}\right]^{\frac{1}{1-\alpha-\beta}} \\ &K' = \left[\alpha^{\alpha}\beta^{1-\alpha}\right]^{\frac{1}{1-\alpha-\beta}} \\ &\frac{Y'}{L'} = \frac{1}{\alpha} \\ &\frac{K'}{L'} = \frac{\beta}{\alpha}. \end{aligned} \tag{5}$$

The welfare optimum is characterized by:

$$W_{MAX} \qquad \begin{aligned} &Y^* = \left[\alpha^{\alpha}\beta^{\beta}\frac{1}{(1-\gamma)^{\alpha}}\right]^{\frac{1}{1-\alpha-\beta}} > Y' \\ &L^* = \left[\alpha^{1-\beta}\beta^{\beta}\frac{1}{(1-\gamma)^{1-\beta}}\right]^{\frac{1}{1-\alpha-\beta}} > \mathrm{L'} \\ &K^* = \left[\alpha^{\alpha}\beta^{1-\alpha}\frac{1}{(1-\gamma)^{\alpha}}\right]^{\frac{1}{1-\alpha-\beta}} > \mathrm{K'} \\ &\frac{Y^*}{L^*} = \frac{1-\gamma}{\alpha} < \frac{Y'}{L'} \\ &\frac{K^*}{L^*} = \frac{\beta(1-\gamma)}{\alpha} < \frac{K'}{L'}. \end{aligned} \tag{6}$$

Comparing (6) with (4) and (5), we see that the welfare optimum can be achieved in a decentralized setting by applying a Pigouvian subsidy, s_L, per unit of land. Producers maximize profit after subsidies, $\Pi + s_L L$ As *CS* is independent of domestic production, this will also maximize $\Pi + CS + s_L L$. Making this equal to W, requires $s_L = \gamma$. W will then be equal to producer surplus after subsidies, $\Pi + \gamma L$, plus consumer surplus, *CS*, plus the amenity benefit, γL, minus taxpayers' cost, γL. Amenity benefits and taxpayers' cost are equal because the benefit function is assumed to be linear. Here it is implicitly assumed that the subsidies are paid from revenue obtained through non-distorting (lump sum) taxation, otherwise a deadweight loss should be deducted. In reality such non-distorting taxes are hard to find, but this can be ignored as our aim is to compare the efficient policy with a production subsidy scheme that requires even more tax revenue and therefore generates a greater potential deadweight loss from taxation. As the price of land is normalized to 1, γ is assumed to be less than 1. We observe that the welfare optimum requires higher production of the agricultural good and greater land use, but lower production per unit of land than the no-subsidy case. The welfare optimum also requires greater use of capital, but lower capital intensity than the competitive (no-subsidy) case.

In this model the absolute and relative PSEs are:

$$W_{MAX} \qquad PSE^* = \gamma L^* = \gamma\left[\alpha^{1-\beta}\beta^{\beta}\frac{1}{(1-\gamma)^{1-\beta}}\right]^{\frac{1}{1-\alpha-\beta}}$$

$$\%PSE^* = \frac{\gamma L^*}{Y^* + \gamma L^*} = \frac{\alpha\gamma}{1-\gamma+\alpha\gamma} \tag{7}$$

We now define a measure of trade distortion, *TD*, as the relative difference between production of the agricultural good in the absence of support and with a subsidy. We acknowledge that this is a rough measure of trade distortion compared to the more sophisticated approach of Anderson and Neary (2005), further developed by Anderson, Croser and Lloyd (2009). In the case of an optimal subsidy, trade distortion equals:

$$TD^* = \frac{Y^*}{Y'} - 1 = \left[\frac{1}{1-\gamma}\right]^{\frac{\alpha}{1-\alpha-\beta}} - 1 > 0 \tag{8}$$

We see that TD^* is increasing in γ. While theoretically sound, an exact measure of trade distortion may be difficult to calculate in practice given that both consumption and production may change and there can be trade reversals. In our empirical analysis we employ an index of the change in net imports as a proxy for trade distortion.

Now consider the case where agricultural support is proportional to production and the subsidy rate is S_Y. This gives the following solution:

$$s_Y > 0 \qquad \widehat{Y} = \left[\alpha^{\alpha}\beta^{\beta}(1+s_Y)^{\alpha+\beta}\right]^{\frac{1}{1-\alpha-\beta}} > Y'$$

$$\widehat{L} = \left[\alpha^{1-\beta}\beta^{\beta}(1+s_Y)\right]^{\frac{1}{1-\alpha-\beta}} > L'$$

$$\widehat{K} = \left[\alpha^{\alpha}\beta^{1-\alpha}(1+s_Y)\right]^{\frac{1}{1-\alpha-\beta}} > K'$$

$$\frac{\widehat{Y}}{\widehat{L}} = \frac{1}{\alpha(1+s_Y)} < \frac{Y'}{L'}$$

$$\frac{\widehat{K}}{\widehat{L}} = \frac{\beta}{\alpha} = \frac{K'}{L'} > \frac{K^*}{L^*}$$

$$\widehat{PSE} = s_Y \widehat{Y} = s_Y \left[\alpha^{\alpha} \beta^{\beta} (1+s_Y)^{\alpha+\beta}\right]^{\frac{1}{1-\alpha-\beta}}$$
$$\%\widehat{PSE} = \frac{s_Y \widehat{Y}}{(1+s_Y)\widehat{Y}} = \frac{s_Y}{(1+s_Y)}$$
$$\widehat{TD} = (1+s_Y)^{\frac{\alpha+\beta}{1-\alpha-\beta}} - 1. \tag{9}$$

In order to compare this to the welfare optimum we set the subsidy rate such that land use is identical under the two regimes, i.e. $\widehat{L} = L*$. It follows from (6) and (9) that:

$$(1+s_Y) = (1-\gamma)^{\beta-1} \quad , \quad s_Y = (1-\gamma)^{\beta-1} \text{ -1} \quad \text{and} \quad \frac{s_Y}{(1+s_Y)} = 1-(1-\gamma)^{1-\beta} \quad , \tag{10}$$

and

$$\widehat{PSE} - PSE* = s_Y \widehat{Y} - \gamma L* = \left[\frac{s_Y}{\alpha(1+s_Y)} - \gamma\right] L* = \left[\frac{1-(1-\gamma)^{1-\beta}}{\alpha} - \gamma\right] L* > 0 \quad . \tag{11}$$

As this difference in absolute PSE is increasing in γ it must always be positive. The ratio of percentage PSEs is given by:

$$\frac{\%PSE*}{\%\widehat{PSE}} = \frac{\frac{\alpha\gamma}{1-\gamma(1-\alpha)}}{1-(1-\gamma)^{1-\beta}} \quad , \tag{12}$$

which may be greater or less than one, depending on the willingness to pay (γ), the scale elasticity ($\alpha+\beta$) and the distribution parameter, $\alpha/(\alpha+\beta)$. In Figure 1, the Cobb-Douglas case in (12) is computed for a distribution parameter equal to 0.1 and a scale elasticity of 0.99, that is $\alpha = 0.099$ and β=0.891. For this case we see that for low values of γ the %PSE is lower for area support than for production support.[14] For γ in excess of 0.2 the opposite applies. In addition to the Cobb-Douglas case, we graph the results for the CES function derived in Appendix 1. We concentrate on two cases. First, a low elasticity of substitution of 0.5, and second a high elasticity of substitution of 2. Again we see that the ratio of the %PSE in (12) is lowest when γ is low. And we see that variation

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[14] As γ approaches zero, the ratio of percentage PSE in (12) approaches α/(1-β), which is less than 1. This is seen by using L'Hospital's rule. Therefore, for low γs, $\%PSE^* < \%\widehat{PSE}$. For large γs, $\%PSE^* > \%\widehat{PSE}$, because of the two following observations: (i) when γ=1 we see from (12) that the ratio of percentage PSE is 1; (ii) for γ=1, the slope of the ratio of percentage PSE is negative. Therefore, for γ's close to 1 $\%PSE^* > \%\widehat{PSE}$.

in the %PSE is highest in the high elasticity case. To explain these results further, it is useful to keep in mind the following definition:

$$\%\text{PSE} = \frac{\text{Subsidies}}{\text{Production} + \text{Subsidies}} = \frac{\frac{\text{Subsidies}}{\text{Production}}}{1 + \frac{\text{Subsidies}}{\text{Production}}}.$$

If we change from production support to land support, both production and subsidies will decrease. From the definition above, we see that the %PSE (and the ratio $\frac{\%PSE*}{\%P\hat{S}E}$) will increase if subsidies per unit of production increase (and vice versa). This is what happens in the right hand side of Figure 1: here the willingness to pay γ is high, which demands a high level of land use, L^*, compared to a pure market solution. When L^* is obtained through production subsidies, use of capital, *K*, as well as production, *Y*, will be high. Consequently, the welfare gain from using land subsidies is related to the potential for lower levels of *K* and *Y*. This potential increases with the elasticity of substitution. The change in subsidy per unit of production is affected by two opposing forces. For a given Y, substitution of *K* for *L* entails costs that raise the unit subsidy. However, when we change from output to land subsidies, output decreases. This implies a reduction in the unit subsidy, because of decreasing returns to scale. On the right hand side of Figure 1, the higher unit cost due to substitution dominates the scale effect, so the %PSE increases, even if the welfare gain is positive. For low levels of L^*, as is the case in the left hand side of the figure, only minor substitution is required, and the cost is therefore low. Here, the %PSE decreases when land subsidies are introduced.

Figure 1 and Appendix 3 demonstrate the sensitivity of the PSE-ratio with respect to parameter values. First, we see that the PSE-ratio declines with the value of the scale elasticity. For scale elasticities below 0.6, the PSE-ratio is mostly below 1. The cost gain from lower production (when using a land subsidy) decreases with the scale elasticity, and tends to be dominated by the costs of substitution.

The PSE ratio also decreases with the cost share of *L*. When this is low, the transition from production support to a land subsidy implies a strong decline in the price of *L* relative to *K*, which promotes substitution, and thereby elevates the costs of substitution in the PSE-ratio. Note that even if the sales price of land is exogenous, the purchase price (defined as the sales price net of land subsidies) is endogenous. Finally, the substitution parameter matters. For high levels of γ (i.e., high levels of L^*), the PSE-ratio increases with the substitution parameter while the opposite applies for low levels of γ. Here, the substitution costs are decisive. In the first case, where substantial substitution takes place these costs are quite high, while they are low in the latter case when only minor substitution applies.

This discussion shows that it is possible that a switch from a suboptimal (production subsidy) to an optimal (input subsidy) policy may well lead to an increase in the relative PSE rather than a decrease. An increase is more likely when the willingness to pay for public goods (or positive externalities) is high, and when: 1) the inputs that enhance the public good have a low cost share in agriculture (which offers the potential for substantial substitution); 2) technology allows substitution towards these inputs (at the expense of others such as capital); and 3) diseconomies of scale are low (so that the increase in unit costs from reducing production is moderate).

For the trade distortion we have that:

$$\widehat{TD} - TD^* = (1+s_Y)^{\frac{\alpha+\beta}{1-\alpha-\beta}} - \left[\frac{1}{1-\gamma}\right]^{\frac{\alpha}{1-\alpha-\beta}} = \left[\frac{1}{1-\gamma}\right]^{\frac{(1-\beta)(\alpha+\beta)}{1-\alpha-\beta}} - \left[\frac{1}{1-\gamma}\right]^{\frac{\alpha}{1-\alpha-\beta}}$$
$$= \left[\frac{1}{1-\gamma}\right]^{\frac{\alpha+\beta(1-\alpha-\beta)}{1-\alpha-\beta}} - \left[\frac{1}{1-\gamma}\right]^{\frac{\alpha}{1-\alpha-\beta}} > 0 \qquad (14)$$

since $\alpha+\beta>0$. Trade distortions will always decline when moving from production to land subsidies. This point was made by Dewbre et al. (2001) in an empirical analysis of the impact of switching from direct payments to area payments.

3. An Empirical Example for Norway

To illustrate the points made in the previous section, we provide an empirical example of how a change in policy from production support to subsidies targeted towards public goods affects the relative PSE, economic welfare and trade distortions.

Norway is a particularly good example in this respect. The relative PSE in 2008 was 62% - the highest among the OECD member countries (OECD, 2009). Norway's agricultural policy is often criticized as being trade distorting and far from optimal (e.g., Lamy, 2007), with more than half of government support directly tied to production. Norwegian agriculture is positioned to the right hand side of Figure 1; i.e. production costs are high (agriculture is uncompetitive) compared to the willingness to pay for agricultural public goods in the country (see Brunstad et al., 2005).

The Model

We use a price-endogenous model of Norwegian agriculture that includes the most important commodities – in all 13 final and 8 intermediate product aggregates. Of the final products, 10 are related to animal production and 3 are related to crops. Inputs are land, labor (family and hired), capital (machinery and buildings), concentrated feed, and an aggregate of other goods. The model distinguishes between tilled land and grazing on arable land and pasture.

Domestic supply is represented by roughly 400 "model farms". Each of these is characterized by Leontief technology, i.e. with fixed input and output coefficients. Although inputs cannot substitute for each other at the farm level, substitution is possible at the sector level. For example, beef can be produced using different technologies, through extensive and intensive production systems, and in combination with milk. Thus, in line with the general Leontief model in which each good may be produced by more than one activity, the isoquant for each product is piecewise linear. Also, production can take place on small farms or larger and more productive farms. Consequently, economies of scale are reflected.

Norway is divided into nine regions, each with limited supply of different grades of land. This introduces an element of diseconomies of scale because, *ceteris paribus*, production will first take place in the most productive regions. Domestic demand for final products is represented by linear demand functions. Economic surplus (consumer plus producer surplus) is maximized, subject to demand and supply relationships, policy instruments and imposed restrictions. The solution to the model is found though prices and quantities that yield an equilibrium in each market. A more detailed description is given in Appendix 2; see also Brunstad et al. (1995).

Assumptions and Results

Two different policy approaches are considered: 1) a policy exclusively targeted towards the provision of public goods through the payment of input-based subsidies (primarily on land); and 2) production support that provides the same supply of these goods. Of these two alternatives the first represents an efficient policy.

As a basis for comparison, Column 1 in Table 1 presents the model's representation of the existing policy in a typical base year (1998). The structure of production in Norway does not vary significantly from year-to-year. In spite of climatic disadvantages, production is high and imports are low. Norway is self-sufficient in most of the products listed. For dairy products there is a surplus, with the equivalent of roughly 12% of domestic milk production being disposed of through subsidized exports of cheese in 1998. The Arctic climate does not permit sufficient production of high-quality grain for bread-making, so roughly half of the wheat used domestically is imported.

As may be observed, the current policy is costly. The total PSE in the base year was 15.2 billion NOK (roughly $2.4 billion at current exchange rates) which equals 64% of the value of production at the farm level. With respect to factors, land support was NOK 250,000 ($39,000) per full-time equivalent worker and NOK 17,000 ($2,700) per hectare. A break-down of the PSE into various categories shows that about 50% of the support is in the form of market price support, generated by import tariffs in the range of 171% to 429% and export subsidies. The remainder of the support is provided through payments based on output (15%), area planted or animal numbers (12%) and input use (25%).

The final row in Table 1 contains an index of trade distortion, *TDI*. In the analytical example we used the relative divergence from production under free trade, but since we estimate that there would be very little agricultural production in Norway under free trade, we have modified the measure. Our index is defined as the weighted sum of the relative divergence between net imports under free trade and the simulation in question:

$$TDI=\sum_j \alpha_j \frac{\overline{M}_j - M_j}{\overline{M}_j}, \quad where \quad \alpha_j = \frac{p_j \overline{M}_j}{\sum_{jj} p_{jj} \overline{M}_{jj}} \quad \forall\ j, jj = 1..m$$

As weights (α), we use the net import value share of each product *j* in the free trade solution, where p_j is the world market price and $\overline{M}_j$ is the free trade net import volume. $\overline{M}_j$ is determined from a simulation with unrestricted imports and no support. M_j is the net import in the counterfactual simulation. With this definition, the magnitude of trade distortion increases with the value of the index. In the simulation of the current policy, we can see that *TDI* is slightly above 1. Compared to a pure self-sufficiency solution (*TDI* = 1), imports of wheat, with a free trade import value share of 3.8%, pull the *TDI* downwards slightly, while subsidized exports of cheese work in the opposite direction.

Most of the support is currently attached to the production of private goods. Even support that is linked to land, animals or other inputs is only targeted to the provision of public goods to a limited degree, e.g., through requirements for landscape preservation or restrictions on agricultural production practices. Therefore, the present policy is weakly targeted to sources of market failure.

The implications of a policy exclusively aimed at the provision of public goods are illustrated in Column 2 of Table 1, following the approach by Brunstad et al. (1999, 2005). In this case, the amenity value of the agricultural landscape is taken into account by incorporating a willingness to pay (*WTP*) function in the objective function of the model (Brunstad et al., 1999):

$$WTP = \beta L^{\varepsilon},$$

where $L= f(G,T)$ is a CES quantity index for landscape which allows for substitution between grassland (*G*) and tilled land (*T*). β is a parameter calibrated from contingent valuation studies indicating that the amenity value is higher for grazing and pasture land than for tilled land, while the parameter $\varepsilon < 1$, taken from Lopez et al. (1994), implies that the marginal willingness to pay is decreasing in *L*. We recognize that willingness to pay estimates may give a different valuation on particular forms of land use than other more “objective” measures of environmental or other benefits. This will influence the absolute values in Table 1, but not the relative rankings of the policies.

As the results demonstrate, when cultural landscape is the policy aim, agricultural production and employment fall substantially, but a large proportion of the land remains in production (64% of the base level solution). A switch towards land-intensive production techniques takes place, represented by extensive sheep meat production. The total PSE falls to roughly 40% of the current level, and economic welfare, defined as the sum of producer and consumer surplus net of subsidies, increases by NOK 8.2 billion ($1.3 billion).

In this simulation, support is exclusively tied to factors related to the public good in question (land, labor and livestock). No market price support or deficiency payments are used. Because of technological interlinkages, production and trade are affected, but to a much smaller extent than under current policies. As a result, the *TDI* declines substantially (from roughly 1 to 0.36), indicating that imports increase substantially. In spite of lower support, higher welfare and a reduction in trade distortions, the relative PSE increases from 64% to 71%.

Table 1. PSE, welfare and trade distortion

		Provision of public goods	
	Current policies	**Efficient policy**	**Production support**
Production (mill. kg.)			
Milk	1,672	710	1,236
Beef and veal	82	29	60
Pig meat	100	0	73
Sheep meat	23	30	17
Poultry meat	28	0	20
Eggs	44	10	32
Wheat	211	150	154
Coarse grains	1,021	339	746
Potatoes	298	312	291
Land use (mill. hectares)	0.85	0.54	0.54
Employment (‘000 person-years)	59.7	17.7	27.8
PSE (billion NOK)	15.2	6.0	9.5
Market price support	6.7	0	0
Output support	2.0	0	9.5
Input support	6.6	6.0	0
PSE (percentage)	64 %	71 %	64 %
Economic welfare (billion NOK) of	36.8	45.0	41.8
which value of landscape	22.3	20.6	20.6
Index of trade distortion	1.002	0.36	0.71

Column 3 of Table 1 shows what happens to the indicators when an inferior policy, i.e., a production subsidy, is used to achieve the same supply of public goods. In this simulation, production (Column 1) is scaled down proportionally until land use and its public value are equal to the levels under the efficient solution (Column 2). There are no import tariffs, but in contrast to the efficient solution, support is now tied directly to production.

Land use is the same as under the efficient solution but production and the use of labor and other inputs are larger. Consequently, both support and trade distortions are higher (*TDI* = 0.71), and welfare is lower. However, in line with the discussion in Section 2, the relative PSE is below the efficient policy level. With reference to Figure 1, the ratio of the relative PSE under efficient policy and production subsidies, respectively, is 1.1. This suggests a location in the right hand side of the figure, where we have a relatively high willingness to pay for amenity values.

4. Conclusions

A substantial share of current agricultural support in OECD countries is provided through market price support and production subsidies. According to the OECD PSE/CSE database (2009), approximately half of Norway's total PSE was in the form of market price support (border protection) and payments linked to output. Tangermann (2005, p. 11) claims that: "for the OECD area overall, less than 5% of the PSE is currently in a form that may potentially be targeted to specific public goods." This policy orientation may need to change if efforts to liberalize international trade through the WTO are successful. There may be pressure to shift away from income support and protection to so-called green support related to the provision of public goods and environmental services.

There is a need for appropriate indicators to capture policy reform. Even if the relative PSE was never intended to provide an indicator of the welfare or trade impacts of agricultural policies, the concept has been widely used as a yardstick of policy misconduct. The higher a country's percentage PSE, the more likely it is that its agricultural policy will be criticized as being inefficient and trade distorting.

When considering conventional agricultural policy grounded on production subsidies, the size of the percentage PSE and economic inefficiency tend to go hand in hand. However, as we have demonstrated, this is not necessarily the case if agricultural policy is targeted to correcting externalities related to agricultural activity. While a welfare-enhancing reform of shifting from the provision of production subsidies to payments targeted towards externalities results in a lower absolute PSE and smaller trade distortions, a higher percentage PSE may well be the likely outcome.

Appendix 1

The following equations are numbered as in the main text. The CES production function is:

$$Y = \left(\alpha L^{\rho} + (1-\alpha)K^{\rho}\right)^{\lambda/\rho} \quad \lambda < 1,\ \rho \leq 1, \tag{1'}$$

λ is the scale parameter assumed to be less than one, i.e. decreasing returns to scale and ρ is connected to the elasticity of substitution, σ, through:

$$\sigma = \frac{1}{1-\rho}.$$

It is useful to consider the following special cases:

i. $\rho = 1$: linear production function
ii. $\rho = 0$: Cobb Douglas, i. e., as in the main text
iii. $\rho = -\infty$: Leontief production function.

The profit function is:

$$\Pi = pY - wL - rK\,, \tag{2'}$$

and the supply and factor demand functions:

$$Y = (p\lambda)^{\lambda/1-\lambda}\left[\alpha^{1/1-\rho} w^{\rho/\rho-1} + (1-\alpha)^{1/1-\rho} r^{\rho/\rho-1}\right]^{(1-\rho)\lambda/(1-\lambda)\rho}$$

$$L = (p\lambda)^{1/1-\lambda}\left(\frac{\alpha}{w}\right)^{1/1-\rho}\left[\alpha^{1/1-\rho} w^{\rho/\rho-1} + (1-\alpha)^{1/1-\rho} r^{\rho/\rho-1}\right]^{(\lambda-\rho)/\rho(1-\lambda)} \tag{3'}$$

$$K = (p\lambda)^{1/1-\lambda}\left(\frac{1-\alpha}{r}\right)^{1/1-\rho}\left[\alpha^{1/1-\rho} w^{\rho/\rho-1} + (1-\alpha)^{1/1-\rho} r^{\rho/\rho-1}\right]^{(\lambda-\rho)/\rho(1-\lambda)}.$$

If output and factor prices equal 1:

$$L' = (\lambda)^{1/1-\lambda}\alpha^{1/1-\rho}\left[\alpha^{1/1-\rho} + (1-\alpha)^{1/1-\rho}\right]^{(\lambda-\rho)/\rho(1-\lambda)}$$

$$K' = (\lambda)^{1/1-\lambda}(1-\alpha)^{1/1-\rho}\left[\alpha^{1/1-\rho} + (1-\alpha)^{1/1-\rho}\right]^{(\lambda-\rho)/\rho(1-\lambda)}$$

$$Y' = (\lambda)^{\lambda/1-\lambda}\left[\alpha^{1/1-\rho} + (1-\alpha)^{1/1-\rho}\right]^{(1-\rho)\lambda/(1-\lambda)\rho} \tag{5'}$$

$$\frac{Y'}{L'} = \frac{1}{\lambda}\left(\frac{1}{\alpha}\right)^{1/1-\rho}\left[\alpha^{1/1-\rho} + (1-\alpha)^{1/1-\rho}\right]$$

$$\frac{K'}{L'} = \left(\frac{1-\alpha}{\alpha}\right)^{1/1-\rho}.$$

We refer to (5') as the perfectly competitive solution.

With a constant willingness to pay for landscape amenities, defined as γ per unit of land, *L,* the welfare optimum yields:

$$Y^* = (\lambda)^{\lambda/1-\lambda}\left[\alpha^{1/1-\rho}(1-\gamma)^{\rho/\rho-1} + (1-\alpha)^{1/1-\rho}\right]^{(1-\rho)\lambda/(1-\lambda)\rho} > Y'$$

$$K^* = (\lambda)^{1/1-\lambda}(1-\alpha)^{1/1-\rho}\left[\alpha^{1/1-\rho}(1-\gamma)^{\rho/\rho-1} + (1-\alpha)^{1/1-\rho}\right]^{(\lambda-\rho)/\rho(1-\lambda)} \qquad (6')$$

$$L^* = (\lambda)^{1/1-\lambda}\left(\frac{\alpha}{1-\gamma}\right)^{1/1-\rho}\left[\alpha^{1/1-\rho}(1-\gamma)^{\rho/\rho-1} + (1-\alpha)^{1/1-\rho}\right]^{(\lambda-\rho)/\rho(1-\lambda)} > L'$$

$$\frac{Y^*}{L^*} = \frac{1}{\lambda}\left(\frac{1-\gamma}{\alpha}\right)^{1/1-\rho}\left[\alpha^{1/1-\rho}(1-\gamma)^{\rho/\rho-1} + (1-\alpha)^{1/1-\rho}\right] < \frac{Y'}{L'}$$

$$\frac{K^*}{L^*} = \left(\frac{(1-\gamma)(1-\alpha)}{\alpha}\right)^{1/1-\rho} < \frac{K'}{L'}.$$

By comparing (6') and (5') we see that welfare optimum requires greater production of the agricultural good, greater land use, but lower production per unit of land than the perfectly competitive case. If $\lambda > \rho$, the welfare optimum requires greater use of capital but capital intensity is always lower than the perfectly competitive case.

The producer subsidy equivalent is given by:

$$PSE^* = \gamma L^* = \gamma(\lambda)^{1/1-\lambda}\left(\frac{\alpha}{1-\gamma}\right)^{1/1-\rho}\left[\alpha^{1/1-\rho}(1-\gamma)^{\rho/\rho-1} + (1-\alpha)^{1/1-\rho}\right]^{(\lambda-\rho)/\rho(1-\lambda)} \qquad (7')$$

$$\%PSE^* = \frac{\gamma L^*}{Y^*} = \gamma\lambda\left(\frac{\alpha}{1-\gamma}\right)^{1/1-\rho}\left[\alpha^{1/1-\rho}(1-\gamma)^{\rho/\rho-1} + (1-\alpha)^{1/1-\rho}\right]^{-1}.$$

This implies that the %PSE is increasing in γ.

Our measure of trade distortion is:

$$TD^* = \frac{Y^*}{Y'} - 1 = \left[\frac{\alpha^{1/1-\rho}(1-\gamma)^{\rho/\rho-1} + (1-\alpha)^{1/1-\rho}}{\alpha^{1/1-\rho} + (1-\alpha)^{1/1-\rho}}\right]^{(1-\rho)\lambda/(1-\lambda)\rho} - 1. \qquad (8')$$

Hence, an increasing γ implies an increasing TD^*.

Subsidizing output instead of land yields:

$$\hat{L} = \left((1+s_Y)\lambda\right)^{1/1-\lambda}(\alpha)^{1/1-\rho}\left[\alpha^{1/1-\rho} + (1-\alpha)^{1/1-\rho}\right]^{(\lambda-\rho)/\rho(1-\lambda)} > L'$$

$$\hat{K} = \left((1+s_Y)\lambda\right)^{1/1-\lambda}(1-\alpha)^{1/1-\rho}\left[\alpha^{1/1-\rho} + (1-\alpha)^{1/1-\rho}\right]^{(\lambda-\rho)/\rho(1-\lambda)} > K'$$

$$\hat{Y} = \left((1+s_Y)\lambda\right)^{\lambda/1-\lambda}\left[\alpha^{1/1-\rho} + (1-\alpha)^{1/1-\rho}\right]^{(1-\rho)\lambda/(1-\lambda)\rho} > Y' \tag{9'}$$

$$\frac{\hat{Y}}{\hat{L}} = \frac{1}{(1+s_Y)\lambda}\left[\alpha^{1/1-\rho} + (1-\alpha)^{1/1-\rho}\right] < \frac{Y'}{L'}$$

$$\frac{\hat{K}}{\hat{L}} = \left(\frac{1-\alpha}{\alpha}\right)^{1/1-\rho} = \frac{K'}{L'}$$

where s_Y is the rate of output subsidy. In this case the PSE is:

$$P\hat{S}E = s_Y\hat{Y} = s_Y\left((1+s_Y)\lambda\right)^{\lambda/1-\lambda}\left[\alpha^{1/1-\rho} + (1-\alpha)^{1/1-\rho}\right]^{(1-\rho)\lambda/(1-\lambda)\rho}$$

and

$$\%P\hat{S}E = \frac{s_Y\hat{Y}}{(1+s_Y)\hat{Y}} = \frac{s_Y}{1+s_Y}.$$

We see that the $\%P\hat{S}E$ is increasing in s_Y. The trade distortion is:

$$T\hat{D} = \frac{\hat{Y}}{Y'} - 1 = (1+s_Y)^{\lambda/1-\lambda},$$

and $T\hat{D}$ is also increasing in s_Y.

A comparison between the two cases, assuming $\hat{L} = L^*$, yields:

$$\left(\frac{1}{1-\gamma}\right)^{1/1-\rho} = \left(1+s_Y\right)^{1/1-\lambda}\left[\frac{\alpha^{1/_{1-\rho}} + (1-\alpha)^{1/_{1-\rho}}}{\alpha^{1/_{1-\rho}}(1-\gamma)^{\rho/_{\rho-1}} + (1-\alpha)^{1/_{1-\rho}}}\right]^{\frac{(\lambda-\rho)}{(1-\lambda)\rho}}$$

It now follows that s_Y must be set such that:

$$s_Y = \left(\frac{1}{1-\gamma}\right)^{(1-\lambda)/_{(1-\rho)}}\left[\frac{\alpha^{1/_{1-\rho}}(1-\gamma)^{\rho/_{\rho-1}} + (1-\alpha)^{1/_{1-\rho}}}{\alpha^{1/_{1-\rho}} + (1-\alpha)^{1/_{1-\rho}}}\right]^{(1-\lambda)(\lambda-\rho)/_{(1-\lambda)\rho}} - 1 \qquad (10')$$

and

$$P\hat{S}E - PSE^* = s_Y\hat{Y} - \gamma L^* = s_Y\left((1+s_Y)\lambda\right)^{\lambda/_{1-\lambda}}\left[\alpha^{1/_{1-\rho}} + (1-\alpha)^{1/_{1-\rho}}\right]^{(1-\rho)\lambda/_{(1-\lambda)\rho}} -$$

$$- \gamma(\lambda)^{1/_{1-\lambda}}\left(\frac{\alpha}{1-\gamma}\right)^{1/_{1-\rho}}\left[\alpha^{1/_{1-\rho}}(1-\gamma)^{\rho/_{\rho-1}} + (1-\alpha)^{1/_1}\right. \qquad (11)$$

and furthermore that:

$$\%P\hat{S}E - \%PSE^* = \frac{s_Y}{1+s_Y} - \gamma\lambda\left(\frac{\alpha}{1-\gamma}\right)^{1/_{1-\rho}}\left[\alpha^{1/_{1-\rho}}(1-\gamma)^{\rho/_{\rho-1}} + (1-\alpha)^{1/_{1-\rho}}\right]^{-1},$$

where s_Y is given by (10').

Appendix 2

We use a partial equilibrium model of the Norwegian agricultural sector. For given input costs and demand functions, market clearing prices and quantities are computed. Prices of goods produced outside the agricultural sector or abroad are taken as given. As the model assumes full mobility of labor and capital and should be interpreted as a long-run model.

The model covers the most important products in the Norwegian agricultural sector, in all 13 final and 8 intermediate products. Most products in the model are aggregates. Primary inputs are: land (four different grades), labor (family members and hired), capital (machinery, buildings, and livestock) and other inputs (fertilizers, fuel, seeds, etc.). The prices of inputs are treated as given.

Total supply is the sum of domestic production and imports. Domestic production takes place on approximately 400 different "model farms". The farms are modeled with fixed input and output coefficients, based on data from extensive farm surveys carried out by the Norwegian Agricultural Economics Research Institute, a research body connected to the Norwegian Ministry of Agriculture. Imports take place at given world market prices inclusive of tariffs and transport costs. Domestic and foreign products are assumed to be perfect substitutes. The country is divided into nine production regions, each with limited supply of different grades of land. This regional division allows for variation in climatic and topographic conditions and makes it possible to specify regional goals and policy instruments. The products from the model farms go through processing plants before they are sold on the market. Processing is partly modeled as pure cost mark-ups (meat, eggs and fruit), and partly through production processes of the same type as the model farms (milk and grains).

The domestic demand for final products is represented by linear demand functions. These demand functions are based on existing studies of demand elasticities, and are linearized to pass through the observed price and quantity combination in the base year (1998). Cross price effects are included for meat products, but only own price effects for other products. The demand for intermediate products is derived from the demand for the final products for which they are inputs. Exports take place at given world market prices.

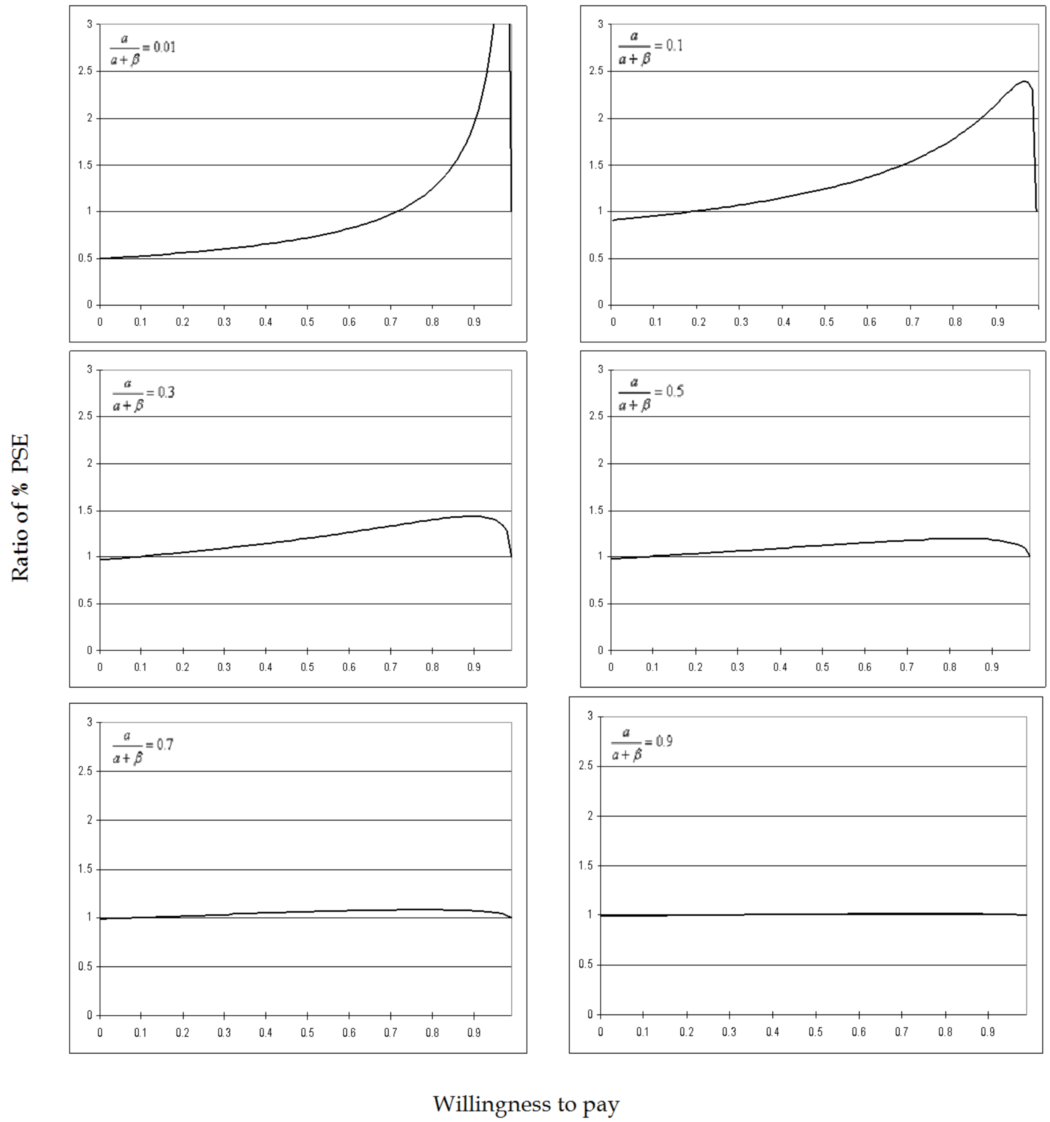
Domestic demand for final products is divided among 5 separate demand regions, each with its own demand function. Each demand region consists of one or several production regions. If products are transported from one region to another, transport costs are incurred. For imports and exports transport costs are incurred from the port of entry or to the port of shipment, respectively. In principle, restrictions can be placed on all the variables in the model. The restrictions that we include can be divided into two groups:

1. Scarcity restrictions: upper limits for the endowment of land, for each grade of land in each region;
2. Political restrictions: lower limits for land use and employment in each region, for groups of regions (central regions and remote areas), or for the country as a whole; maximum or minimum quantities for domestic production, imports or exports; and maximum prices.

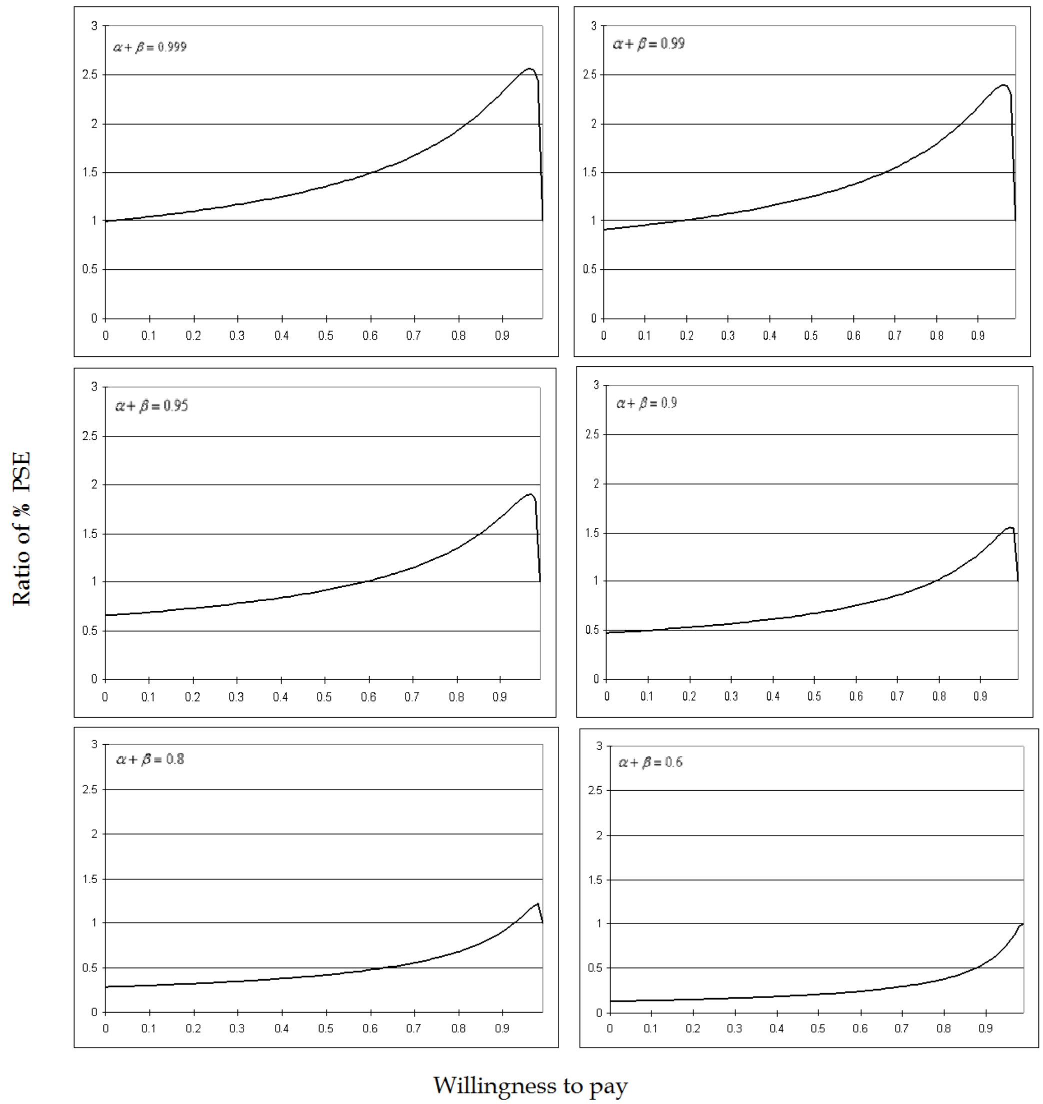
In the model, economic surplus (consumer plus producer surplus) is maximized. This is performed subject to demand and supply relationships and imposed restrictions. Which restrictions are included depends on what kind of simulation is performed. The solution to the model is found through prices and quantities that yield equilibrium in each market. No restrictions can be violated, and no model farm or processing plant that is active, runs at a loss.

Appendix 3: Sensitivity Analysis

In 12 enclosed figures



Variable distribution parameter. Scale elasticity 0.99.



Variable scale elasticity. Distribution parameter 0.1.

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COMPETITIVENESS OF EGYPT IN THE EU MARKET FOR FRUITS AND VEGETABLES

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Abstract

Fruits and vegetables represent a great export potential for Egypt to the European Union (EU), the leading importer of fruits and vegetables in the world. With that in mind, this paper assesses the competitiveness of Egypt in the EU fruit and vegetable market relative to nine Southern Mediterranean Countries (SMCs) over the period 2004-2008, by adopting the Constant Market Share Analysis (CMSA) methodology at the Harmonized System disaggregated product level of four digit codes. Results of the CMSA indicate that Egypt has increased its share in the EU market for fresh and processed fruits and vegetables, particularly onions and garlic, fresh or dried grapes and prepared or preserved vegetables as a result of enhancing its competitiveness. However, Egypt's weak capability to cope with changes in the EU consumers' demand and adjust its export supply to the structure of the EU market demand have been critical in limiting a gain that could have been higher for Egypt. To improve the country's access to the EU market, the paper suggests speeding the ratification and implementation of the new agricultural agreement between Egypt and the EU; enhancing the efficiency of transport and related logistics services; improving technologies for the preservation and processing of fruits and vegetables; developing marketing through joining the international food chains and large scale retail trade; and implementing a more flexible exchange rate regime. Egypt also needs to promote exports of products whose EU demand is growing rapidly, and to better comply with EU quality, health and environmental standards.

Keywords: competitiveness; constant market share analysis; Egypt; European Union; fruits and vegetables

1. Introduction

Fruits and vegetables are the main agricultural exports of Egypt accounting for 57 percent of total agricultural exports in 2008. The European Union (EU), the country's first trading partner, is the largest importer of fresh and processed fruits and vegetables in the world with a share of 57.7 percent of global imports in the same year.[15] Hence, the EU

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[15] Author's calculations based on data from the United Nations Commodity Trade Statistics Database (UN COMTRADE, http://comtrade.un.org).

constitutes a potentially large market for Egypt as far as exports of fruits and vegetables are concerned.

However, the main concerns for Egypt are the high protection given to European fruit and vegetable producers in a sensitive sector, where production is often highly seasonalized and where perishable products are difficult to stock; the heterogeneity in the level of preferences that are applied by the EU to Egypt and other Southern Mediterranean Countries (SMCs), namely: Algeria, Israel, Jordan, Lebanon, Libya, Morocco, the Palestinian Authority, Syria and Tunisia; and the potential erosion of Egypt's preferential access to the EU fruit and vegetable market that could result from the generalization of European preferences to other suppliers in the framework of the ongoing Doha negotiations of the World Trade Organization (WTO).

The aim of this paper is to assess Egypt's competitiveness in the EU fruit and vegetable market over the period 2004-2008 in comparison to other SMCs; analyze the change of Egypt's export share in the EU market and determine its sources by using the Constant Market Share Analysis (CMSA) methodology; and suggest policies to enhance Egypt's fruit and vegetable exports to the EU.

The paper is organized as follows. In Section 2 EU fruit and vegetable import flows are analyzed and the position of the EU as a leading importer of fruits and vegetables in the world is highlighted. Export flows from Egypt to the EU are examined and Egypt's revealed comparative advantage in exporting fruits and vegetables is illustrated. In Section 3 the EU import regime and the protection for the fruit and vegetable market are investigated. Preferential access conditions to the EU fruit and vegetable market for Egypt's exports are then explored and evaluated in comparison to other SMCs. In Section 4 the Constant Market Share Analysis (CMSA) methodology is presented and the trade data utilized to assess the competitiveness of Egypt in the EU fruit and vegetable market are described. Main results of the CMSA are reported and discussed. Section 5 puts forth some conclusions and policy implications based on the evaluation of Egypt's preferential access to the EU fruit and vegetable market and the findings of the empirical analysis.

2. EU Fruit and Vegetable Import Flows

With 500 million customers, the EU is endowed with one of the highest purchasing powers in the world constituting a potentially large market for Egypt as far as exports of fruits and vegetables are concerned.[16] The EU is the leading importer of fruits and vegetables in the world and Egypt has a clear comparative advantage in exporting them.

[16] The EU gross domestic product per capita (PPP, $) is estimated at 33,700 in 2008; while it is 34,100 for Japan; 39,200 for Canada and 47,500 for the United States (Central Intelligence Agency 2009).

2.1. European Union: The Leading Importer of Fruits and Vegetables in the World

The EU is the world's biggest importer and exporter of food and drink.[17] The sum of its exports and imports in 2007 was EUR 138 billion (Table 1), compared with EUR 115 billion for the second largest player, the United States (European Commission 2009a).

As for fruits and vegetables, the EU is the leading importer (57.7 percent) and second largest exporter (51.3 percent) in the world. Throughout the period 2000-2008, fruits and vegetables made up a quarter of total EU imports of food and drink and the EU deficit on trade in fruits and vegetables recorded a large increase of 36 percent (European Commission 2009a).

Table 1. Extra EU Trade of Vegetables and Fruits (Value in Million Euros)

	2000	2006	2007	2008	Average annual increase 2000-2008 (%)	Share in extra EU exports/ imports of food and drink 2008 (%)	Share in extra EU exports/ imports 2008 (%)
Total exports of food and drink	47 720	57 959	62 015	68 319	4.6%	100.0%	5.2%
Exports of vegetables and fruits (SITC 05)	4 444	6 503	7 381	7 942	7.5%	11.6%	0.6%
Total imports of food and drink	54 823	67 922	75 576	80 203	4.9%	100.0%	5.2%
Imports of vegetables and fruits (SITC 05)	13 813	18 604	20 495	20 703	5.2%	25.8%	1.3%
Trade balance of food and drink	-7 103	-9 963	-13 561	-11 884			
Trade balance of vegetables and fruits (SITC 05)	-9 369	-12 101	-13 114	-12 761			

Source*:* European Commission (2009a).

The main EU imports of fruits and vegetables consist of fresh or dried fruits and nuts and fresh, chilled and frozen vegetables (Table 2).

While Morocco and Israel together provided around 20 percent of total EU's imports of fresh, chilled and frozen vegetables in 2007, Morocco alone provided more than 5 percent of EU's imports of preserved vegetables (Table 3).

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[17] Under the 4th revision of the Standard International Trade Classification (SITC), the food and drink product group is made up of Section (0) food and live animals and Section (1) beverages and tobacco.

Table 2. Main EU Imports of Fruits and Vegetables in 2007 (Value of Trade Balance in Million Euros)

Product	Surplus (+) / Deficit (-) in million euros in 2007
Fruits and nuts, fresh or dried, including:	**-9 586**
Bananas	-2 732
Citrus fruits	-895
Dates, figs, pineapples, avocados, guavas and mangoes	-1 105
Preparations of fruits	**-1 215**
Vegetables, fresh, chilled and frozen	**-1 435**
Vegetables, roots, tubers, prepared or preserved	**+556**

Source*:* European Commission (2008).

Table 3. Main Exporters of Fruits and Vegetables to the EU, 2007

Product	EU total imports in thousand tons	Share of main exporters of fruits and vegetables to the EU from its total imports (%)		
		Share of first EU partner (%)	Share of second EU partner (%)	Share of third EU partner (%)
Vegetables: fresh, chilled and frozen	5 316	Thailand (23.6)	Morocco (11.2)	Israel (8.7)
Vegetables: preserved	1 130	China (40.0)	Turkey (18.9)	Morocco (5.2)
Fruits: fresh	10 309	Costa Rica (16.0)	Ecuador (12.4)	Colombia (11.5)
Fruits: preserved and preparations	1 626	Thailand (16.0)	China (15.8)	Turkey (9.7)
Juices prepared from vegetables and fruits	1 779	Brazil (40.2)	China (13.5)	Switzerland (7.7)

Source*:* European Commission (2008).

2.2. Egypt's Exports to the EU

During 2004-2008, Egyptian merchandize exports to the EU grew at an average annual rate of 17.1 percent, but lower than the average annual growth rate of the country's exports to the world (18.9 percent) [Table 4]. Hence, Egypt could further promote its exports to the EU.

The EU is the main market for the exports of Egypt and several SMCs (Table 5). While the EU absorbed more than 37 percent of Egypt's total merchandize exports in 2008, it was the main destination for the exports of Tunisia (74 percent), Morocco (57 percent) and Algeria (50 percent). Agricultural exports account for 11.5 percent of Egypt's total exports to the EU, while they represent 16.3 percent of Moroccan exports to the European market (WTO 2009a).

Table 4. Egypt's Trade with the World and the EU (Value in Million Euros, Growth in %)

Period	Egypt's exports to the:		
	World	EU	EU as a share of the world (%)
2004	9 789	3 910	39.94
2005	12 549	4 793	38.20
2006	16 458	7 071	43.0
2007	17 131	6 399	37.35
2008	19 595	7 351	37.51
Average annual growth (2004-2008)	18.9%	17.1%	-

Source*:* Compiled by the author from Eurostat (2009); Delegation of the European Union to Egypt (2009f).

Table 5. The EU is the Main Destination for the Exports of Egypt and other SMCs (2008)

	Algeria	Egypt	Israel	Jordan	Lebanon	Morocco	Syria	Tunisia
Rank of the EU in the SMC exports	1	1	2	6	3	1	2	1
SMC exports to the EU (Mn.euros)	25 831.2	7 374.1	12 093.9	273.0	326.4	7 669.4	3 288.8	8 680.8
EU share of total SMC exports (%)	50.0%	37.7%	29.3%	6.0%	12.0 %	57.2%	27.9%	73.5%

Source*:* Compiled by the author from Eurostat (2009).

Nearly 6.7 percent of total EU 2008 imports from Egypt are agricultural products. Egypt is the 37th supplier of EU agricultural imports. The country's share in total EU agricultural imports is 0.5 percent. Morocco, Israel and Tunisia outperform Egypt as suppliers of EU agricultural imports, accounting for 1.7 percent, 0.9 percent and 0.6 percent of total EU agricultural imports, respectively (Table 6).

However, it is important to note that over the period 2004-2008, Egypt became the third main SMC exporter of fruits and vegetables to the European Union (exporting 481 thousand tons and 439 thousand tons, respectively in 2008), following Morocco and Israel (GREENMED 2009).

Table 6. EU Agricultural Imports from Egypt and other SMCs (2008, Value in Million Euros and Share in %)

		Algeria	Egypt	Israel	Jordan	Lebanon	Morocco	Palestinian Authority	Syria	Tunisia
EU agriultural imports from the SMC	Rank	98	37	29	122	94	21	146	92	34
	Imports (million euros)	48.5	545.8	1 017.5	17	55.5	1 939.9	4.4	73	642.1
	Agricultural products as a % of total EU imports	0.20	6.7	9.1	5.6	15.5	23.1	62.2	2	6.8
	Share in total EU agricultural imports, %	0	0.5	0.9	0	0	1.7	0	0.1	0.6

Source*:* Compiled by the author from Eurostat (2009).

Table 7. Vegetables, Fruits, Grapes, Olives and Dates: Average Yearly Production 2000-2006 (Tons)

SMCs	Vegetables		Fruits		Grapes		Olives		Dates	
	Tons	% of total SMCs' production	Tons	% of total SMCs' production	Tons	% of total SMCs' production	Tons	% of total SMCs' production	Tons	% of total SMCs' production
Algeria	4 678 904	12.0	1 231 043	9.1	275 466	10.8	261 004	8.3	449 251	25.3
Egypt	18 036 983	46.3	5 564 996	41.0	1 217 670	47.7	327 300	10.4	1 140 924	64.2
Israel	1 946 026	5.0	1 248 361	9.2	127 641	5.0	41 500	1.3	14 685	-
Jordan	1 209 077	3.1	229 454	1.7	30 017	1.2	130 815	4.2	2 363	-
Lebanon	1 201 486	3.1	805 686	5.9	113 529	4.4	123 314	3.9	-	-
Morocco	5 841 440	15.0	2 076 946	15.3	271 333	10.6	571 749	18.2	50 713	2.9
Palestinian Authority	578 196	1.5	140 768	1.0	61 303	2.4	112 648	3.6	3 921	-
Syria	3 021 943	7.8	1 637 657	12.1	333 343	13.1	812 357	25.8	3 686	-
Tunisia	2 434 786	6.3	625 214	4.6	123 314	4.8	762 143	24.3	111 857	6.3
Total SMCs	38 948 840	100.0	13 560 125	100.0	2 553 615	100.0	3 142 829	100.0	1 777 401	100.0

Source*:* European Commission (2009b).

2.3. Egypt's Revealed Comparative Advantage in Exporting Fruits and Vegetables

Fresh vegetables are the leading crops in the SMCs, accounting for nearly 40 percent of total crop production, with 38.9 million tons produced on average per year over the period 2000-2006.[18] Fresh fruits represent 14 percent of total production with 13.6 million tons harvested on average each year (European Commission 2009b).

Among the SMCs, Egypt is the main producer of fresh vegetables, with 18.0 million tons produced on average each year, followed by Morocco, Algeria and Syria with 5.8, 4.7 and 3.0 million tons, respectively. Egypt is again the main producer of fresh fruits, with a yearly average of 5.6 million tons. The breakdown of fresh vegetables and fruits in the SMCs is shown in Table 7.

Production of fruits in SMCs is dominated by *citrus fruits*: 3.2 million tons were produced in Egypt and 1.2 million tons in Morocco in 2006. Egypt is the largest producer of *grapes*, with a peak in production of 1.4 million tons in 2006 and a yearly average production of 1.2 million tons over 2000-2006. In SMCs, the average yearly production of *dates* over the period 2000-2006 is 1.8 million tons, most of which comes from Egypt (1.1 million tons).

Table 8. Average Growth Rates in Exports of Fresh and Processed Fruits and Vegetables, from the World, Egypt and Other SMCs to the EU Market (2004-2008, %)

Fresh vegetables HS 07		Fresh fruits HS 08		Processed fruits and vegetables HS 20	
World average	56.7	World average	36.5	World average	42.6
SMCs average	75.2	SMCs average	28.1	SMCs average	42.4
Libya	12 591.8*	Syria	407.3	Palestinian Authority	2 092.4*
Algeria	810.2	Lebanon	219.6	Jordan	207.2
Jordan	191.6	Egypt	90.3	Egypt	203.4
Palestinian Authority	165.0	Tunisia	31.0	Tunisia	155.8
Tunisia	156.8	Algeria	20.0	Algeria	101.7
Syria	105.6	Morocco	20.0	Libya	71.6
Morocco	90.8	Jordan	13.0	Lebanon	66.3
Lebanon	90.6	Israel	10.7	Syria	63.6
Egypt	59.2	Libya	4.8	Morocco	39.7
Israel	55.0	Palestinian Authority	-68.2	Israel	27.4

Source*:* Author's calculations based on data from the United Nations Commodity Trade Statistics Database (UN COMTRADE, http://comtrade.un.org).

Note*:* *It is important to note that if EU imports of fruits and vegetables from a certain SMC (for example, Libya and the Palestinian Authority), were extremely scarce in 2004 and growth rates are percentages of 2004 values, so they can easily reach high values. Conversely, if initial values in 2004 were large, the large effects would be unlikely.

[18] Main crops include: cereals, rice, fresh vegetables, fresh fruits, grapes, olives and dates.

Over the period 2004-2008, Egypt enjoyed a strong export performance in *fresh fruits* and *processed fruits and vegetables*, well above the average of other SMCs. On average, Egypt's exports of *fresh fruits* grew at 90.3 percent, more than triple the SMCs' average annual growth rate of 28.1 percent. As for *processed fruits and vegetables*, Egypt's exports grew at an average annual growth rate of 203.4 percent, largely exceeding the average annual growth rate of 42.4 percent for other SMCs (Table 8).

Egypt's exports of *fresh vegetables* grew at an average annual rate of 59.2 percent, lower than the SMCs' annual average growth rate of 75.2 percent.[19] Vegetable products account for almost 5 percent of EU's total imports from Egypt (Table 9). The share of Egypt in total EU imports of vegetable products is 1.1 percent, lower than the shares of Morocco (2.4 percent) and Israel (1.8 percent).

Table 9. EU Imports of Vegetable Products from Egypt and other SMCs (2008, Value in Million Euros and Share in %)

		Algeria	Egypt	Israel	Jordan	Lebanon	Morocco	Palestinian Authority	Syria	Tunisia
HS-Ch.06-14 – vegetable products	Million euros	29	440	726	14	7	960	3	20	133
	Share of total EU imports from the SMC:	0.1 %	5.4 %	6.5 %	4.7 %	1.9 %	11.5 %	44.8 %	0.6%	1.4%
	Share of SMC in total EU imports	0.1 %	1.1 %	1.8 %	0	0	2.4%	0%	0.1%	0.3%

Source*:* Compiled by the author from Eurostat (2009).

At a more disaggregated product level, Figures 1a and 1b show the most dynamic Egyptian exports of fresh fruits (pears, watermelons, apricots, grapes and citrus fruits) and vegetables (tomatoes, onions and garlic, carrots and potatoes) to the EU market over the period under consideration.

In 2008, Egypt proved to have a clear comparative advantage in exporting several fresh and processed fruits and vegetables with respect to the rest of the world as shown in Figure (2).

[19] Over the period 2004-2008, the EU became larger with the adhesion of new countries, a situation that has certainly influenced the trade flows of the SMCs, including Egypt, to the EU.

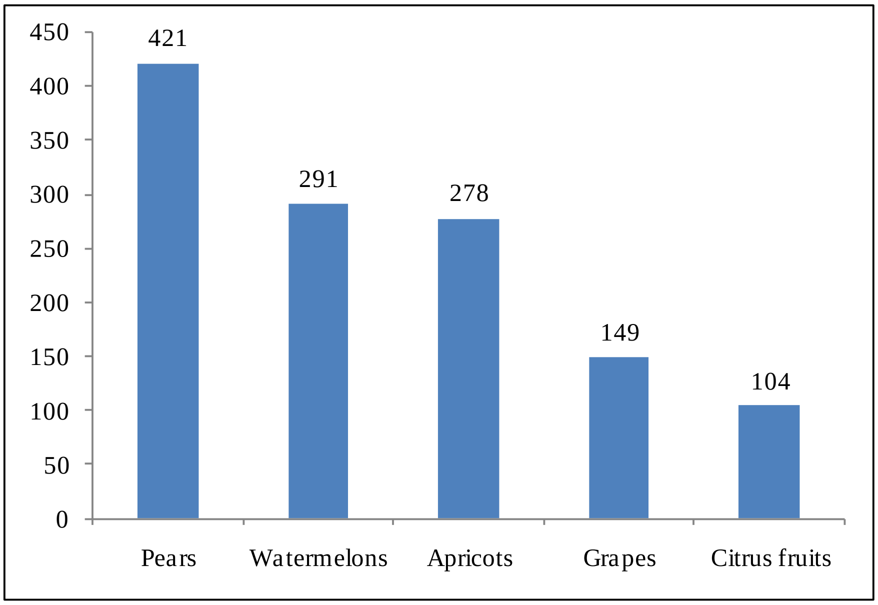


Figure 1a. Egyptian Exports of Fresh Fruits

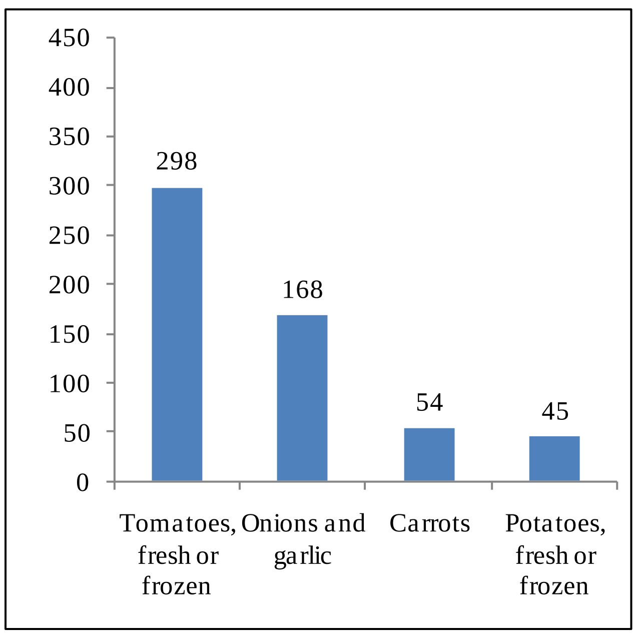
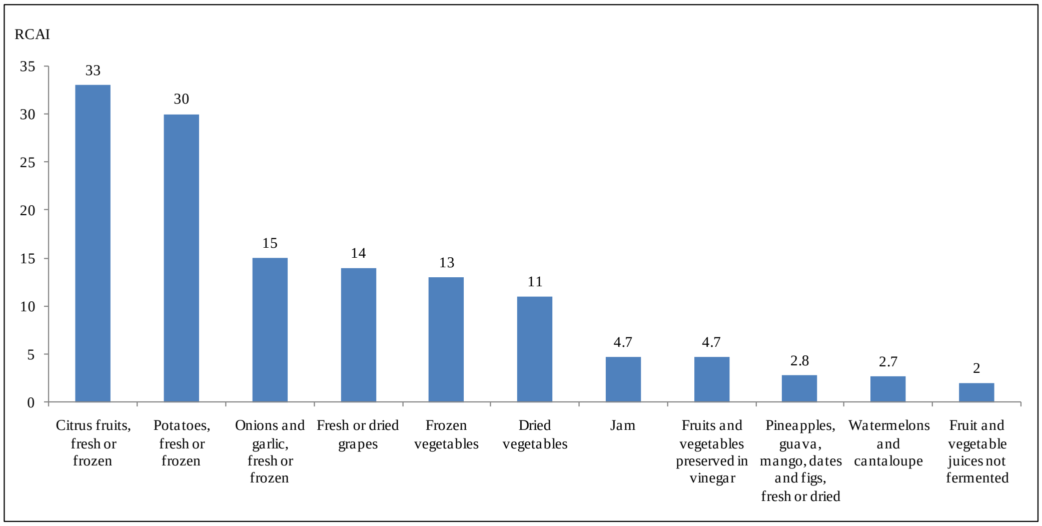


Figure 1b. Egyptian Exports of Fresh Vegetables

Source: Author's calculations based on the United Nations Commodity Trade Statistics Database (UN COMTRADE, http://comtrade.un.org).

Figure 1. Growth Rates for Egypt's Most Dynamic Exports of Fresh Fruits and Vegetables to the EU Market (2004-2008, %).



Source*:* Author's calculations based on United Nations Commodity Trade Statistics Database (UN COMTRADE, http://comtrade.un.org).

Note*:* The Revealed Comparative Advantage Index (RCAI) = Egypt exports of commodity X as a percent of total Egyptian exports divided by world exports of commodity X as a percent of total world exports. A value of RCAI greater than unity indicates that Egypt has a revealed comparative advantage in exporting commodity X (Greenaway and Milner 1993).

Figure 2. Egypt's Revealed Comparative Advantage in Exporting Several Fresh and Processed Fruits and Vegetables.

3. Access to the EU Fruit and Vegetable Market

The purpose of this section is to examine the EU import regime for fruits and vegetables. General provisions that apply to all imports into the EU are first discussed, followed by an investigation of EU protection for the fruit and vegetable market. Preferential access conditions to the EU fruit and vegetable market for Egypt's exports are then explored and evaluated.

3.1. EU Protection for Import Flows

The structure of the EU's common most-favored-nation (MFN) tariff remains complex (Table 10).[20] It comprises ad valorem (89.9 percent of all tariff lines) and non-ad valorem rates (10.1 percent of all tariff lines). The non-ad valorem duties are specific (6.5 percent of all tariff lines), compound (2.8 percent) and mixed or variable per entry price range

[20] With respect to customs duties, any advantage, favor, privilege or immunity, granted by any WTO member to any product originating in or destined for any other country, are accorded in principle to the like product originating from or destined for the territories of all other WTO members, under the principle of MFN treatment. Free trade areas are exceptions to the MFN treatment.

(0.8 percent). Non-ad valorem rates apply mainly to agricultural goods (WTO definition), many of which are also subject to seasonal tariffs and tariff quotas.[21]

Table 10. Structure of EU MFN Tariffs, 2008 (%)

	2008
1- Bound tariff lines (% of all tariff lines)[a]	100.0
2- Duty-free tariff lines (% of all tariff lines)	25.3
3- Non-ad valorem tariffs (% of all tariff lines)	10.1
4- Tariff quotas (% of all tariff lines)	4.8
5- Non-ad valorem tariffs with no AVEs (% of all tariff lines)	2.7
6- Simple average tariff rate	6.7
Agricultural products (WTO definition)	17.9
Non-agricultural products (WTO definition)[b]	4.1
Agriculture, hunting, forestry and fishing (ISIC 1)	9.3
Mining and quarrying (ISIC 2)	0.2
Manufacturing (ISIC 3)	6.7
7- Domestic tariff "spikes" (% of all tariff lines)[c]	5.3
8- International tariff "peaks" (% of all tariff lines)[d]	8.4
9- Overall standard deviation of applied rates	14.1
10 -"Nuisance" applied rates (% of all tariff lines)[e]	9.6

Source*:* WTO (2009b).

Notes*:* Calculations include calculable ad valorem equivalents (AVEs), as available, based on 2007 data in Eurostat (as of 15 January 2009). a- GATT Article II provides that signatories may "bind" tariff duties by including them in their schedules of tariff concessions, annexed to the General Agreement on Tariffs and Trade. Once a duty is bound, it may not be raised above that bound level without compensating affected parties. b- excluding petroleum. c- domestic tariff spikes are defined as those exceeding three times the overall simple average applied rate. d- international tariff peaks are defined as those exceeding 15 percent. e- nuisance rates are those greater than zero, but less than or equal to 2 percent.

The simple average applied MFN tariff rate is estimated at 6.7 percent for 2008, with rates ranging from zero to 604.3 percent. The coefficient of variation of 2.1 depicts a wide dispersion of the rates, essentially in agriculture, mainly due to the imposition of non-ad valorem tariffs and of high tariffs of 17.9 percent, on average, on agricultural products and generally lower rates of 4.1 percent on average on non-agricultural products. All products with tariff rates above 100 percent remain agricultural (Table 11). The EU maintains tariff quotas on 4.8 percent of tariff lines, mostly agricultural products (WTO 2009b).[22]

[21] Agricultural goods according to the World Trade Organization Agreement on Agriculture (WTO AOA) definition refer to the Harmonized System (HS) chapters 1 to 24 (excluding fish and fish products) and a number of manufactured agricultural products (for further information see 'The Legal Texts, The Results of the Uruguay Round of Multilateral Negotiations', WTO).

[22] The agricultural tariff quotas are managed through two methods. First come-first served (at the border), and import licensing. Licenses may be issued on a pro-rata or a historical basis. For agricultural products, the period of validity of import licenses depends on the product; general periods of validity are set in the relevant regulations. The validity of licenses allocated in the context of tariff quotas also varies. Validity may only be extended in case of "force majeure". Several administrative organs can grant import licenses for agricultural products (WTO 2009b).

Using International Standard Industrial Classification (ISIC), Revision 2, the simple average MFN tariff on agriculture, hunting, forestry and fishing is 9.3 percent, with rates ranging up to 139.7 percent (Table 11).

Table 11. Summary Analysis of EU MFN Tariff, 2008

Analysis	No. of lines[a]	Applied 2008 rates					
		No. of lines used	Simple avg. tariff (%)	Range tariff (%)	Std-dev (%)	CV	Share of duty free (%)
Total	9 699	9 557	6.7	0-604.3	14.1	2.1	25.3
By WTO definition[b]							
Agriculture	2 000	1 858	17.9	0-604.3	28.4	1.6	18.1
Fruits and vegetables	428	428	15.6	0-280.9	20.4	1.3	7.0
By ISIC sector[c]							
Agriculture, hunting, forestry and fishing	565	559	9.3	0-139.7	13.8	1.5	34.5

Source*:* WTO (2009b).

Notes*:* CV = coefficient of variation. a- total number of lines is listed. Tariff rates are based on a lower frequency (number of lines), since lines with no ad valorem equivalents may be excluded. b- 41 tariff lines on petroleum products are not taken into account. c- International Standard Industrial Classification (Rev. 2). Electricity, gas and water are excluded (1 tariff line).

3.2. EU Protection for the Fruit and Vegetable Market

Fruits and vegetables are politically sensitive products for the EU. They represent about 25 percent of the value of agricultural production in many EU member countries (such as Spain, Italy, Greece, Portugal, Malta and Cyprus), and are labor intensive (Petit 2009). This political sensitivity is reflected in the level of protection and the diversity and complexity of the protection instruments used [Tariff-rate quotas (TRQs), seasonal quotas and tariffs, threshold prices, sanitary and phytosanitary (SPS) measures and a host of preferential arrangements, often country by country, related to individual instruments, etc.] (Charlotte, Jacquet and Chevassus-Lozza 2008; Chevassus-Lozza et al. 2005).

For fruits and vegetables, the simple average applied MFN tariff rate is estimated at 15.6 percent for 2008, with rates ranging from zero to 280.9 percent (Table 11). MFN tariffs average 10.0 percent on fruits (edible fruits and nuts, peel of citrus fruits or melons), with rates ranging up to 30.5 percent; 13.5 percent on vegetables (edible vegetables and certain roots and tubers), with rates ranging up to 168.4 percent; and 23.7 percent on preparations of vegetables, fruits, nuts or other parts of plants, with rates ranging up to 280.9 percent (Table 12).

These figures all refer to tariffs applied on an MFN basis and do not take into account lower tariffs agreed upon in the numerous preferential trade agreements concluded by the EU. In practice, the average tariffs taking into account preferential trade are much lower.

EU growers of fruits and vegetables are protected against international competition not only by means of ad valorem tariffs (in percentage) and specific duties (in €/kg), but also a de facto minimum import price, which is established by the EU Entry Price System (EPS) (Goetz and Grethe 2007a, b).

Table 12. EU Applied MFN Tariff Averages by HS2, 2008

HS Code	Commodity description	No. of lines	No. of lines used	Average tariff (%)	Range (%)	Std-dev (%)
	Total /Average	9 699	9 557	6.7	0-604.3	14.1
07	Edible vegetables and certain roots and tubers	106	106	13.5	0-168.4	21.6
08	Edible fruits and nuts; peel of citrus fruits or melons	117	117	10.0	0-30.5	8.0
20	Preparations of vegetables, fruits, nuts or other parts of plants	296	296	23.7	0-280.9	26.6

Source*:* WTO (2009b).

Notes*:* HS2 refers to the Harmonized Commodity Description and Coding System of tariff nomenclature for the year 2002, which is an internationally standardized system of names and numbers for classifying traded products developed and maintained by the World Customs Organization.

For a number of products considered *sensitive* (tomatoes, cucumbers [including for processing], artichokes, courgettes, sweet oranges, clementines, mandarins, lemons, table grapes, apples, pears, apricots, [sour] cherries, peaches and plums), the EU has implemented as of July 1, 1995, a system of special protection called the Entry Price System (EPS) in order to limit price fluctuations and to avoid the presence on the European market of goods whose prices are too low (WTO 2009b).[23]

In the (EPS), the level of the duties depends on the import price of the product relative to its prevailing price in the EU market.[24] The EU defines, for each product and for each seasonal period, a threshold entry price, also called "trigger price". The threshold price is, on average, equivalent to the price of the same product on the EU domestic market. In cases when the import price is higher than this threshold price, only an ad valorem duty is applied. But when the import price is lower than the trigger price, then an additional specific duty is levied. The amount of this specific duty is equal to the difference between the import price and the trigger price. If the price of the consignment imported is between 100 percent and 92 percent of the full threshold entry price, the specific duty is progressive; it changes in steps of 2 percent, each of which corresponds with a "price band" equal to 2 percent of the threshold entry price. In case the import price is lower than 92 percent of the threshold entry price (the trigger price), then a

[23] EPS was established in 1995, replacing the former EU reference price system (RPS).

[24] Under the current functioning of the EU entry price system, an exporter to the EU can choose between three methods for classifying a product in the customs tariff of the European Communities. First, the invoice method, if an invoice exists at the time of declaration for free circulation. Second, the deductive method, which is based on the lodging of a security and serves to postpone the presentation of an invoice at the time of sale of the imported goods. Finally, the standard import value (SIV), that is calculated by the European Commission daily based on the weighted average of wholesale market prices, surveyed by origin of the produce in different EU countries. If the SIV is higher than the entry price, no specific tariffs are charged. The last method is the most popular one for purposes of customs clearance in the case of fruits and vegetables subject to the entry price system. The importers are attached to this system because it gives them transparency and predictability (WTO 2009b).

specific duty is levied and is equal to the "maximum specific duty" fixed by the EU and referred to as the "full tariff equivalent" (WTO 2009b).

Seasonal variations in tariffs are another characteristic of the EU's protection system for fruits and vegetables. Ad valorem and specific duties and entry prices vary over the year, except for tomatoes, apples, lemons, cucumbers and courgettes, on which the entry price system is applied year-round. The seasonality of the protection system is related to the EU production calendar: customs duties are higher during European production periods to protect domestic producers from import competition. Consequently, the schedule of protection measures regulates the level of imports (Charlotte, Chevassus-Lozza and Jacquet 2008, 2006).

EU imports of fruits and vegetables are subject to strict sanitary and phytosanitary (SPS) measures. Legal requirements for quality assurance systems and food control along the entire food chain—from seed and agricultural production through food processing and the distribution system up to the consumer's table—are increasing considerably, raising concerns about likely food regulatory impacts on international trade (European Commission 2009e; Korinek, Melatos and Rau 2008; Aloui and Kenny 2005).

The EU's food safety regime, which is in line with the Sanitary and Phytosanitary Agreement of the World Trade Organization (SPSA-WTO),[25] aims at ensuring a high level of health protection and is based on five principles: (i) a high level of food safety at all stages of the food chain, from primary production to the consumer (farm-to-fork approach); (ii) risk analysis as a fundamental component of food safety policy;[26] (iii) full responsibility of operators for the safety of products they import, produce, process, place on the market or distribute; (iv) traceability of products at all stages of the food chain;[27] and (v) the right of citizens to clear and accurate information from public authorities (EC Regulation, no. 178/2002, which was fully operated in January 2007).

[25] WTO agreements allow governments to act on trade matters in order to protect human, animal or plant life or health, provided they do not discriminate or use restrictions as disguised protectionism (WTO, Understanding the WTO: The Agreements (Standards and Safety), at [http://www.wto.org/English/thewto_e/ whatis_e/tif_e/agrm4_e.htm] (Johnson 2008). The SPSA-WTO is designed to protect animals and plants from diseases and pests, and to protect humans from animal- and plant-borne diseases and pests, and food-borne risks. The SPSA-WTO entered into force on January 1, 1995, as part of the establishment of the WTO, following the Uruguay Round of the General Agreement on Tariffs and Trade (GATT) (Becker 1999).

[26] The European Food Safety Authority (EFSA) operates as the EU's independent risk assessment body. Under the EU's alert system for food and feed, EU Member States are required to notify the Commission immediately about measures (requiring rapid action) they have taken to restrict the sale of products, product withdrawals or recalls of food or feed in order to protect human and animal health. Special powers are given to the European Commission to implement emergency measures to contain serious risks to human or animal health, or to the environment in the EU (Article 53 of EC Regulation, No. 178/2002).

[27] Traceability (laid down in Article 18 of Regulation EC 178/2002) means the ability to trace and follow a food, feed, animal or substance through all stages of production, processing and distribution in the EU, from the importer to the retail level. Traceability is necessary to ensure that food or feed business, including an importer, can identify at least the business from which inputs have been supplied (i.e., the identification of the origin of feed and food) for the protection of consumers (Delegation of the European Union to Egypt 2009a). Traceability requires systems and procedures to be in place to enable operators to identify the immediate supplier and immediate customer of their products. It requires establishing a link "Supplier-Product" (which products supplied from which suppliers) and establishing a link "Customer-Product" (which products supplied to which customers).

Mandatory standards represent an additional cost of production in the form of non-trivial compliance costs to adapt the product to meet EU requirements and/or undertake conformity assessment procedures both prior to export and/or at the port of entry (Korinek, Melatos and Rau 2008).

3.3. Preferential Access to the EU Fruit and Vegetable Market for Egypt

The EU Common Customs Code provides for the possibility of granting preferential tariffs unilaterally, or on a reciprocal basis, through trade agreements (Chapter II (5)(i)). The EU has the most extensive network of preferential trade agreements of any WTO member and as a result applies the MFN to only nine countries—Australia, New Zealand, Canada, Hong Kong China, Republic of Korea, Japan, Singapore, Chinese Taipei and the United States. These nine WTO Members accounted for 27.5 percent of the EU's total merchandize imports in 2007. Other nations enjoy preferential tariff treatment that varies according to the terms of different agreements.

Under EU preferential trade agreements (PTAs) and the Barcelona process initiated in 1995, trade relations between the EU and SMCs aim at establishing a fully fledged Euro-Mediterranean regional free trade area (FTA) by 2010, i.e., free trade in non-agricultural products, and progressive liberalization of trade in agricultural goods and services (Commission of the European Communities 2009).[28]

The EU negotiated with single SMCs a sequence of bilateral agreements, stipulating different conditions of mutual concessions on a product-by-product basis. The bilateral agreements and state of progress of negotiations between the European Union and Southern Mediterranean Countries (SMCs) differ from one country to another, as shown in Table 13.

Preferences granted by the EU to different SMCs, on a reciprocal basis, on selected agricultural products can consist in a reduction (or elimination) of the ad valorem duty, in a reduction of the trigger price, or, for the products that are not subject to the entry-price system, in a reduction or elimination of the specific duties. Furthermore, these ad valorem or specific duty concessions can either be extended to all goods imported from the partner country, or limited in volume, in the framework of tariff quotas. Trigger prices, however, can only be reduced within quota limits. In cases where a tariff quota system applies, imports out of quota can also benefit from tariff preferences, though they are not as significant as those granted within the quota. Concessions may be also restricted to a specific period (Charlotte, Chevassus-Lozza and Jacquet 2008, 2006).

As each agreement is being negotiated separately, there is considerable heterogeneity among products as well as among SMCs in terms of access conditions to the EU fruit and vegetable market. Hence, the purpose of the following sub-section is to explore the extent to which the EU fruit and vegetable market is accessible to Egyptian exporters and in comparison to other SMCs' exporters.

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[28] Although Turkey also participates in the Euro-Mediterranean Partnership, it is linked to the EU through a customs union since 1995 and it is a candidate country since 1999. Hence, Turkey is not covered in this paper.

Table 13. Free Trade Agreements between the EU and Southern Mediterranean Countries

SMC	Nature of agreement	Date of entry into force	Current status
Algeria	Association Agreement	01.09.05	Euro-Mediterranean Agreement
Egypt	Association Agreement	01.06.04. The trade provisions entered into force provisionally on January 1, 2004 and the whole Association Agreement entered into force on June 1, 2004.	Euro-Mediterranean Agreement. Negotiations on further liberalization for agricultural, processed agricultural and fisheries products have been concluded in 2008.
Israel	Association Agreement	01.06.00	Euro-Mediterranean Agreement; trade provisions initially applied under Interim (1995). Negotiations on further liberalization for agricultural, processed agricultural and fisheries products have been concluded in 2008.
Jordan	Association Agreement	01.05.02	Euro-Mediterranean Agreement. Negotiations on further liberalization for agricultural, processed agricultural and fisheries products have been concluded in 2005.
Lebanon	Interim Agreement Association Agreement	01.02.03 April, 2006	Euro-Mediterranean Agreement. Agricultural negotiations have not yet started
Libya	Negotiations over the framework agreement/FTA formally launched on 12-13 November 2008, 3rd round took place on 12-13 May 2009. Libya started to discuss an ambitious FTA including trade in goods, in services/establishment, trade rules, regulatory cooperation and dispute settlement.		
Morocco	Association Agreement	01.03.00	Euro-Mediterranean Agreement. Agricultural negotiations under way.
Palestinian Authority	Association Agreement	01.07.97	Interim Euro-Mediterranean Agreement. Agricultural negotiations have not yet started.
Syria	Cooperation Agreement	01.07.77	Euro-Mediterranean Agreement signed in October 19, 2004. It has not entered into force yet. Agricultural negotiations under way.
Tunisia	Association Agreement	01.03.98	Euro-Mediterranean Agreement. Agricultural negotiations under way.

Sources*:* European Commission (2009c, d).

3.3.1. Preferential EU Market Access Conditions for Egypt

The Association Agreement (AA) between Egypt and the EU provides for reciprocal liberalization of imports of raw and processed agricultural and fishery products, where mutual concessions are given in various forms, including zero tariff, reduced import duties (both within and out of quota), and increased tariff quotas.

Egyptian agricultural and processed agricultural products included in Protocol 1 and Annex II of Protocol 3 of the AA are receiving a preferential treatment when exported to the EU. For almost all products listed in Protocol 1, the AA grants a 100 percent reduction of customs duties, in many cases up to certain tariff quota, in other cases free. Most of the tariff quota volumes are increased annually by 3 percent of the volume of the previous year. For the quantities imported in excess of the quotas, the common customs duties shall be applied in full or reduced as indicated in the Protocol. Finally, for some products the tariff quota only applies during a certain period of the year (Table 14).

Table 14. Examples of Quotas for Egyptian Agricultural Products in the EU Market (Tons)

<table>
<tr><th>Product</th><th>Export calendar</th><th>Duty reduction (%)</th><th>Tariff quota totally exempted from tariffs, in 2004</th><th>Duty reduction beyond quota (%)</th></tr>
<tr><td>Onions</td><td>1/02 to 15/06</td><td rowspan="5">100</td><td>15 000</td><td rowspan="2">60</td></tr>
<tr><td>Potatoes</td><td>1/10 to 31/03</td><td>130 000</td></tr>
<tr><td>Pears</td><td>-</td><td>500</td><td rowspan="3">No Duty Reduction</td></tr>
<tr><td>Carrots</td><td>1/01 to 30/04</td><td>500</td></tr>
<tr><td>Sweet potatoes</td><td>-</td><td>3 000</td></tr>
<tr><td>Tomatoes</td><td>1/11 to 31/03</td><td colspan="3" rowspan="3">Totally exempted from tariffs</td></tr>
<tr><td>Watermelons</td><td>1/02 to 30/04</td></tr>
<tr><td>Grapefruit</td><td>1/02 to 14/ 07</td></tr>
</table>

Sources*:* Delegation of the European Union to Egypt (2009b, c, d, e); the EU-Egypt Association Agreement, Chapter 2, Protocol 1 and Annex 2 of Protocol 3.

In principle, all processed agricultural products listed in Annex II to Protocol 3 of the AA are benefiting from duty-free access to the EU without any quantitative restrictions. Some Egyptian processed fruits and vegetables enjoy 100 percent customs duty reduction (for example, tomato sauces and mango chutney). However, products listed in Tables 2 and 3 of the mentioned Annex are charged for the agricultural component of the product (agricultural products actually used in the manufacture of the processed agricultural product) with a specific duty per each 100 kg. of imported product. For products listed in Table 3, customs duties are eliminated within the limit of a tariff quota (Delegation of the European Union to Egypt 2009b, c).

Egypt seeks to continually improve its exporters' access to the EU fruit and vegetable market. To achieve this objective, a new agreement has been reached on the 1st of July 2008, to further liberalize trade in agricultural, processed agricultural and fish and fishery products between Egypt and the EU.

Under the new agreement, the EU significantly improved its concessions for Egyptian agricultural exports. Tariff protection is removed for all fruits and vegetables, except for garlic and strawberries for which quotas of 4,000 and 10,000 tons respectively have been established. For potatoes and onions for which Egypt's productive and export potential is very high, quotas that used to be respectively of 250,000 tons and 15,000 tons are now removed.

All other fruits and vegetables are exempt from customs duties, except for some fruits and vegetables whose trade is considered "delicate": these are tomato, garlic, cucumber, zucchini, artichoke, table grapes and strawberry. For these products some limitations are maintained regarding in particular the export calendar. For tomato, for instance, a reduction is established by 100 percent in customs duty for exports that enter the EU between 1 November and 30 June: in this period Egypt will have to respect only the minimum entry price. The same applies for cucumber, zucchini, artichoke and table grapes (Delegation of the European Commission to Egypt 2009b, c, d).

It is important to note that the date on which the agreement with Egypt will be signed and will come into force has not been decided yet. On the EU side, the text of this agreement was first adopted by the Commission in January 2009. It was then adopted by the European Council on 9 October 2009. On the Egyptian side, the text of the agreement has been presented to the Parliament during the parliamentary session which has started in November 2009. The entry into force of this agreement will occur on the first day of the second month following the date of approval by the Egyptian Parliament.

3.3.2. Evaluation of the Preferential EU Market Access for Egypt

Before evaluating the advantage granted by the EU to Egypt's fruit and vegetable exports, global market access conditions for Egyptian exports are assessed.

Egypt's exports access to global markets is less favorable than its SMCs comparators' and the country is ranked 67th (out of 125) on the latest Market Access Trade Tariff Restrictiveness Index [MA-TTRI] (World Bank 2010, 2008).[29] Egypt's (MA-TTRI) is 3.3 percent, higher than that for Algeria (0.6 percent), Israel (0.9 percent), Tunisia (0.9 percent), Morocco (1.8 percent), Lebanon (1.9 percent), and also higher than the averages for the Middle East and North Africa (MENA) region and lower-middle-income country group of 2.1 and 2.3 percent, respectively (Table 15).

When trade flows are taken into consideration, the weighted rest of the world tariff (including preferences) for agricultural products is 8.2 percent for Egypt, lower than that for Morocco (9.8 percent) but much higher than that of other SMCs (0.5 for Algeria; 1.7 for Jordan; 1.8 for Lebanon; 1.9 for Tunisia; 2.1 for Syria; 3.6 for Libya; 5 for Israel). As such, it is apparent that Egypt's agricultural exports have less favorable access to international markets than all other SMCs except Morocco (Table 15), reflecting heterogeneity among SMCs as well as products in terms of preferential access conditions to the world market.

[29] MA-TTRI calculates the equivalent uniform tariff of trading partners that would keep their level of imports constant. It is weighted by import values and import demand elasticities of trading partners (World Bank 2010, 2008).

Table 15. Egypt's Exports Access to Global Markets (2009)

	Algeria	Egypt	Israel	Jordan	Lebanon	Libya	Morocco	Syria	Tunisia
Market Access–Trade Tariff Restrictiveness Index (applied tariffs incl. prefs.)	0.6	3.3	0.9	4.6	1.9	..	1.8	..	0.9
ROW applied tariff (incl. prefs.)-trade weighted average (%), for:									
Agriculture	0.5	8.2	5.0	1.7	1.8	3.6	9.8	2.1	1.9
Non-agriculture	2.25	1.2	0.5	2.7	0.5	0.1	1.7	0.5	0.6

Sources*:* World Bank (2010, 2008).

Focusing on the EU weighted preferential margins for the agricultural exports of Egypt and each SMC in the framework of the Euro-Mediterranean Association Agreements (which compare the amount of the customs duties paid by an exporting country with the amount of the duties this country would have paid if it had not enjoyed tariff preferences), in addition to, Egypt's preference utilization rate, would allow an assessment of the value of preferential access to the EU fruit and vegetable market for Egypt and its comparator SMCs.

The weighted preferential margin for Egypt's agricultural exports is (5.6 percent), lower than Jordan (9.6 percent), Morocco (8.6 percent), Lebanon (7.9 percent) and Israel (6.1 percent). Low weighted preferential margin observed for Egypt may result from one of two factors: either the country exports products which are already subject to relatively low MFN duties within the framework of WTO multilateral agreements (i.e., the export structure effect), or the duties applied inside the preferences remain high despite the preferences.

As discussed before, the weighted rest of the world tariff (including preferences), which Egypt would have paid upon entering global agricultural markets if the country did not benefit from preferences, is high (8.2 percent). Hence, the low weighted preferential margin cannot be explained by Egypt's *export structure effect*, but rather by the low level of preferences allocated (i.e., the high duties actually paid by Egypt when the preference is applied).

In addition, although 28.1 percent of EU agricultural imports from Egypt is duty-free, it is the lowest share among all SMCs, reflecting a less favorable access to the EU market for Egypt's agricultural exports in comparison to other SMCs (Table 16).

Heterogeneity among SMCs in terms of the advantages granted by the EU could be explained by the progress of negotiations between each country and the EU and by the export specialization of the country. Hence, Egypt would benefit from the increase in the current preferences as agreed upon with the EU on July 2008 and needs to speed up the process of ratifying and implementing this agreement.

Table 16. Agricultural Exports of Egypt and Other SMCs to the EU and Duties Faced

SMCs	EU agricultural imports from the SMC (in million $, 2007)[a]	MFN AVG of traded tariff lines		Preferential margin	EU Duty-free imports from the SMC	
		Simple[b]	Weighted[c]	Weighted[d]	Tariff lines in %[e]	Value in %[f]
Algeria	44	15.0	7.8	4.4	31.9	52.9
Egypt	835	15.2	12.0	5.6	28.7	28.1
Israel	1 687	16.4	11.8	6.1	24.9	38.8
Jordan	24	17.8	19.7	9.6	74.6	61.0
Lebanon	52	16.6	9.0	7.9	68.2	80.9
Libya	3	11.9	13.8	0.1	50.0	76.6
Morocco	1 823	15.9	16.5	8.6	42.6	63.7
Tunisia	296	14.6	17.0	4.3	38.5	34.4

Sources*:* World Trade Organization and International Trade Centre UNCTAD/WTO (2009).

Notes*:* a) Total imports of EU. b) Simple average of MFN duties based only on tariff lines with imports. c) Trade-weighted average MFN duty. d) Trade-weighted average difference between the MFN duty and the most advantageous preferential duty. Tariff lines where either MFN or preferential duties cannot be expressed in ad valorem terms have been excluded. e) Duty-free tariff lines in percent of all traded tariff lines; included duty-free preferential treatment. Partially duty-free subheadings are taken into account on a pro rata basis if tariff line imports are not available. f) Share of duty-free trade in percent of all bilateral trade flows; includes duty-free preferential treatment. Partially duty-free subheadings are taken into account on a pro rata basis if tariff line imports are not available.

Otherwise, Egypt could suffer preference erosion regarding access to the European fruit and vegetable market as a result of three main factors. *First*, the EU and Israel signed on November 4, 2009 a new agreement on further liberalization of trade in agriculture, which will enter into force on January 1, 2010 (Delegation of the European Union to Israel 2009). *Second*, agricultural trade liberalization negotiations between the EU and some SMCs, such as Morocco, are currently under way. *Finally*, on agricultural goods, the EU has offered to increase market access and decrease domestic support and to eliminate all trade-distorting export practices by 2013, including export subsidies. More specifically, the EU accepted to reduce overall trade distorting subsidies in agriculture by up to 80 percent, to eliminate export subsidies by 2013, and to cut its final bound tariffs by between 50 percent and 70 percent (except on some sensitive products) depending on the level of the tariffs, while developing countries would cut tariffs by two thirds of the rates set for developed countries (WTO 2009b; OECD 2009; Kavallari and Schmitz 2008). So, Egypt could lose out in the event of a generalization of European preferences to other suppliers in the framework of the WTO multilateral negotiations.

Comparing the weighted preferential margins granted by both the EU and US for Egypt and the rest of SMCs highlights that the actual value of preferences as a percent of exports is 2.6 percent for Egypt, lower than that for Jordan (14.7 percent), the Palestinian Authority (7.5 percent) and Tunisia (4.4 percent) [Table 17].[30]

[30] The value of preferential margins corresponds to the gains resulting from the reduction in customs duties granted by the EU and the US to a country. It is equal to the difference between the duties in euros and

Table 17. Value of Weighted Preferential Margins Granted by the EU and the US to SMCs Exports (2008, %)

	Algeria	Egypt	Israel	Jordan	Lebanon	Morocco	Palestinian Authority	Syria	Tunisia
Preferences (EU+US) actual value (% of exports)	0.1	2.6	1.3	14.7	2.4	0.1	7.5	0.3	4.4

Sources*:* World Trade Organization and International Trade Centre UNCTAD/WTO (2009); Eurostat (2009).

The degree to which Egypt utilizes tariff quotas for its fruit and vegetable exports is another indicator of the gains resulting from the preferences granted to Egypt. Over 2004-2009, EU tariff quotas have been increasing. However, these quotas may not be totally utilized, implying a lost opportunity to increase Egyptian exports. Table 18 shows the start and end dates for the tariff quota (that is, the quota application period), the balance and the products associated to the quota. In case the last import date is beyond the quota application period and a balance remains, then the quota is not fully utilized. This is the case for several fruits and vegetables, including carrots, cucumbers and garlic.

Egypt's utilization of EU and US preferences is 81.1 percent, though the value of such preferences was a very low of 2.6 percent of bilateral exports (Table 19). However, preference utilization rate of Egypt (81.1 percent) is lower than that of Jordan (97.6 percent), the Palestinian Authority (85.2 percent), Israel (82 percent) and Syria (81.3 percent), indicating that Egypt benefits less from the preferences granted by the EU and the US than the other SMCs.

4. Competitiveness of Egypt in the EU Fruit and Vegetable Market

The purpose of this section is to assess Egypt's competitiveness in the EU fruit and vegetable market by using the Constant Market Share Analysis (CMSA) methodology (Leamer and Stern 1970; Fagerberg and Sollie 1987; Asciuto, Crescimanno and Galati 2007; Malorgio and Hertzberg 2007; Malorgio, Giulio and Luca Mulazzani 2009). The results for Egypt are then compared with those of the EU's main Southern Mediterranean Countries (SMCs) suppliers of fruits and vegetables, namely: Algeria, Israel, Jordan, Lebanon, Libya, Morocco, Palestinian Authority, Syria and Tunisia.

dollars that the country would have paid for its exports towards the EU and the US if it did not enjoy any preferences and the duties actually paid for the same volume of exports while benefiting from the tariff concessions (World Trade Organization and International Trade Centre UNCTAD/WTO 2009).

Table 18. The Use of EU Tariff Quotas for Egyptian Products during 2008-2009

Description	Quota application period	Quota volume (Kgs.)	Import amount (Kgs.)	Balance (Kgs.)	Last import date	Quota utilization rate (%)*
Fruits and nuts	01-01-2009 – 31-12-2009	3 000 000	3 000 000	0	14/9/2009	100.0
Prepared or preserved potatoes	01-01-2009 – 31-12-2009	1 800 000	42 000	1 758 000	12/3/2009	2.33
Carrots and turnips, fresh or chilled	01-01-2009 – 30-04-2009	579 638	42 598	537 040	5/5/2009	7.35
Sweet potatoes	01-01-2009 – 31-12-2009	3 477 823	396 577	3 081 246	14/9/2009	11.40
Other melons, fresh	15-10-2009 – 31-05-2010	1 403 013	0	1 403 013	-	0.00
Oranges, fresh	01-07-2009 – 30-06-2010	70 320 000	9 954 680	60 365 320	8/9/2009	14.20
Oranges, fresh	01-12-2009 – 31-05-2010	36 300 000	0	36 300 000	8/9/2009	0.00
Husked rice	01-01-2009 – 31-12-2009	57 600 000	0	57 600 000	-	0.00
Strawberries, fresh	01-10-2008 – 31-03-2009	1 705 000	1 705 000	0	28/5/2009	100.0
Strawberries, fresh	01-10-2009 – 31-03-2010	1 705 000	0	1 705 000	-	0.00
Oranges, fresh	01-07-2008 – 30-06-2009	70 320 000	70 320 000	0	1/9/2009	100.0
Oranges, fresh	01-12-2008 – 31-05-2009	36 300 000	36 300 000	0	1/9/2009	100.0
Dried vegetables	01-01 2009 – 31-12-2009	19 185 987	11 021 989	8 163 998	14/9/2009	57.45
Leguminous vegetables, fresh or chilled	01-11-2009 – 30-04-2010	20 000 000	0	20 000 000	-	0.00
Peaches, including nectarines, fresh	15-03-2009 – 31-05-2009	579 638	579 638	0	22/6/2009	100.0
Fruit juices	01- 01-2009 – 31-12-2009	1 217 238	615 963	601 275	10/9/2009	50.60
Foliage, branches	01- 01-2009 – 31-12-2009	579 638	1 680	577 958	11/9/2009	0.30
Cucumbers and gherkins, fresh or chilled	01-01-2009 – 28-02-2009	579 638	57 026	522 612	6/4/2009	9.84
Cabbage lettuce, fresh or chilled	01-11-2008 – 31-03-2009	579 637	579 637	0	20/1/2009	100.0
Jams, jellies, etc.	01-01-2009 – 31-12-2009	1 159 275	127 365	1 031 910	10/9/2009	11.00
Plums and sloes, fresh	15-04-2009 – 31-05-2009	579 638	0	579 638	-	0.00
Garlic, fresh or chilled	01-02-2009 – 15-06-2009	3 477 823	2 050 814	1 427 009	26/8/2009	58.97
Cabbage lettuce, fresh or chilled	01-11-2009 – 31-03-2010	597 027	0	597 027	-	0.00
Semi-milled or wholly milled rice	01-01-2009 – 31-12-2009	19 600 000	17 858 368	1 741 632	9/9/2009	91.11

Table 18. (Continued)

Description	Quota application period	Quota volume (Kgs.)	Import amount (Kgs.)	Balance (Kgs.)	Last import date	Quota utilization rate (%)*
Onions and shallots, fresh or chilled	01-01-2009 – 15-06-2009	18 722 278	18 722 278	0	22/7/2009	100.0
Cabbages, cauliflowers, etc. fresh or chilled	01-11-2009 – 15-04-2010	1 791 079	0	1 791 079	-	0.00
Pears and quinces, fresh	01-01-2009 – 31-12-2009	579 638	0	579 638	-	0.00
Frozen and provisionally preserved vegetables	01-01-2009 – 31-12-2009	3 000 000	3 000 000	0	14/4/2009	100.0
Potatoes, new	01-04-2009 – 30-06-2009	1 750 000	1 750 000	0	7/4/2009	100.0
Potatoes, prime	01-04-2009 – 31-03-2009	250 000 000	124 552 655	125 447 345	20/5/2009	49.82
Cabbages, cauliflowers, etc. fresh or chilled	01-11-2008 – 15-04-2009	1 738 911	526 264	1 212 647	9/7/2009	30.30
Other melons, fresh	15-10-2008 – 31-05-2009	1 362 148	965 501	396 647	11/9/2009	70.88
Leguminous vegetables, fresh or chilled	01-11-2008 – 30-04-2009	20 000 000	20 000 000	0	28/8/2009	100.0
Broken rice	01-01-2009 – 31-12-2009	5 000 000	3 827 720	1 172 280	14/9/2009	76.55
Rice	01-01-2008 – 31-12-2008	32 000 000	32 000 000	0	17/1/2008	100.0
Rice	01-01-2008 – 31-12-2008	5 605 000	5 605 000	0	-	100.0

Source*:* Delegation of the European Union to Egypt (2009e).
Note*:* *= Quota utilization rate is the import amount as a percent of the quota volume.

Table 19. Utilization Rate of Weighted Preferential Margins Granted by the EU and the US to SMCs Exports (2008, %)

	Algeria	Egypt	Israel	Jordan	Lebanon	Morocco	Palestinian Authority	Syria	Tunisia
Preferences (EU+US) actual value (% of exports)	0.1	2.6	1.3	14.7	2.4	0.1	7.5	0.3	4.4
Preferences (EU+US) utilization rate (%)	63.5	81.1	82.0	97.6	77.1	50.7	85.2	81.3	77.2

Sources*:* World Trade Organization and International Trade Centre UNCTAD/WTO (2009); Eurostat (2009).

4.1. Constant Market Share Analysis (CMSA) Methodology

The CMSA is a technique that can be adopted to analyze the change of the export market share of Egypt (*k*) in the EU (*l*) market for fruits and vegetables (i.e., ΔM^{kl}) between two temporal thresholds decomposing it into three terms: The market share effect (ΔM^{kl}_{a}); the commodity composition effect (ΔM^{kl}_{b}) and the residual effect (ΔM^{kl}_{ab}). Hence, $\Delta M^{kl} = \Delta M^{kl}_{a} + \Delta M^{kl}_{b} + \Delta M^{kl}_{ab.}$

The market share effect quantifies the change (between the end and the beginning of the considered period) of market share for every commodity to measure the ability of Egypt to make each of its commodities enter the EU market. The gain of market share of every commodity is added to produce the total gain. Every commodity is however weighted by its importance in the world imports of the EU market in the initial year. The market share effect [$\Delta M^{kl}_{a} = \sum_i (\alpha^{kl}_{it} - \alpha^{kl}_{i0})\, b^{l}_{i0}$] is calculated by multiplying the change of the export market share ($\alpha^{kl}_{it} - \alpha^{kl}_{i0}$) [for each commodity *i* used to split the total trade flow from Egypt (*k*) to the EU (*l*) by the weight of each commodity (at the beginning year: b^{l}_{i0}) in the world import of the EU market (*l*)].

By considering the initial export market share of Egypt and the weight change of each commodity in the EU market, *the commodity composition effect* measures how much the total export market share should change just due to a change in the composition of imports in the EU market. The commodity composition effect [$\Delta M^{kl}_{b} = \sum_i (b^{l}_{it} - b^{l}_{i0})\, \alpha^{kl}_{i0}$] is calculated by multiplying the weight change of each commodity ($b^{l}_{it} - b^{l}_{i0}$) in world imports of the EU market (*l*) by the initial export market share of Egypt (α^{kl}_{i0}).

The residual effect explains the difference between the actual change of the export market and the sum of the two previous effects. It provides a measurement of Egypt's capacity to adjust the commodity composition of its exports (its export structure) to the changes intervened in the structure of the EU market, increasing Egypt's share in commodities with faster growing EU demand. If the residual effect is equal to zero it means that Egypt has modified its export structure at exactly the same rate as the average of all the other competing exporting SMCs. The residual effect [$\Delta M^{kl}_{ab} = \sum_i (\alpha^{kl}_{it} - \alpha^{kl}_{i0})(b^{l}_{it} - b^{l}_{i0})$] is calculated by multiplying the change of the export share ($\alpha^{kl}_{it} - \alpha^{kl}_{i0}$) by the change of the weight of each commodity ($b^{l}_{it} - b^{l}_{i0}$).

4.2. Trade Data Utilized

Data utilized come from the United Nations Commodity Trade Statistics Database (UN COMTRADE, http://comtrade.un.org). The data include EU imports of fresh and processed fruits and vegetables from Egypt and the other nine comparator SMCs, as reported in the Harmonized Commodity Description and Coding System (known as the Harmonized System "HS"), chapters 07, 08 and 20. To allow for the heterogeneity of the fruit and vegetable sector, the analysis is performed at the disaggregated product level of 4 digit codes.

Since the trade provisions of the Association Agreement between Egypt and the EU entered into force on January 1, 2004, the period analyzed in this paper covers the years

2004 up to 2008, the most recent year for which data are available at the time of writing this paper.

Changes in trade values and shares between the beginning and the end of the period are calculated for the average biennium 2004-2005 and 2007-2008.

4.3. Results of CMSA Analysis of Egypt's Fruit and Vegetable Exports to the EU

The CMSA indicates that over the period 2004-2008, Egypt has increased its share in the EU market for fresh vegetables (+0.46%), fresh fruits (+1.43%) and processed fruits and vegetables (+0.33%).[31] Egypt proves to be more successful in fresh fruits than in fresh vegetables or in processed fruits and vegetables (Table 20).

Table 20. Decomposition of CMSA: EU Imports of Fresh and Processed Fruits and Vegetables from Egypt (Percentage Variations over 2004-2008; %)*

Description	HS-code	Market share effect	Commodity composition effect	Residual effect	Total effect
Fresh vegetables	07	- 0.86	+ 1.46	- 0.14	+ 0.46
Fresh fruits	08	+ 2.73	- 0.88	- 0.42	+ 1.43
Processed fruits and vegetables	20	+ 0.37	- 0.02	- 0.02	+ 0.33
All fresh and processed fruits and vegetables	07 + 08+ 20	+ 2.24	+ 0.56	- 0.58	+ 2.22

Source: Based on the author's calculations in Table A.1, Appendix 1.
Note: * Average 2004-2005 is the initial period and average 2007-2008 is the terminal period.

Egypt's accomplishment in the EU market *for fresh vegetables* (+0.46%) is the result of an advantageous development in EU demand (+1.46). This positive commodity composition effect reflects a strong EU import demand for fresh vegetables. However, the negative market share effect (-0.86%) gives evidence of a drop in Egypt's competitiveness in these commodities in the EU market and the difficulty to withstand the competition of other exporting SMCs. Likewise, the negative residual effect (-0.14%) indicates Egypt's weak capacity to adjust the commodity composition of its exports to changes in the structure of the EU market demand.

For fresh fruits, Egypt's strong performance (+1.43%) stems from the country's high competitiveness in the EU market (+2.73%), that is to say from Egypt's actual ability to gain market shares. However, Egypt did not catch up with EU's demand evolution as reflected by the negative composition effect (-0.88%) and the country's limited capacity for compatibility between its exports of fresh fruits with European imports as the negative residual effect (-0.42%) reveals.

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[31] CMSA detailed calculations for Egypt are in Table A.1, Appendix 1. As for the other nine SMCs, detailed CMSA calculations are available upon request to the author.

For processed fruits and vegetables, Egypt's performance in the EU market (+ 0.33%) is attributed to increased competitiveness in these products as shown by the positive market share effect (+0.37%). A decline in the composition effect (-0.02%) reflects a diversion in European consumers' demand away from Egyptian exports of processed fruits and vegetables, and the negative residual effect (-0.02%) is evidence of a weak capacity to adjust Egypt's export structure to the changes in the structure of the EU market demand.

Disadvantageous developments in EU demand for several Egyptian exports of fresh and processed fruits and vegetables could be attributed to the heterogeneity of growth rates among products in the imports of the EU coming from different SMCs which may negatively affect Egypt according to the initial composition of its exports, and/or the difficulty to comply with the EU safety standards and requirements.

A comparison between Egypt and other SMCs reveals that Morocco outperforms Egypt in the EU market for fresh vegetables (Table 21). Morocco's strong performance (+5.66%) is attributed to an increase in the rate of growth in EU demand for Moroccan exports (+3.41%), the country's increased competitiveness (+1.95%) and its capability to adjust its export supply to the EU market demand (+0.30%).

Table 21. Decomposition of CMSA: EU Imports of Fresh Vegetables from Egypt and Other SMCs (Percentage Variations over 2004-2008, %)*

SMC:	**Fresh vegetables HS-07**			
	Market share effect	**Commodity composition effect**	**Residual effect**	**Total effect**
Morocco	+ 1.95	+ 3.41	+ 0.30	+ 5.66
Egypt	- 0.86	+ 1.46	- 0.14	+ 0.46
Tunisia	+ 0.25	+ 0.08	+ 0.04	+ 0.37
Israel	- 1.68	+ 2.25	- 0.26	+ 0.31
Jordan	+ 0.18	+ 0.04	+ 0.03	+ 0.25
Syria	+ 0.06	+ 0.05	+ 0.01	+ 0.12
Lebanon	0.00	+ 0.01	0.00	+ 0.01

Source*:* Author's calculations.
Note*:* * Average 2004-2005 is the initial period and average 2007-2008 is the terminal period.

For both fresh fruits and processed fruits and vegetables, Egypt stands out among other SMCs because its exports to the EU underwent the highest increase, (+1.43%) and (+ 0.33%), respectively. Egypt's better performance is mainly attributed to the country's higher competitiveness in the EU market as reflected by the market share effect for fresh fruits (+2.73%) and processed fruits and vegetables (+0.37%), relative to the other analyzed SMCs (Table 22). However, the decline in the rate of growth in EU demand for Egyptian exports of fresh fruits and processed fruits and vegetables as suggested by the negative composition effects and the weak capability of Egypt to adjust its export structure to the changes in the structure of the EU market demand have been critical in limiting a gain that could have been higher for Egypt.

Table 22. Decomposition of CMSA: EU Imports of Fresh Fruits and Processed Fruits and Vegetables from Egypt and Other SMCs (Percentage Variations over 2004-2008, %)*

SMC:	Fresh fruits HS-08				SMC:	Processed fruits and vegetables HS-20			
	Market share effect	Commodity composition effect	Residual effect	Total effect		Market share effect	Commodity composition effect	Residual effect	Total effect
Egypt	+ 2.73	- 0.88	- 0.42	+ 1.43	Egypt	+ 0.37	- 0.02	- 0.02	+ 0.33
Syria	+ 0.30	- 0.02	- 0.05	+ 0.23	Tunisia	+ 0.13	- 0.01	- 0.01	+ 0.11
Lebanon	+ 0.07	- 0.01	- 0.01	+ 0.05	Lebanon	+ 0.05	- 0.02	0.00	+ 0.03
Jordan	- 0.01	- 0.02	0.00	- 0.03	Syria	+ 0.01	- 0.01	0.00	0.00
Tunisia	+ 0.10	- 0.68	- 0.02	- 0.60	Jordan	0.00	0.00	0.00	0.00
Morocco	- 1.10	- 2.70	+ 0.17	- 3.63	Morocco	- 0.09	- 0.29	+ 0.01	- 0.37
Israel	- 1.94	- 2.24	+ 0.30	- 3.88	Israel	- 0.48	- 0.28	+ 0.03	- 0.73

Source: Author's calculations.
Note: * Average 2004-2005 is the initial period and average 2007-2008 is the terminal period.

At a more disaggregated product level, Egypt's best performing exports to the EU market are onions and garlic (+ 0.60%) within the category of *fresh vegetables*, fresh or dried grapes (+ 0.92%) within the category of *fresh fruits* and prepared or preserved (not frozen) vegetables (+ 0.20%) within the category of *processed fruits and vegetables* (Table 23). Egypt's good performance reflects greater competitiveness in the EU market summarized by the positive market share effects for these three products (+0.28%, +0.64% and +0.20%, respectively). For onions and garlic, as well as, fresh or dried grapes, Egypt benefited from the increased EU imports of these products as indicated by the positive commodity composition effects (+0.21% and +0.21%, respectively) and succeeded in gaining quotas in commodities with faster growing EU demand, as proved by its positive residual effects for these products (+0.11% and +0.07%, respectively). However, for prepared or preserved (not frozen) vegetables, the insignificant commodity composition effect reflects no changes in the relative weight of these products in European imports and a zero residual effect means that Egypt has modified its export structure at the same rate as the average of all other competing, exporting SMCs.

Egypt's main SMCs competitors in the EU market *for onions and garlic* are Algeria, the Palestinian Authority and Morocco; *for fresh or dried grapes,* competitors are Lebanon, Tunisia and Libya, while *for prepared or preserved (not frozen) vegetables* they are Tunisia, Jordan and Palestine (author's calculations).

Over the period 2004-2008, Egypt's weakest export performance was in fresh or chilled potatoes (-0.32%) within the category of *fresh vegetables*, in fresh or dried citrus fruits (-0.21%) within the category of *fresh fruits* and in processed fruits, nuts and other edible parts of plants (-0.01%) within the category of *processed fruits and vegetables* (Table 24).

Table 23. Decomposition of CMSA: Egypt's Best Performing Exports to the EU Market for Fruits and Vegetables (Percentage Variations over 2004-2008, %)*

Description	HS-code	Market share effect	Commodity compositio n effect	Residual effect	Total effect
Fresh vegetables	07	- 0.86	+ 1.46	-0.14	+ 0.46
Onions, shallots, garlic, leeks and other alliaceous vegetables	0703	+ 0.28	+ 0.21	+ 0.11	+ 0.60
Fresh fruits	08	+ 2.73	- 0.88	- 0.42	+ 1.43
Grapes, fresh or dried	0806	+ 0.64	+ 0.21	+ 0.07	+ 0.92
Processed fruits and vegetables	20	+ 0.37	- 0.02	- 0.02	+ 0.33
Other vegetables prepared or preserved (not frozen)	2005	+ 0.20	0.00	0.00	+ 0.20

Source*:* Author's calculations.
Note*:* * Average 2004-2005 is the initial period and average 2007-2008 is the terminal period.

Table 24. Decomposition of CMSA: EU Imports of Fresh Vegetables from Egypt and Other SMCs (Percentage Variations over 2004-2008, %)*

Potatoes, fresh or chilled HS-0701				
	Market share effect	**Commodity composition effect**	**Residual effect**	**Total effect**
Tunisia	+ 0.06	- 0.02	-0.01	+ 0.03
Egypt	**+0.25**	**-0.53**	**- 0.04**	**- 0.32**
Citrus fruits, fresh or dried HS-0805				
	Market share effect	**Commodity composition effect**	**Residual effect**	**Total effect**
Lebanon	+0.02	0.00	0.00	+0.02
Egypt	**+0.50**	**-0.60**	**- 0.11**	**-0.21**
Fruits, nuts and other edible parts of plants HS-2008				
	Market share effect	**Commodity composition effect**	**Residual effect**	**Total effect**
Lebanon	+ 0.05	-0.02	-0.01	+ 0.02
Egypt	**0.00**	**-0.01**	**0.00**	**-0.01**

Source*:* Author's calculations.
Note*:* * Average 2004-2005 is the initial period and average 2007-2008 is the terminal period.

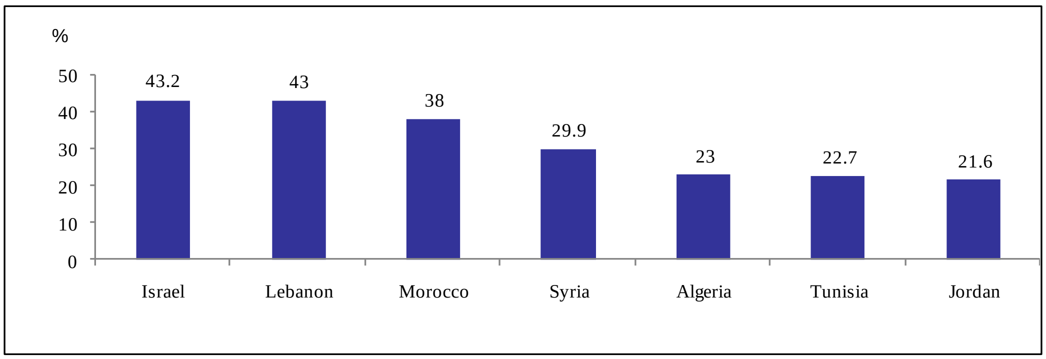
A comparison between Egypt and other SMCs reveals that Tunisia is the best export performer in the EU market for fresh or chilled potatoes among the SMCs (+0.03%). Although Egypt's competitiveness in the EU market for fresh or chilled potatoes increased at a higher rate (+0.25%) than that of Tunisia (+0.06%), Egypt's export performance is weaker as EU demand for Egyptian exports decreased at a faster rate (-0.53%) than that for Tunisian exports (-0.02%).

Lebanon is the best SMC exporter of fresh or dried citrus fruits to the EU market (+0.02%), as a result of its increased competitiveness suggested by its positive market share effect (+0.02%). Although the increase in competitiveness was much higher for

Egypt (+0.50%) than for Lebanon (+0.02%), Egypt's weaker performance is attributed to disadvantageous development in EU demand for Egyptian exports (-0.60%), in addition to Egypt's weak capability to adjust its supply to the EU market for citrus fruits (-0.11%).

Lebanon is again the best SMC exporter of processed fruits, nuts and other edible parts of plants to the EU market. While Lebanon increased its competitiveness (+0.05%), Egypt lost it as suggested by the absence of any market share effect.

To sum up, Egypt was able to increase its export share in the EU fruit and vegetable market over the period 2004-2008. To maintain this achievement, Egypt needs to continuously enhance its competitiveness to withstand the strong competition from several SMCs, whose fruit and vegetable export structures are quite similar to Egypt's, as suggested by the calculated export similarity index (Figure 3). Also, Egypt needs to better respond to changes in European consumers' demand and enhance its capability to adjust its supply to the EU market demand.



Source*:* Author's calculations based on the UN Comtrade Database. Latest available data for the SMCs are for 2007.

Note*:* Export Similarity Index (ESI) $_{a,b}$ = sum [min (X_{ia}, X_{ib}) * 100]. Where, X_{ia} and X_{ib} are the export shares of commodity i (a fruits or vegetables, whether fresh or processed), in country a's (e.g., Egypt) and country b's (e.g., a SMC) total exports of fresh and processed fruits and vegetables. The value of (ESI) ranges between zero and 100 percent, with zero indicating complete dissimilarity and 100 percent representing identical export composition. This measure is subject to aggregation bias (as the data are more finely disaggregated, the index will tend to fall) and hence embodies certain arbitrariness due to product choice (World Bank, Data and Statistics, Trade Indicators and Indices, http://web.worldbank.org, last visited on 12/31/2009; Kreinin and Plummer 2007).

Figure 3. Export Similarity Index Between Egypt and Several SMCs for Fresh and Processed Fruits and Vegetables in 2008.

Increasing Egypt's exports of fruits and vegetables to the EU is hindered by several factors including: appreciation of the Egyptian pound exchange rate and inefficient maritime transport and related logistics services.

Generally, as the Egyptian pound exchange rate appreciates, Egyptian exports may become less competitive or relatively more costly. Over the period 2005-2008, the Egyptian pound has appreciated by 6.9 percent in real, trade weighted terms, while the Moroccan dirham and the Tunisian dinar have depreciated by 0.1 percent and by 2.5 percent in real terms, respectively, making Egyptian exporters less competitive abroad relative to their Moroccan and Tunisian competitors (Johnson 2008).

Export flows from Egypt to the EU suffer from inefficient maritime transport and related logistics services, which are inappropriate for perishable commodities as fruits and vegetables (Malorgio and Mulazzani 2009; Ghoneim and Helmy 2007; Helmy 2002). Egypt lags behind the regional and lower-middle-income country averages on nearly all aspects of the Logistics Performance Index (LPI). Egypt was 97th out of 150 ranked countries and 6th in the MENA region on the 2006 LPI, reflecting a less conducive climate for trade. Its weakest logistics indicator was the quality of transport and information technology (IT) infrastructures, with severe constraints posed by its underdeveloped seaports and airports and by poor telecommunications services (Table 25).

Table 25. Trade Facilitation in Egypt and Other SMCs, 2007

	Algeria	**Egypt**	**Israel**	**Jordan**	**Lebanon**	**Libya**	**Morocco**	**Syria**	**Tunisia**
Logistics Performance Index (LPI, 1 to 5 best)	2.1	2.4	3.2	2.9	2.4	..	2.4	2.1	2.8
Efficiency of customs and other border procedures	1.6	2.1	2.7	2.6	2.2	..	2.2	2.2	2.8
Quality of transport and IT infrastructures	1.8	2.0	3.0	2.6	2.1	..	2.3	1.9	2.8
International transportation costs	2.0	2.3	3.3	3.1	2.5	..	2.8	2.0	2.9
Logistics competence	1.9	2.4	3.2	3.0	2.4	..	2.1	1.8	2.4
Tractability of shipments	2.3	2.6	3.5	2.8	2.3	..	2.0	2.0	2.8
Domestic transportation costs	3.2	2.8	2.2	2.9	3.4	..	2.4	2.9	3.2
Timeliness of shipment	2.8	2.8	3.6	3.2	2.7	..	2.9	2.7	2.8
Trading across borders (rank out of 181)	118	24	9	74	83	..	64	111	38
No. of documents required for exports	8	6	5	7	5	..	7	8	5
No. of days process required for exports	17	20	19	14	…	12	12	22	16
Cost to export ($ per container)	1 248	737	665	730	872	..	700	1 190	733
Liner shipping connectivity index (0-100 best)	7.9	45.4	21.4	16.5	30.0	6.6	9.0	14.2	7.2

Source*:* World Bank (2010, 2008).

5. Conclusion and Policy Implications

Egypt has a revealed comparative advantage in exporting fruits and vegetables and could use the EU trade concessions more efficiently to further promote its exports to the EU, the leading importer of fruits and vegetables in the world.

SMCs, including Egypt, enjoy preferential access to the EU fruit and vegetable market, which is highly protected against international competition by means of diverse and complex protection instruments. However, bilateral preferential trade agreements between the EU and each SMC stipulate different conditions of mutual concessions on a product-by-product basis, resulting in considerable heterogeneity among products as well as among SMCs in terms of preferential access conditions to the EU fruit and vegetable market. This heterogeneity could be explained by the progress of negotiations between each SMC and the EU and by the export specialization of the country.

Despite Egypt's preferential access to the EU's highly protected fruit and vegetable market, several indicators suggest that the country still has less favorable access to the EU market than its SMCs comparators'. Egypt's Market Access Trade Tariff Restrictiveness Index (MA-TTRI) is higher than the averages for the MENA region and lower-middle-income country group; the country's weighted rest of the world tariff (including preferences) for agricultural products is much higher than for the majority of SMCs, and the weighted preferential margin for Egypt's agricultural exports to the EU is lower than for the exports of several SMCs (for example, Jordan, Morocco, Lebanon and Israel). Tariff reductions granted by the EU are small in relation to Egypt's exports and the duties actually paid by Egypt when the preference is applied remain relatively high.

The new agreement that has been reached on the 1st of July 2008 to further liberalize trade in agricultural, processed agricultural and fish and fishery products between Egypt and the EU would improve Egyptian exporters' preferential access conditions to the EU fruit and vegetable market. However, Egypt needs to speed up the process of ratifying and implementing this new agreement with the EU, particularly that Israel and the EU have signed a new agreement for further liberalization of agricultural trade on November 4, 2009 that will enter into force on January 1, 2010 and agricultural trade liberalization negotiations between the EU and some SMCs, such as Morocco, are currently under way.

Egypt may not fully utilize its EU tariff quotas, implying forgone export opportunities. The degree to which Egypt utilizes tariff quotas for its exports of fruits and vegetables is lower than that for several SMCs (for example, Jordan, the Palestinian Authority, Israel and Syria), indicating that Egypt benefits less from trade preferences than its SMCs comparators. Improving farmers' productivity and lowering production costs would enable Egypt to fully utilize its tariff quotas and increase fruit and vegetable exports. Government-funded programs would help farmers improve their productivity by obtaining specific varieties, adopting better farming practices, providing research and agricultural extension services, promoting exports and providing market information. Compensation for further processing, export subsidies, and several types of financial aid and risk protection would effectively lower production costs and allow Egyptian fruit and vegetable producers to become more competitive on the EU market.

Despite Egypt's less favorable access to the EU fruit and vegetable market and lower preference utilization rate than its SMCs comparators', the implementation of the Association Agreement between Egypt and the EU has increased Egypt's exports of fruits and vegetables to the EU. Over the period 2004-2008, Egypt had a strong export performance in *fresh fruits* and *processed fruits and vegetables*, with average annual export growth rates well above the average of other SMCs. However, for *fresh vegetables*, Egypt's exports to the EU grew at an average annual rate that is lower than that of other SMCs, with Morocco and Israel outperforming Egypt as suppliers to the EU market. Egypt's most dynamic fruit and vegetable exports to the EU market were pears, watermelons, apricots, grapes, citrus fruits, tomatoes, onions and garlic, carrots and potatoes.

Notwithstanding the value of Egypt's preferential access to the EU fruit and vegetable market, the country's preferential treatment may not be sustainable in the long run in case European agricultural preferences to other suppliers are generalized in the framework of the ongoing Doha negotiations of the WTO. Hence, enhancing the competitiveness of Egypt in the EU fruit and vegetable market is needed to sustain and further promote the country's exports.

Competitiveness of Egypt in the EU fruit and vegetable market relative to other SMCs over the period 2004-2008 was assessed by using the Constant Market Share Analysis (CMSA) methodology. Results of the CMSA indicate that over the period under consideration, Egypt has increased its share in the EU market for fresh vegetables, fresh fruits and processed fruits and vegetables relative to several SMCs. However, Egypt proved to be more successful in exporting fresh fruits than gaining market share in fresh vegetables or in processed fruits and vegetables.

For both fresh fruits and processed fruits and vegetables, Egypt stood out among other SMCs because its exports to the EU underwent the highest increase. Egypt's better performance is mainly attributed to the country's higher competitiveness in exporting these products relative to the other SMCs. However, the decline in the rate of growth in EU demand for Egyptian exports of fresh fruits and processed fruits and vegetables and the weak capability of Egypt to adjust its export structure to the changes in the structure of the EU market have been critical to limit a gain that could still be higher for Egypt.

Despite strong EU demand *for fresh vegetables* and Egypt's revealed comparative advantage in producing and exporting these products, Egypt was hindered by a drop in its competitiveness relative to other SMCs and the weak capability to adjust its supply to the EU market for fresh vegetables. Morocco outperformed Egypt in the EU market for fresh vegetables as a result of an increase in the rate of growth in EU demand for Moroccan exports, the country's increased competitiveness and its capability to adjust its supply to the EU market demand.

At a more disaggregated product level, Egypt's best performing exports to the EU market were onions and garlic, fresh or dried grapes and prepared or preserved (not frozen) vegetables. Egypt's good performance reflects greater competitiveness in the EU market for these three commodities relative to other SMCs. Egypt has succeeded in gaining quotas in commodities with faster growing EU demand.

Egypt’s weakest export performance was in fresh or chilled potatoes, fresh or dried citrus fruits and processed fruit, nuts and other edible parts of plants. This relatively weak performance mainly reflects a diversion in European consumers’ demand away from Egyptian exports towards Tunisian exports of fresh or chilled potatoes and Lebanese exports of fresh or dried citrus fruits. Egypt seems to have lost its competitiveness in processed fruits, nuts and other edible parts of plants, while Lebanon has enhanced its competitiveness in these products.

The findings of the empirical analysis, besides the evaluation of Egypt’s preferential access to the EU fruit and vegetable market, suggest that Egypt needs to continuously enhance its competitiveness to maintain its accomplishments in the EU market and withstand the strong competition from several SMCs, whose fruit and vegetable export structures are quite similar to Egypt’s. Also, Egypt needs to better respond to changes in European consumers’ demand and enhance its capability to adjust its supply to the EU market demand.

The margins of improving Egypt’s competitiveness in the EU fruit and vegetable market are still high. A more flexible Egyptian pound exchange rate could make Egyptian exports more competitive and relatively less expensive than SMCs’ exports and commodities produced domestically in the EU.

If Egypt manages to reduce the costs of transport and related logistics services by establishing highly efficient ports and a competitive shipping services industry, the cost-competitiveness of its fruit and vegetable supply would improve. By enhancing the efficiency of transport and related logistics services, Egypt could become an important SMC player in the logistical organization and in distributing fresh and processed fruits and vegetables to the EU market.

Further development of technologies for the preservation and processing of fruits and vegetables would add a higher economic value to Egyptian exports and the country’s location would allow processed goods to easily reach the EU market.

Egypt needs to consider increasing its exports of fruits and vegetables whose demand is growing rapidly in the EU market. One particular category of special products that is receiving a lot of attention in the EU market is organic produce and it is widely accepted that the market share of organic fruits and vegetables has increased. Given the environmentally friendly character of the organic production systems, besides the need for motivating farmers to specialize in organic certified products, the government could make a special contribution to the organic sector and share some of the costs incurred due to compliance with the strict organic standards.

Fruits and vegetables represent a great export potential for Egypt. In order to make the most of this potential, it is, however, necessary to improve and adjust the quality of the products in order that they may live up to the requirements of the EU export market. Greater compliance with the EU food safety regime and the SPSA-WTO in the processing, preservation, packaging, labeling, exportation, distribution and advertising of fruits and vegetables will increase the quality and safety of food, thus protecting consumers and increasing access to the EU food value chain.[32] Technical and financial assistance provided by the EU to Egypt would help improve the country's capabilities to comply with the quality, health and environmental standards required by European consumers.

In addition, Egypt needs to develop marketing processes through joining the international food chains and large scale retail trade.[33] It is important to note that Thailand, for example, is currently a leading global exporter of canned peaches, pears and fruits mixtures, despite its insignificant domestic production of fresh peaches and pears. Fruit canneries in Thailand rely largely on imported fruits from the United States which are repackaged into plastic jars and cups in Thailand, and then re-exported back to the United States in the form of retail-ready products.[34]

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[32] Egyptian exporters of fruits and vegetables are not legally required to fulfill the traceability requirement. However, requests from EU business operators to their Egyptian trading partners are part of the food business's contractual arrangements and not of requirements established by the EU regulation.

[33] Large scale retail trade is a type in which either single type of goods or a variety of goods is made available to a large number of consumers in a big shop under a single roof or may be made available at the convenience of customers.

[34] Thailand's competitive advantages in producing canned fruits are based primarily on relatively inexpensive labor and technological investments provided by US-based Dole Food Company which accounts for the majority of Thailand's peach and pear canning industry through its subsidiary Dole Thailand Ltd. US-based Dole Food Company implements global business strategies to source complementary fruits and vegetable products globally to meet year-round demand. Such strategies reduce processing costs and build an international customer network and brand recognition (Johnson 2008).

Appendix 1.

Table A.1. Decomposition of CMSA: Egypt (Percentage Variations over 2004-2008, %)*

Egypt		Columns									
Commodity description	HS-code	1	2	3	4	5	6	7	8	9	10
		α^{kl}_{it}	α^{kl}_{i0}	$\alpha^{kl}_{it} - \alpha^{kl}_{i0}$	b^{l}_{i0}	$\sum_i (\alpha^{kl}_{it} - \alpha^{kl}_{i0})\, b^{l}_{i0}$	b^{l}_{it}	$b^{l}_{it} - b^{l}_{i0}$	$\sum_i (b^{l}_{it} - b^{l}_{i0})\, \alpha^{kl}_{i0}$	$\sum_i (\alpha^{kl}_{it} - \alpha^{kl}_{i0})(b^{l}_{it} - b^{l}_{i0})$	5+8+9
		Figures in percentages (%)									
Edible vegetables and certain roots and tubers	07	18.1331	19.9596	-1.8265	47.1276	-0.8608	54.4223	7.2947	1.4560	-0.1332	0.4620
Potatoes, fresh or chilled	0701	38.7888	36.2853	2.5035	10.0837	0.2524	8.6301	-1.4536	-0.5274	-0.0364	-0.3114
Tomatoes, fresh or chilled	0702	1.1151	0.6375	0.4776	10.3672	0.0495	12.0187	1.6515	0.0105	0.0079	0.0679
Onions, shallots, garlic, leeks and other alliaceous vegetables	0703	67.1209	44.3023	22.8186	1.2201	0.2784	1.6982	0.4781	0.2118	0.1091	0.5993
Cabbages, cauliflowers, kohlrabi, kale and similar edible brassicas	0704	7.9545	0.2107	7.7438	0.0523	0.0040	0.1984	0.1461	0.0003	0.0113	0.0157
Lettuce (Lactuca sativa) and chicory (Cichorium spp.)	0705	34.5288	31.1058	3.4231	0.1614	0.0055	0.3454	0.1840	0.0572	0.0063	0.0691
Carrots, turnips and similar edible roots	0706	0.3781	1.3668	-0.9886	0.1762	-0.0017	0.3957	0.2195	0.0030	-0.0022	-0.0009
Cucumbers and gherkins, fresh or chilled	0707	7.4810	10.4536	-2.9725	0.2244	-0.0067	0.2685	0.0440	0.0046	-0.0013	-0.0034
Leguminous vegetables, shelled or unshelled, fresh or chilled	0708	23.1107	25.6161	-2.5054	8.5728	-0.2148	7.5913	-0.9816	-0.2514	0.0246	-0.4416
Other vegetables, fresh or chilled	0709	3.7291	6.2140	-2.4849	11.4683	-0.2850	18.3667	6.8984	0.4287	-0.1714	-0.0277
Vegetables (uncooked), frozen	0710	64.1279	37.7446	26.3833	1.1134	0.2937	0.9007	-0.2127	-0.0803	-0.0561	0.1574
Vegetables provisionally preserved	0711	34.4692	8.0900	26.3793	0.7483	0.1974	1.0682	0.3199	0.0259	0.0844	0.3077
Dried vegetables, whole, cut, sliced, broken or in powder	0712	72.8930	74.7696	-1.8766	1.5770	-0.0296	1.7806	0.2036	0.1522	-0.0038	0.1188
Dried leguminous vegetables, shelled	0713	78.5135	67.1578	11.3557	0.6105	0.0693	0.4302	-0.1803	-0.1211	-0.0205	-0.0722
Manioc, arrowroot, sweet potatoes and similar roots	0714	9.5320	11.4947	-1.9627	0.7456	-0.0146	0.7295	-0.0161	-0.0018	0.0003	-0.0162
Edible fruits and nuts; peel of citrus fruits or melons	08	19.5155	13.1301	6.3854	42.7157	2.7276	36.0491	-6.6666	-0.8753	-0.4257	1.4266
Coconuts, Brazil nuts and cashew nuts, fresh or dried	0801	8.1551	4.2824	3.8727	0.0040	0.0002	0.0056	0.0016	0.0001	0.0001	0.0003
Other nuts, fresh or dried	0802	2.3269	0.4628	1.8641	0.8178	0.0152	0.6741	-0.1437	-0.0007	-0.0027	0.0119
Bananas, including plantains	0803	0.1836	88.8841	-88.7005	0.0025	-0.0023	0.0062	0.0037	0.0032	-0.0032	-0.0022

Table A.1. (Continued)

Egypt		Columns									
		1	2	3	4	5	6	7	8	9	10
Commodity description	HS-code	α^{kl}_{it}	α^{kl}_{i0}	$\alpha^{kl}_{it} - \alpha^{kl}_{i0}$	b^{l}_{i0}	$\sum_i(\alpha^{kl}_{it} - \alpha^{kl}_{i0})\, b^{l}_{i0}$	b^{l}_{it}	$b^{l}_{it} - b^{l}_{i0}$	$\sum_i(b^{l}_{it} - b^{l}_{i0})\, \alpha^{kl}_{i0}$	$\sum_i(\alpha^{kl}_{it} - \alpha^{kl}_{i0})(b^{l}_{it} - b^{l}_{i0})$	5+8+9
		Figures in percentages (%)									
Dates, figs, pineapples, avocados and mangosteens, fresh or dried	0804	0.5375	0.4612	0.0763	9.4559	0.0072	8.1147	-1.3412	-0.0062	-0.0010	0.0000
Citrus fruits, fresh or dried	0805	18.9937	15.8134	3.1803	15.6584	0.4980	12.0906	-3.5678	-0.5642	-0.1135	-0.1797
Grapes, fresh or dried	0806	73.7480	55.0241	18.7239	3.4092	0.6383	3.7824	0.3732	0.2053	0.0699	0.9135
Melons (including watermelons) and papaws (papayas), fresh	0807	9.6652	4.3102	5.3550	3.5431	0.1897	2.9886	-0.5545	-0.0239	-0.0297	0.1361
Apples, pears and quinces, fresh	0808	0.0061	0.0000	0.0061	0.0094	0.0000	0.0296	0.0202	0.0000	0.0000	0.0000
Apricots, cherries, peaches (including nectarines), plums and sloes, fresh	0809	15.3144	10.4428	4.8716	1.0568	0.0515	0.8435	-0.2132	-0.0223	-0.0104	0.0188
Other fruits, fresh	0810	27.0782	14.4214	12.6568	6.1311	0.7760	4.2060	-1.9251	-0.2776	-0.2437	0.2547
Fruits and nuts	0811	10.5574	2.4666	8.0908	2.2932	0.1855	3.0509	0.7576	0.0187	0.0613	0.2655
Fruits and nuts, provisionally preserved	0812	1.8308	0.7087	1.1222	0.1931	0.0022	0.1639	-0.0292	-0.0002	-0.0003	0.0016
Fruits, dried	0813	1.4395	1.1097	0.3298	0.0876	0.0003	0.0655	-0.0221	-0.0002	-0.0001	0.0000
Peel of citrus fruits or melons (including watermelons)	0814	23.8124	1.8463	21.9661	0.0292	0.0064	0.0275	-0.0017	0.0000	-0.0004	0.0060
Preparations of vegetables, fruits or nuts	20	6.9010	3.2375	3.6635	10.1567	0.3721	9.5286	-0.6281	-0.0203	-0.0230	0.3287
Vegetables, fruits or nuts	2001	1.7476	1.8326	-0.0850	0.4154	-0.0004	0.3151	-0.1003	-0.0018	0.0001	-0.0021
Tomatoes prepared or preserved	2002	18.6061	0.4968	18.1093	0.2743	0.0497	0.4027	0.1284	0.0006	0.0233	0.0736
Mushrooms and truffles, prepared or preserved	2003	0.0000	0.0000	0.0000	0.0232	0.0000	0.0166	-0.0066	0.0000	0.0000	0.0000
Other vegetables prepared or preserved	2004	41.0667	6.8682	34.1985	0.0471	0.0161	0.1027	0.0556	0.0038	0.0190	0.0389
Other vegetables prepared or preserved	2005	9.7724	5.3788	4.3936	4.2538	0.1869	4.2503	-0.0035	-0.0002	-0.0002	0.1866
Vegetables, fruits, nuts, fruit-peel	2006	5.7202	0.9627	4.7574	0.0029	0.0001	0.0056	0.0027	0.0000	0.0001	0.0003
Jams, fruits jellies, marmalades, fruits or nut pastes	2007	40.1070	10.5737	29.5333	0.0188	0.0056	0.0496	0.0307	0.0032	0.0091	0.0179
Fruits, nuts and other edible parts of plants	2008	1.5759	1.7157	-0.1397	1.6045	-0.0022	1.2727	-0.3318	-0.0057	0.0005	-0.0075
Fruit juices (including grape must) and vegetable juices	2009	2.5488	1.6871	0.8617	3.4506	0.0297	3.1134	-0.3372	-0.0057	-0.0029	0.0211

Source: Author's calculations. *Note:* *= Average 2004-2005 is the initial period and average 2007-2008 is the terminal period.

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