Agricultural and Food Policies in Global Trade: The Case of Almonds and Hazelnuts

by

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Abstract

This dissertation consists of three essays. The first essay presents an industry model developed to analyze the link between targeted production subsidies and excess inventory holdings. The Turkish hazelnut industry is a highly relevant case to analyze this relationship due to the fact that hazelnut acreages expanded in unapproved areas led to overproduction and caused government inventory accumulation. The state ended long-lasting guaranteed purchase policies and introduced targeted production subsidy and diversion payment policies in 2009. According to new policies, hazelnut producers in approved production areas (i.e., "licensed" producers) started to receive a subsidy of 1,000 USD per hectare. At the same time, the government offered diversion payments to producers in unapproved farmlands (i.e., "unlicensed" producers).The goals of the new policies were to support producers that were reliant on hazelnuts as their primary source of income, to reduce the acreages of hazelnut grown by unlicensed producers, and to lessen the volume of excess hazelnuts held in government reserves.

In Essay 1, I present an economic analysis of the impact of this major policy change and specify an equilibrium displacement model (EDM) that incorporates inventory holdings to examine the relationship between the production subsidy and carry-over stocks. The essay includes an analysis of the economic impacts of the policy on domestic producer groups, government inventories and world trade flows. A major question to be investigated is whether a targeted production subsidy can be effective at reducing excess inventory while providing welfare gains to the domestic producers. The study attempts to quantify the magnitude of the

difference between the changes in domestic production and total consumption (domestic plus export) stimulated by an increase in subsidy.

Findings suggest a 10 percent increase in the targeted production subsidy raises licensed producer price by 8.4 percent and depresses unlicensed producer price by 1.6 percent. Accordingly, licensed acreages increase by 1.6 percent and unlicensed acreages will decrease by 0.4 percent following a 10 percent increase in the subsidy. However, total production will increase by 0.8 percent due to licensed acreages having a larger share of domestic supply (61 percent) than unlicensed acreages (39 percent).

Domestic (export) consumption increases by 0.5 percent (1 percent), on average, with a 10 percent increase in subsidy, while government inventories declined as much as 0.5 percent because the increase in total consumption (domestic plus export) exceeds the increase in domestic production.

Welfare gains are mainly split between licensed producers ($74 million) and domestic and foreign consumers ($14 million and $66 million, respectively). Despite net domestic welfare loss up to $63 million, the Turkish treasury gains $14 million due to reduced inventory holdings. These results suggest the major beneficiaries from an increase in subsidy are the licensed producers and foreign consumers.

Overall, the policy is expected to achieve its objectives as it improves the welfare of licensed producers and reduces government inventories. However, the impact of the subsidies is limited in terms of inventory reduction, as the elasticity of inventory with respect to subsidy is highly inelastic at 0.05. Furthermore, an increase in the targeted production subsidy results in a decrease in unlicensed acreages. This was the primary objective of the diversion payment policy, which failed, given the fact that the applications for diversion payments were limited to 1 percent of total unlicensed acreages. The cost of an increase in the production subsidy to taxpayers would have been 22 percent higher had treasury gains from reduced inventories not been taken into account in the welfare analysis.

Findings suggest that a targeted production subsidy that shifts production from prime agricultural land to hill country may be a more cost-effective policy for supporting hazelnut producers than an inventory policy that diverts production from the market when prices are low.

Essay 2 examines the factors affecting world exports to the European Union and the interaction between food safety regulations and export responses of nut producers. The impact of domestic production factors, as well as natural and manmade trade barriers for bilateral imports to the EU were investigated in a dynamic setting. A major hypothesis to be investigated is whether food safety standards act as barriers or catalysts in the EU almond and hazelnut markets. The hypothesis is extended to examine the effects of foodstuff regulations on exports from developing versus developed countries. The essay also analyzes the impact of harmonization of EU food safety standards on EU imports from EU exporting countries (i.e., intra-EU trade). The impact of domestic production factors and natural and manmade trade barriers on bilateral imports are estimated for a range of percentile values of the supply size distribution (10^{th}, 50^{th}, and 90^{th}) to identify structural differences in dominant and small scale supplier exports.

The empirical findings suggest that stringent aflatoxin standards significantly reduced trade and impeded the establishment of new trade partnerships. The results further suggest that harmonization of food standards promotes market integration and intra-EU trade. In contrast to claims (Anders and Caswell, 2009; Disdier, Fotagne, and Mimouni, 2008), the present analysis suggests restrictive aflatoxin measures have a negative impact on developing countries, at least with respect to almond and hazelnut exports. Furthermore, the relative impact of stringent standards is greater (more negative) for exports from newly emerging economies. The estimated marginal effects of trade determinants did not differ by size of the supplier. The estimated coefficients of most variables vary less than 10 percent between large and small suppliers, except for geographical distance between trading partners, which reduces the trade flow by 18 percent for large producers (those in the 90^{th} percentile of the size distribution) in comparison to small suppliers (those in the 10^{th} percentile).

This study provides a comprehensive analysis of the role of food safety standards, domestic production factors, and natural and manmade trade barriers on world hazelnut and almond exports to EU markets. The results of this study should be considered in the establishment of new policies for other tree-nut industries (e.g., walnuts, cashews, and pecans) as, to date, the EU's food standards remain unchanged at more restrictive levels than international standards. Particularly, findings suggest that tree-nuts exports from developing and developed countries would significantly increase if the EU aligns its food standards at the international level for other tree-nut products.

The final essay focuses on the sensitivity of world demand for almonds and hazelnuts to changes in relative prices and income. To address this issue, a generalized differential demand model developed by Eales, Durham, and Wessells (1997) is estimated using quarterly data for almonds from the US, Spain, Australia and the rest of the world and for hazelnuts from Turkey, Georgia, the US and EU for the period 2005 to 2014. An important issue to be resolved is whether almonds and hazelnuts can be treated as separable products. This issue is important because if the products are separable, the estimation problem is simplified in that the demand system for almonds (differentiated by source origin) can be estimated independently of the demand system for hazelnuts (also differentiated by source origin). Therefore, the analysis includes a formal test for weak separability in world almond and hazelnut demand.

Findings suggest that almonds and hazelnuts are separable goods in demand. Conditional on this finding, price and expenditure elasticities are estimated for these two products separately. The generalized model is utilized to estimate the world hazelnut demand system, which consists of four equations (i.e., Turkey, the EU, Georgia, and the US). The results of the hazelnut demand estimation indicate that world demand for hazelnuts from Turkey and the US is less price-sensitive in comparison to hazelnuts from the EU. The estimated Marshallian own-price elasticities are -0.69, -0.88, and -1.93 for hazelnuts exported from Turkey, the US and the EU, respectively. Furthermore, the calculated expenditure elasticities for hazelnuts suggest that an increase in world expenditure on hazelnuts has an insignificant impact on the exports from the EU, but benefits other exporting countries with the least gain for US hazelnuts (0.57). Surprisingly, Georgian hazelnuts exhibit a 1.24 percent gain from a 1 percent increase in world expenditure on hazelnuts, which exceeds that of hazelnuts from Turkey at 1.17 percent.

World demand for almonds is investigated using a generalized differential demand system approach for almonds from the US, Spain, Australia, and ROW. The Rotterdam model is found to be compatible with the almond data. Conditional own-price elasticity estimates suggest that world demand for almonds from the US, the leading almond exporter, is more price sensitive relative to almonds of other origins, as its Marshallian own-price elasticity is elastic at -1.07, contrary to the inelastic demand for almonds from Spain (-0.64) and the rest of the world (-0.55). The conditional expenditure elasticities are found to be highly inelastic for almonds from Spain (0.003) and the rest of the world (0.12), but elastic for almonds from the US (1.36). This finding suggests an increase in world almond expenditure significantly stimulates almond demand from the US at a much greater extent than almonds from elsewhere.

World demand for hazelnuts and almonds from all sources is estimated to be inelastic with almonds having relatively higher price elasticity (-0.76 and -0.95, respectively). The more

elastic demand for almonds suggests that removal or reduction of trade barriers to international markets would stimulate world demand for almonds to a greater extent than demand for hazelnuts. In addition, more elastic demand implies that global markets are more likely to absorb supply increases with less reduction in producer prices. Accordingly, supply shocks may result in high price volatility for goods having less elastic demand. Findings of this study are anticipated to inform policy makers, growers, and marketers in their effort to develop effective strategies for expanding sales and market shares for almonds and hazelnuts.

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I dedicate this dissertation to all oppressed innocents across the globe.

"*Each individual instance of all the sorts of praise that has been offered by whatever to whatever since pre-eternity and will be offered to post-eternity is particular to and due to the Necessarily Existent One alone, Who is named Allah*." R.N.C

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Introduction

Many countries provide agricultural support to their domestic producers by means of a variety of policy measurements (i.e., production subsidies, price supports). The economic consequences of these policies are well documented in the literature (e.g., Rucker and Thurman, 1990; Houck, 1986). This study aims to provide a detailed view of the economic impacts of targeted production subsidies on producer groups, domestic and export market consumers in a large open economy where overproduction and excess inventory holdings are significant concerns for the government and the industry in question. To accomplish this goal, an industry model is developed to analyze the link between targeted production subsidies and excess inventory holdings by using an equilibrium displacement model approach. The Turkish hazelnut industry was selected to show welfare distribution effects of targeted production subsidies and to outline the relationship between production subsidies and carry-over stocks as the Turkish hazelnut industry is a highly relevant case to analyze this relationship.

Turkey is the leading supplier and exporter of hazelnuts (also known as filberts). The country accounts for approximately 75% of the world hazelnut production and 81% of total world exports during the last decade (International Nut Council, 2012). Despite having the largest share of the global hazelnut trade, the Turkish treasury has had to finance the cost of over production and excess inventory holdings.

The Turkish government has been supporting the hazelnut growers mainly through guaranteed purchases to regulate the market price, particularly, in the high production years since 1964, due to the socioeconomic and strategic importance of hazelnuts. After a record harvest in 2008, government inventories reached up to 95% of the domestic production in 2009. The financial burden of the guaranteed purchase policies led the state to initiate new policies in 2009.

According to the new policies (The Official Gazette of the Turkish Republic, 2009), the government ended guaranteed purchases and instead provided land-based subsidy payments to licensed[1] hazelnut growers only. The targeted production subsidy aimed to achieve two objectives. The first objective was to provide support to licensed farmers who were highly dependent on hazelnut production in native hazelnut farmlands. The second objective was to decrease the standing inventories by stimulating exports and domestic consumption through lowered market prices. At the same time, the government offered diversion payments to unlicensed producers in effort to reduce the acreages of hazelnut grown by unlicensed producers.

Findings of this research suggest that targeted production subsidies are effective policy tool for increasing welfare surplus to targeted producer groups and reducing government inventories. Particularly, the targeted production subsidy stimulates exports and domestic market consumption associated with lowered market prices to a greater extent than the domestic production, thereby, reducing the level of carry-over stocks. Although, the elasticity of inventory with respect to the subsidy is inelastic at 0.05, the cost of the targeted production subsidy might be less than the actual amount paid by taxpayers due to high volume of government stocks.

The paper continues with an overview of the hazelnut industry and governmental policies, as well as a brief literature review concerning the economic impacts of supply control and support policies. The following sections contain a graphical analysis of the economics of the targeted production subsidy and present an industry model to investigate the link between

[1] The government provides a license for hazelnut farms based on location. To be eligible to receive a license, the producers must have farms located in the steep lands in the Black Sea region of Turkey (i.e., the first standard region). The terms “licensed producers” and “licensed farms” are used interchangeably. First and second standard regions refer to licensed and unlicensed acreages, respectively.

targeted production subsidies and inventory holdings using an equilibrium displacement model. After the model simulation and discussion of the welfare distribution effects of production subsidy, the paper concludes with policy recommendations and a summary of findings.

An Overview of Turkey's Hazelnut Industry and the Government Policies

Hazelnut cultivation is native to the steep lands in the Black Sea region of Turkey. These steep lands are referred to "The First Standard Region" where the local ecology generally is not suitable for production of other crops. The Second Standard Region covers the western part of the Black Sea region. The landscape in this region is flatter and includes more fertile lowlands that are ecologically suitable for growing a variety of crops which would otherwise be imported.

The government of Turkey intervened into the hazelnut market mainly by providing guaranteed purchases at the farm level. Additionally, small amounts in the form of direct income payments were often provided by the government to support hazelnut growers. From 1964 to 2009, the Hazelnut Growers Union (HGU) and the Turkish Grain Board (2006-2009) made all purchases financed by the Turkish treasury (National Hazelnut Council, Hazelnut Report 2012). The government did not set a production quota at the time, and the HGU was required to make purchases from all growers (i.e., licensed and unlicensed farmers) at the price set by the government.

Relatively high support prices have led to a major expansion in the area dedicated to hazelnut cultivation and caused significant amounts of excess production and inventory accumulation. Bozoglu (2005) reported average margins of the support prices with respect to production costs at 38.1% and 68% for the periods of 1964-1993 and 1994-2000, respectively. The price support system in the form of a price floor set by the government caused hazelnut farmlands to double in acreage, resulting in a four-fold increase in hazelnut production between

1964 and 2011. The total area dedicated to hazelnut production considerably expanded from 253,000 (ha) in 1964 to around 650,000 (ha) in 2009 (Hazelnut Industry Report 2010, Department of Commerce). Parallel to this expansion in total acreage, hazelnut production increased from 147,000 tons in 1964 to a record level of 800,000 tons in 2008, primarily due to favorable climatic conditions coinciding with an on-production year. Bozoglu (2009) reports 65 % of the total acreage expansion and 55% of the increase in total production, occurred in the second standard region between 1964 and 2008.

Due to the guaranteed purchase policies, the government had to bear the financial costs of excess production resulting in ending stocks that consistently increased until 2008. The government converted surplus stocks into hazelnut oil, which has very low economic value relative to the nut themselves. In order to control the industry output, the Turkish government initiated new policy measurements that restricted subsidy payments to licensed producers and offered diversion payments to unlicensed producers.

According to the new policies implemented in 2009, the government ended guaranteed purchases, and provided a production subsidy to licensed producers and diversion payments to unlicensed growers based on their planted acreages. Licensed producers received an annual payment of 1,000 USD per hectare in the marketing years of 2009 and 2010, and 833 USD in 2011[2]. The goals of the subsidy policy were to support farmers who were highly dependent on hazelnut production due to the topographic characteristics of the first standard region and to

[2] Licensed producers received subsidy payments in local currency (i.e., Turkish Lira) in March and April of each marketing year. Therefore, the subsidy amounts were converted to US Dollars by averaging the monthly exchange rates for March and April of each year considered. The exchange rates used in the analysis are obtained from OECD database (1 USD=1.5 TL for 2009 and 2010, and 1.8 for 2011).

decrease ending inventories by stimulating exports and domestic consumption by lowering market prices, in addition, the government.

The policy included diversion payments for unlicensed producers in effort to reduce the acreage of unlicensed hazelnut farmlands and to promote alternative crop production in the second standard region. This region is more suitable for growing a variety of produce as it is flatter and fertile compared to the first standard region. Consequently, land based diversion payments were offered to unlicensed producers. The diversion payments included a one-time payment of 1,000 USD/ha for replacing hazelnut orchards with alternative crops and associated inputs costs. Additionally, the government offered diversion payments of 1,000 USD/ha per year to unlicensed producers during the policy period.

However, the policy failed to achieve its goal of reducing hazelnut acreages in the second standard region at the end of the effective policy period. According to the Department of Agriculture, applications for diversion payments accounted for only 1,500 (ha) or 1% of the targeted area (Table 1). Since diversion payments only covered approximately 25% of producer prices, once the land based diversion payments were converted into per kilogram value, they were insufficient to result in the intended policy goals. Therefore, the regulation for diversion payments is not included in the analysis.

Contribution to Existing Literature

The applied literature provides a great amount of research that examined the economic impacts of the supply control and support policies, particularly, for storable agricultural crops as overproduction and excess inventory holdings are among the major concerns of policy makers. For instance, the US peanut program employed a number of complex policy tools to regulate the industry outcome and to increase and stabilize the producer prices since 1934. Rucker and

Thurman (1990) reviewed the history of US peanut program and provided an economic analysis of supply control and support policies (i.e., poundage quota, the quota support price, and buy-back provisions) in US peanut industry. McDonald and Sumner (2003) investigated the crop supply response to support policies including direct payments in the form of marketing loans and deficiency payments based on the choice of planted acreages. Sumner and Wolf (1996) examined the economic impact of California dairy policies, a production quota system which did not restrict production or marketing of the fluid milk but "modifies how the end-use class prices affected milk prices faced by producers". Authors concluded that the California dairy program created more producer gains and less welfare losses compared to the typical marketing quotas applied in other dairy markets.

This study employs an equilibrium displacement model as a way to conveniently measure the economic impacts of supply shift due to a targeted production subsidy on producer groups, domestic and export market consumers in a large open economy where overproduction and excess inventory holdings are significant concerns for the government and the industry in question. As Piggott (1992) suggested, the main strength of the EDM is its usefulness in qualitative assessments of the impacts of changes in exogenous variables on endogenous variables without having any assumptions about functional forms.

EDM has been widely used to analyze the impacts of various supply and demand shocks for a wide range of agricultural products in the applied literature[3]. However, inventory holdings were commonly considered as working inventories; thus, were suppressed in economic analyses reported in these studies. For instances, Kinnucan and Belleza (1995) developed an industry

[3] Wohlgenant (2011) and Piggott (1992) provided a detailed discussion of EDM applications in policy analysis.

model to investigate the Canada's dairy advertising programs while accounting for the government purchases using equilibrium displacement model. Wohlgenant and Clary (1993) employed an EDM approach to examine the link between government purchases and advertising as well as the relationship between support prices and government purchases in US dairy market. Both studies found advertising program significantly reduces government costs. These analyses, however, did not explicitly consider the economic impacts of the changes in inventory holdings.

Regarding the welfare impacts of subsidy programs, considerable attention has been focused on the role of agricultural subsidies in the domestic and global markets (Gardner, 1983; Houck, 1986; Abbott *et al*., 1987). Yet, relatively few researches considered the ending stocks in their welfare analysis.

Alston *et al.* (1993) investigated the implications of deadweight costs of agricultural subsidy programs for optimal income distribution policies in a large open economy (i.e., able to influence world price). Their analysis compared the welfare implications of export and production subsidies and suggested that government outlays can be minimized by implementing an appropriate subsidy program (i.e., export or production subsidy), depending on domestic and export market shares and corresponding price elasticities. They additionally noted that a subsidy for a storable product that is worth a dollar on the market may cost less than a dollar to tax payers due to the reduction in government stocks.

Sadoulet and Janvry (1995) examined various types of production subsidies and found that when a government supports farmers without production control, and lets the market clear under the subsidized price, the financial burden on tax payers will be exceedingly high due to the fact that the government subsidizes producers with higher prices and consumers with lower market prices. They concluded that such subsidy policies will create a net social loss.

In a recent study, Koo and Kennedy (2006) investigated the effects of agricultural subsidies on global welfare where they accounted for beginning and ending stocks in their analysis[4]. Koo and Kennedy (2006) found that export subsidy programs caused larger trade distortions compared to domestic production support. The authors also suggested that for a large exporting country, production subsidies harm producers in other exporting countries, benefit the consumers in the rest of the world, and result in net global welfare loss.

This research contributes to the existing literature by introducing an industry model to analyze the link between targeted production subsidies and excess inventory holdings using an equilibrium displacement model approach. Furthermore, welfare distribution effects of targeted production subsidies are discussed, particularly, for treasury gains or losses associated with the changes in inventory holdings. Thus, the analysis sheds light on the welfare implications of the inventory holdings which are not addressed in the literature.

Graphical Analysis

The economics of a targeted production subsidy in a partial equilibrium setting is illustrated in figure 1. The analysis is based on certain theoretical assumptions which are also applied in the conceptual model. Following Kinnucan and Zhang (2004), these assumptions include: (a) product in question is a homogenous good; (b) supply and demand curves are linear in the relevant region; (c) policy in question is assumed to cause parallel shifts in supply and demand curves; (d) competitive market conditions hold; (e) law of one price holds in all markets; and (f) the country in question is sufficiently large in the sense that it can influence the world prices.

[4] Koo and Kennedy (2006) did not address the link between subsidy policies and inventory holdings and the welfare impacts of stocks on trade flow.

Figure 1 shows an aggregated supply curve (S), a domestic demand curve (D), an excess supply curve to the rest of the world (ES), and an export demand curve (ED). Competitive market clearing occurs at the initial world equilibrium price P with total domestic production Q_S comprising domestic consumption Q_D and exports Q_X in panel A. The domestic supply is disaggregated into unlicensed supply curve S_U and licensed supply curve S_L (where, $Q_S = Q_U + Q_L$) in panel B. When a targeted production subsidy of S per unit is introduced to the licensed producers, the licensed supply curve shifts to S_L*. The licensed producers expand the production to Q_L' as the subsidy lowers the cost of production, and, in turn, increases the market supply price of the product to P_S. The licensed producer surplus increases by the area of trapezoid PP_smk. Under the new equilibrium, unlicensed producers decrease their production to Q_U' associated with lower market price P_D. The welfare loss for unlicensed producers is depicted by the dashed area PP_shi in panel B. The aggregate impact of the targeted subsidy on total supply depends on whether the expanded production by the licensed producers is less or greater than the reduced production by the unlicensed producers. The reduced-form elasticities derived in the following section suggest that an increase in the targeted subsidy expands the aggregate production.

The production subsidy causes the domestic consumer surplus and the net foreign surplus to increase by the trapezoid PP_dec and by the lined area *cdeg*, respectively. Taxpayers finance the cost of the program illustrated with rectangle P_sP_dkn. Thus, the net change in domestic welfare[7] is equal to the sum of welfare increases for licensed producers and domestic consumers

[7] Following section presents an industry model which addresses the welfare impacts of the ending stocks on producers and domestic and global market consumers. Thus, the net welfare estimates include the

($PP_s mk + PP_d ec$), the welfare loss of unlicensed producers ($PP_s hi$), and the government outlays (rectangle $P_s P_d kn$).

Conceptual Model

The nature of the subsidy program requires the disaggregation of the domestic hazelnut production into acreage and yields because the subsidy payments are based on the planted acreages. Following Houck and Gallagher (1976), the supply equation is specified as a function of acreage and yield. Total production is calculated as the acreage multiplied by the yield. Then, the elasticity of supply is equal to the sum of acreage and yield response elasticities. This specification allows the analysis to disaggregate the total supply into licensed and unlicensed farm productions. Thus, it is useful for a clear identification of the impacts of the production subsidy provided for the licensed growers only.

Excess inventory is one of the main concerns in the domestic hazelnut market. Therefore, the Turkish government aimed to reduce the ending stocks by stimulating exports and domestic consumption via production subsidy. This study uses an industry model that accounts for beginning and ending government stocks in the hazelnut market. Following Koo and Kennedy (2006), ending inventories are expressed as a function of the market price which implicitly reflects the impact of the subsidy payments. Although an increase in the current market price reduces the consumption, it expands the production. The increased production and decreased consumption cause the ending inventories to accumulate. Thus, the price elasticity of ending inventories is positive. The targeted subsidy is expected to decrease the market price and

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treasury gains/ losses due to changes in ending inventories driven by the percentage change of subsidy payments.

increase targeted producer prices. The magnitudes of changes in quantity demanded and quantity supplied will determine the levels of ending inventory holdings.

Consider the following partial-equilibrium model for an industry that produces homogeneous products for sale in domestic and export markets:

$Q_D = D(P_D)$ (1)

$Q_X = X(P_D)$ (2)

$Q_S = \overline{Y}_L A_L + \overline{Y}_U A_U$ (3)

$A_L = A(P_L)$ (4)

$A_U = A(P_D)$ (5)

$P_L = P_D * \overline{P}_{SL}$ (6) $where\ \overline{P}_{SL} = 1 + \overline{P}_S/P_D$

$INV_E = f(P_D)$ (7)

$Q_{TS} = Q_S + \overline{INV}_B$ (8)

$Q_{TD} = Q_D + Q_X + INV_E$ (9)

$Q_{TS} = Q_{TD}$ (10)

Equations (1)-(10) present the structural model for the hazelnut industry under the competitive clearing assumption. $\overline{P}_{SL}$ is an operator for price linkage equation. The variable definitions and corresponding values are presented in Table 3. The model contains ten endogenous variables ($Q_D, Q_X, Q_S, A_L, A_U, P_L, P_D, INV_E, Q_{TS}, Q_{TD}$) and four exogenous variables[8] ($\overline{Y}_L, \overline{Y}_U, \overline{P}_S, \overline{INV}_B$). Exogenous variables other than primary interest are held constant in the model and the analysis will focus on the impacts of the land based subsidy.

Equations (1) and (2) represent the consumer demand in the domestic and export markets.

[8] Yields are treated as exogenous in the analysis based on the findings in Yavuz *et al*. (2005)

Three supply equations (3)-(5) capture the domestic production with respect to the licensed and unlicensed acreages. The price linkage equation (6) accounts for the relationship between the proportional targeted production subsidy and the price received by licensed producers. Equation (9) shows the total quantity demanded, which consists of the sum of consumer demands in domestic and export markets and the ending inventories denoted in equation (7). Market clearing is expressed in equation (10) where the total quantity demanded is equal to the total quantity supplied represented as the sum of domestic production and beginning inventories in equation (8). Table 3 contains the variable values for the effective policy period of 2009-2011.

To identify the impacts of the government intervention, the model is expressed in the percentage changes (displaced form) as follows:

$$Q_d^* = -\eta_d \, {P_D}^* \qquad (9)$$

$$Q_x^* = -\eta_x \, {P_D}^* \qquad (10)$$

Quantity supplied is specified as a function of yield and acreage in the structural form to account for the target production subsidy received by the licensed producers. Dividing the total derivative of equation (3) by total supply provides a useful percentage change form and converts the yield into a share component.

$$Q_S^* = k_L A_L^* + k_U A_U^* \qquad (11)$$

where the relative change in supply (Q_S^*) is represented by the share of licensed and unlicensed hazelnuts to total production ($k_L + k_U = 1$) and respective acreage response elasticities.

$$A_L^* = \varepsilon_L P_L^* \qquad (12)$$

$$A_U^* = \varepsilon_U P_D^* \qquad (13)$$

$$P_L^* = P_D^* + \overline{P}_{SL}^* \qquad (14)$$

$$INV_E^* = \eta_{INV} P_D^* \qquad (15)$$

$$Q_{TS}^* = k_S Q_S^* + k_B \overline{INV}_B^* \quad (16)$$

$$Q_{TD}^* = k_D Q_D^* + k_X Q_X^* + k_E INV_E^* \quad (17)$$

$$Q_{TS}^* = Q_{TD}^* \quad (18)$$

Variables with an asterisk represent percentage changes such as $Q_d^* = dQ_d/Q_d$. All parameters are in absolute value including downward sloping demand elasticities. The parameters in the displaced form are defined in table 4 with their empirical values.

Reduced-form elasticity formulas are calculated to illustrate the net effects of a percent increase in subsidy on endogenous variables, in particular, to determine the effect of a change in targeted subsidy on the net price received by licensed and unlicensed producers and the ending government inventories. Solving the equations simultaneously to yield:

$$P_D^* = -\frac{k_S\, k_L\, \varepsilon_L}{\varepsilon+\eta} \overline{P}_S^* \quad (19)$$

$$P_L^* = \frac{\varepsilon+\eta-k_S\, k_L\, \varepsilon_L}{\varepsilon+\eta} \overline{P}_S^* \quad (20)$$

$$INV_E^* = -\frac{\eta_{INV} k_S\, k_L\, \varepsilon_L}{\varepsilon+\eta} \overline{P}_S^* \quad (21)$$

where $\varepsilon = k_S\, k_L\, \varepsilon_L + k_S\, k_U\, \varepsilon_U$ and $\eta = k_D \eta_D + k_X \eta_X - k_E \eta_E$

An increase in production subsidy to licensed producers depresses the market price which raises the domestic and global market consumptions and reduces the price received by unlicensed producers. Thus, ending inventories are reduced by increased total demand and lowered unlicensed production. Conversely, the licensed producer price is positively affected by an increase in targeted subsidy. The relative effect of the production subsidy on the producer and consumer prices depends on the domestic and export market shares and corresponding price elasticities. The more elastic licensed supply causes inventories to stay at higher levels. For instance, ε_L and ε_U are perfectly inelastic in the short run. Thus, the licensed supply price rises by the amount of subsidy increase ($P_L^*/\overline{P}_S^* = 1$), but the demand price, and thus, the unlicensed producer price, is unchanged ($P_D^*/\overline{P}_S^* = 0$).

To obtain reduced-form elasticities, the EDM setting is expressed in matrix notation[9] as:

$$\Pi Y = \Gamma Z \qquad (22)$$

where Π is a 10 x 10 matrix of parameters (elasticities and shares) of endogenous variables, Y is a 10 x 1 vector of endogenous variables, Γ is a 10 x 2 matrix of parameters for exogenous variables, and Z is a 2 x 1 vector of exogenous variables. Pre-multiplying equation (22) by inverse of Π yields:

$$Y = EZ \qquad (23)$$

where $E = \Pi^{-1}\,\Gamma$ is a 10 x 1 matrix containing the reduced-form elasticities. The numerical values of parameters are assigned in order to calculate the matrix E.

Model Parameters and Welfare Measures

The existing literature provides very few elasticity estimates for hazelnuts industry. The domestic demand and inventory elasticities were obtained from Bozoglu (2009). The author estimated domestic demand and inventory elasticities as 0.32 and 0.29, respectively. Hazelnut export demand elasticity is one of the key parameters in the analysis owing to the countries large export shares. Bozoglu (2009) estimated export demand elasticity to be -0.36. Export demand elasticity for Turkish hazelnuts is recalculated in this study. The nature of the global hazelnut industry allows derivation of a formula to approximate theoretically consistent export demand elasticity. Due to Turkey's very large production and export shares in the world (approximately 75% and 80%, respectively), the analysis considers the global hazelnut market consisting of two

[9] The approach is adopted from Kinnucan and Myrland (2002, 2005).

markets, Turkey and the rest of world (ROW). Thus, Turkey's export demand elasticity is equivalent to the ROW's import demand elasticity which is calculated as -0.63. (See Appendix for formulas and computational details). The world import demand elasticity for hazelnuts ranged between -0.58 and -0.80 with an average of -0.63 during the period of 1961-2011. It is also estimated as -0.63 for the effective policy period of 2009-2011.

Yavuz *et al.* (2004) estimated price elasticity of hazelnut acreage response between the range of 0.19 - 0.23. It is expected for unlicensed farms to have a relatively more elastic acreage response in the long run since the option for growing alternative crops is more available to them than for licensed farms. Thus, unlicensed farmlands were assigned the upper range of the elasticity estimates in Yavuz *et al.* (2004). Quantity shares used in the analysis are calculated from table 3. Houck and Gallagher (1976) concluded that total supply elasticities are seriously underestimated when the yield response is ignored in the calculation. The analysis includes deterministic and stochastic simulations to address parameter uncertainty including supply elasticities used in the analysis.

Average prices and quantities for the period of 2009-2011 are used for defining an initial equilibrium. The impact of any exogenous change to the system (i.e., targeted production subsidy) is assumed to cause a parallel shift on the relevant market supply curve from the initial equilibrium.

The welfare distribution effects of an increase in production subsidy on producer groups, domestic and export market consumers, and treasury are calculated by equations (24) - (26) adopted from Kinnucan and Cai (2011).

$\Delta PS_i = PQ_{Si}(P_i^* - V_S)(1 + 0.5Q_{Si}^*)$ (24) for *i = licensed and unlicensed producers*

$\Delta CS_i = -PQ_{Di}P_D^*(1 + 0.5\,Q_{Di}^*)$ (25) for *i = domestic and export market consumers*

$$\Delta IS = -PQ_E P_D^* (1 + 0.5\, Q_E^*) \qquad (26)$$

where ΔPS_i is the change in surplus for a given producer; ΔCS_i denotes the relative change in consumer surplus in domestic and export markets; ΔIS represents the change in treasury surplus due to the potential savings from inventory reduction from increased subsidies; P, Q_S, Q_D, and Q_E are initial equilibrium values previously defined. Variables with an asterisk are the reduced-form elasticities estimated by the displacement model earlier; PQ_{Si} is the industry revenue at the farm level for a given producer; PQ_{Di} is the value of the Turkish farm exports and domestic consumption; and V_S is the relative vertical shift in the domestic supply curve due to the production subsidy. The vertical shift parameter is obtained by solving equations (11)-(14) simultaneously for P_D^* with Q_S^* set zero to yield:

$$V_S = \frac{-k_L\, \varepsilon_L}{k_L\, \varepsilon_L + k_U\, \varepsilon_U}\ \overline{P}_S^* \qquad (27)$$

Relative vertical distance $|V_S|$ identifies the vertical shift between S and S^* in figure 1 panel B. The variables in equation (27) are defined in table 4. Setting $\overline{P}_S^*$ = 0.1 and assigning the reduced-form elasticities derived from the displaced model into equations (24) - (26) yield the welfare changes for a 10 % increase in the subsidy.

Simulation Results and Discussion

The analysis includes deterministic and stochastic simulations of Equation (25). Baseline values in Table 4 are used to derive deterministic reduced-form elasticities, whereas they are considered as random variables and are assumed to follow triangular distribution in stochastic simulation. Most likely, minimum, and maximum values are required to define a triangular distribution. The baseline values are used as most likely values. The minimum and maximum values are set to 0.5

and 1.5 times the baseline values, respectively[10].

Reduced-form elasticities simulated for the preceding parameter values are presented in table 5. Results conform to the expected incidence signs. Focusing first on supply side, findings indicate that a 10 percent increase in targeted production subsidy increases licensed producer price by 8.4 percent and reduces unlicensed producer price by 1.6 percent. Accordingly, the licensed acreage increases by 1.6 percent and unlicensed acreages decreases by 0.4 percent due to a 10 percent increase in subsidy. However, total production increases by 0.8 percent because licensed acreages have a larger share of total supply (61 percent) than unlicensed acreages (39 percent).

A 10 percent increase in targeted production subsidy stimulates domestic and export market consumption by 0.5 and 1 percent, respectively. However, ending inventories are reduced by 0.5 percent since the increase in domestic and export consumption due to lower market price (1.5 percent) is greater than the increase in total production (0.8 percent).

The results of stochastic simulation suggest estimated reduced-form elasticities have expected incidence signs and are inelastic at 5 percent and 95 percent confidence limits. A 10 percent increase in targeted subsidy would decrease (increase) the market price (licensed producer price) between 1 percent and 2.6 percent (7.5 percent and 9 percent) at 5 percent and 95 percent confidence limits, respectively. Domestic (export) consumption increases by 0.3 and 0.9 percent (0.5 and 1.8 percent) at previously mentioned limits due to a 10 percent increase in subsidy, while excess inventories decline between 0.2 and 0.8 percent because the increase in total demand exceeds the change in total production.

[10] Mean values and confidence intervals are calculated from a Monte Carlo simulation of 1000 random draws using the software Simetar.

The welfare distribution effects of a 10 percent increase in targeted production subsidy are presented in Table 6. The welfare gains are split between licensed producers, domestic and foreign consumers, and the Turkish treasury due to reduced inventory holdings.

Producer welfare changes are calculated at mean values for licensed and unlicensed producers by inserting respective reduced-form elasticities and cumulative producer revenues for 2009-2011 into equation (24). A 10 percent increase in targeted production subsidy causes licensed producer surplus to increase by $74 million and unlicensed producer gain to decrease $27 million.

An increase in production subsidy depresses market price, therefore, raises the welfare of consumers in domestic and export markets. In particular, the domestic and export market consumers surplus increase by $14 million and $66 million due to a 10 percent increase in production subsidy, respectively. The result of welfare calculations for the government inventory holdings indicates that the treasury surplus increases by $14 million following a 10 percent increase in subsidy as the subsidy stimulates total consumption to a greater extent than domestic production.

The welfare distribution effects of the subsidy are computed at 5 percent and 95 percent confidence limits. The results suggest that expected incidence signs are robust to parameter uncertainty. Particularly, the licensed producer surplus ranges between $49 million and $90 million, while the welfare loss of unlicensed producers distributed from $16 million to $45 million at 5 percent and 95 percent limits, respectively. Domestic (export) market consumer surplus increases by $8 million and $22 million ($39 million and $109 million). The net welfare loss ranges between $46 million and $87 million at 5 percent and 95 percent levels, respectively. These findings suggest that the major beneficiaries from the subsidy policy are the licensed producers and foreign consumers.

Overall, the policy is expected to achieve its objectives as it improves the welfare of licensed producer and reduces the government inventories; despite it causes a net domestic welfare loss. However, the welfare loss of the production subsidy to taxpayers would have been 22 percent higher had treasury gains from reduced inventories not been considered in the welfare analysis.

Concluding Remarks

Overproduction and excess inventory accumulation are among the major concerns in storable agricultural products. A number of policy tools including, but not limited to, acreage allotments, poundage and marketing quotas, and price discrimination policies among producer groups are employed to regulate industry output and to stabilize market price in many industries (e.g., the US tobacco and peanut industries and the European Union sugar industry). Economic evaluation of governmental policies should account for the inventory structure if overproduction and excess inventory holdings are concerns of the industry in question.

This study examines the economic impacts of targeted production subsidies on producer groups, domestic and export market consumers in a large open economy where overproduction and excess inventory holdings are significant concerns for the government and the industry in question. An industry model is developed to analyze the link between targeted production subsidies and excess inventory holdings using an equilibrium displacement model approach. The Turkish hazelnut industry was selected to demonstrate welfare distribution effects of targeted production subsidies and to discuss the relationship between production subsidies and left-over stocks as the Turkish hazelnut industry is a highly relevant case to analyze this relationship.

The analysis includes deterministic and stochastic simulations to address parameter uncertainty. Simulation results indicated that expected incidence signs of reduced-form elasticities and calculated welfare effects are robust to the parameter uncertainty. In particular, an increase in targeted subsidy raises the price received by licensed producers and depressed the market price to unlicensed producers at 5 percent and 95 percent confidence limits. Total production increases because licensed acreages have a larger share of total production (61 percent) than unlicensed acreages (39 percent). However, ending inventories decline as the increase in domestic and export market consumptions (due to lower market price) is greater than the increase in total production.

Welfare gains due to an increase in subsidy payments are split between licensed producers, domestic consumers, and particularly, global consumers. Unlicensed producer as well as the treasury welfare decline following an increase in the subsidy. However, ignoring the gains from reduced inventories would exaggerate the net cost of the policy as much as 22 percent. This indicates the cost of the targeted production subsidy is less than the actual amount paid by taxpayers due to the reduction in government stocks.

Despite net domestic welfare loss, increasing targeted production subsidy will effectively accomplish the policy goals, namely, generating producer surplus to licensed producers and reducing the cost of government inventories. In addition, an increase in the targeted production subsidy decreases unlicensed acreages. This was the primary objective of the diversion payment policy which failed as the applications for diversion payments were limited to 1 percent of total unlicensed acreages.

Findings suggest that targeted production subsidies may be effective policy tools for increasing welfare of the selected producer groups and reducing inventory holdings depending on inventory, domestic and export market shares and corresponding price elasticities. The industry model introduced in this paper is a static economic model. Thus, incorporating dynamics of inventory holdings into policy analysis would be an appropriate step for future research.

Table 1.1. Hazelnut Planted Area and Production for Standard Regions (1,000 ha)

Years	I. Standard Region	II. Standard Region	Total	% Change in II. Standard Region
2000-2002	387	168	555	2.5
2003-2005	452	183	635	8.9
2006-2008	481	183	664	0
2009-2011	485	184	669	0.5

Source: Calculated from the Turkish Statistical Institute data.

Note: I. Region is mostly consists of provinces in east part of the Black Sea territory with more than 6% slope. Farmlands with less than 6% slope and that has altitude less than 750 meters considered as 2nd standard region.

Table 1.2. Major Hazelnut Producers and Exporters in the World (%)

	Production			Exports		
Country	2009	2010	2011	2009	2010	2011
Turkey	72	78	66	77	85	81
EU-27[a]	16	14	22	5	5	7
USA	7	3	5	6	5	6
Others	5	4	6	12	6	6

Source: Calculated from USDA data.

[a] Italy and Spain are hazelnut producing and exporting countries in EU-27. Spain accounts for 1% of the world exports according to International Nut Council data.

Table 1.3. Turkey's Hazelnut Industry, 2009-2011 Marketing Years

Item	Definition	2009	2010	2011	Average
P_L	Licensed producer price (USD/Kg)[a]	4.09	4.17	4.60	4.29
P_D	Consumer price (USD/Kg)	5.87	6.25	5.78	5.97
P_S	Subsidy for licensed producers (USD/Kg)	1.51	1.35	1.61	1.49
INV_B	Beginning inventories (1,000MT)	525	425	350	433
Q_S	Domestic production (1,000MT)	500	600	430	510
Q_{TS}	Total quantity supplied including beginning inventories (1,000MT)	1025	1025	780	943
INV_E	Ending inventories (1,000MT)	425	350	152	152
Q_D	Domestic consumption (1,000MT)	90	110	100	100
Q_X	Exports (1,000MT)	437	561	459	486
Q_{TD}	Total quantity demanded including ending inventories (1,000MT)	527	673	711	637
A_L	Licensed acreages (1,000 ha)	458	484	512	485
A_U	Unlicensed acreages (1,000 ha)	184	184	185	184
Y_L	Yield for licensed farms (Kg/ha)	0.66	0.74	0.52	0.64
Y_U	Yield for unlicensed farms (Kg/ha)	1.07	1.31	0.89	1.09
G	Government outlays (Million USD)	458	484	427	1369[b]

Source: Turkish Statistical Institute, USDA

Note: The marketing years start in August 1st.

Subsidy payments are converted into per kg amounts according to regional production.

[a] Producer prices excluding subsidy payments were 2.58, 2.82, and 3.00 in 2009, 2010, and 2011, respectively.

[b] The number represents the total government subsidy payments.

Table 1.4. Parameters and Baseline Values

Item	Definition	Value
η_d	Domestic demand elasticity	0.32[a]
η_x	Export demand elasticity	0.63[a,b]
η_{INV}	Ending stocks price elasticity	0.29
ε_L	Licensed acreage response elasticity	0.19
ε_U	Unlicensed acreage response elasticity	0.23
k_d	Domestic quantity share (Q_D/Q_{TD})	0.11
k_x	Export quantity share (Q_x/Q_{TD})	0.55
k_E	Ending stocks share (INV_E/Q_{TD})	0.34
k_L	Licensed production share (Y_L*A_L/Q_S)	0.61
k_U	Unlicensed production share (Y_U*A_U/Q_S)	0.39
k_S	Domestic production share (Q_S/Q_{TS})	0.54
k_B	Beginning stocks share (Inv_B/Q_{TS})	0.46

[a] Parameters are in absolute value.

[b] Calculated value based on Gopinath and Saito (2006). See the appendix for details.

Table 1.5. Reduced-form Elasticities for Targeted Production Subsidy

Endogenous Variables	Mean	5% limit	95% limit
P_D^*	-0.160	-0.095	-0.264
P_L^*	0.841	0.746	0.904
INV_E^*	-0.046	-0.079	-0.024
A_L^*	0.158	0.102	0.215
A_U^*	-0.036	-0.019	-0.065
Q_S^*	0.081	0.046	0.117
Q_X^*	0.099	0.054	0.180
Q_D^*	0.050	0.027	0.090

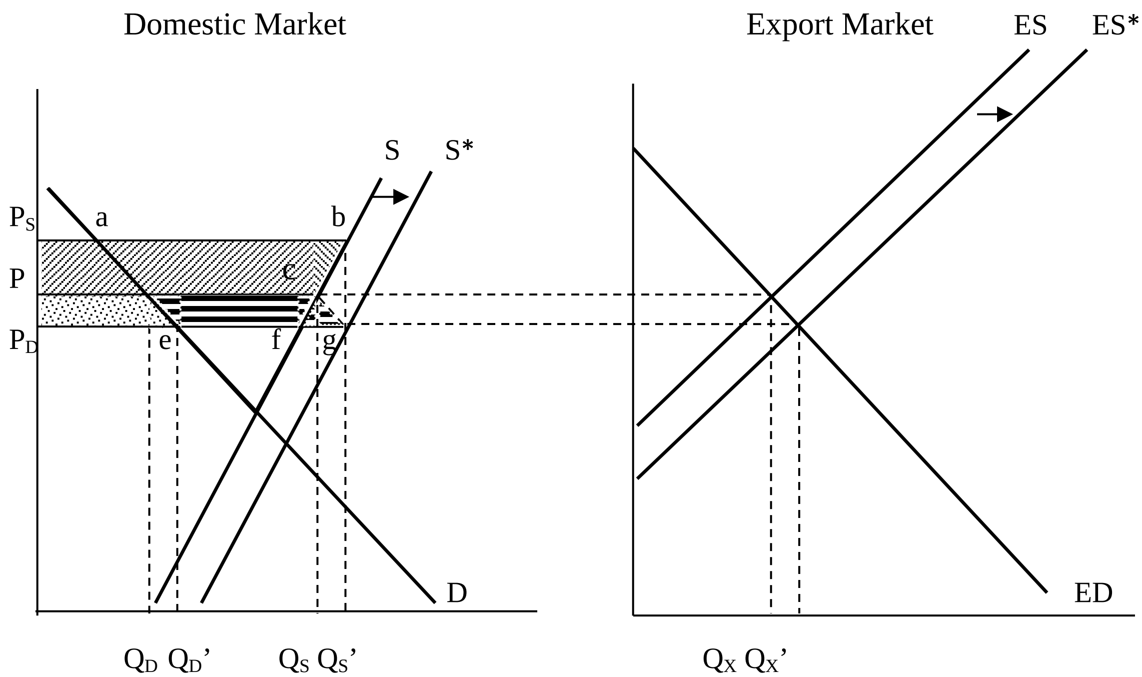
Note: Elasticities are calculated based on stochastic simulation of Equation 23. Refer to text for detailed explanations.

Table 1.6. Welfare Effects of 10% Increase in Targeted Production Subsidy (in million USD)

Item	Mean	5 % limit	95 % limit
Licensed producer gain	74	49	90
Unlicensed producer loss	27	16	45
Domestic consumer gain	14	8	22
Foreign consumer gain	66	39	109
Treasury gain from inventory reduction	14	8	23
Net domestic welfare loss	63	87	46
Inventory impact ratio (%)	22	9	50

Note: Government outlays are 137 million USD for a 10 percent increase in subsidy.

Panel A.



Panel B.

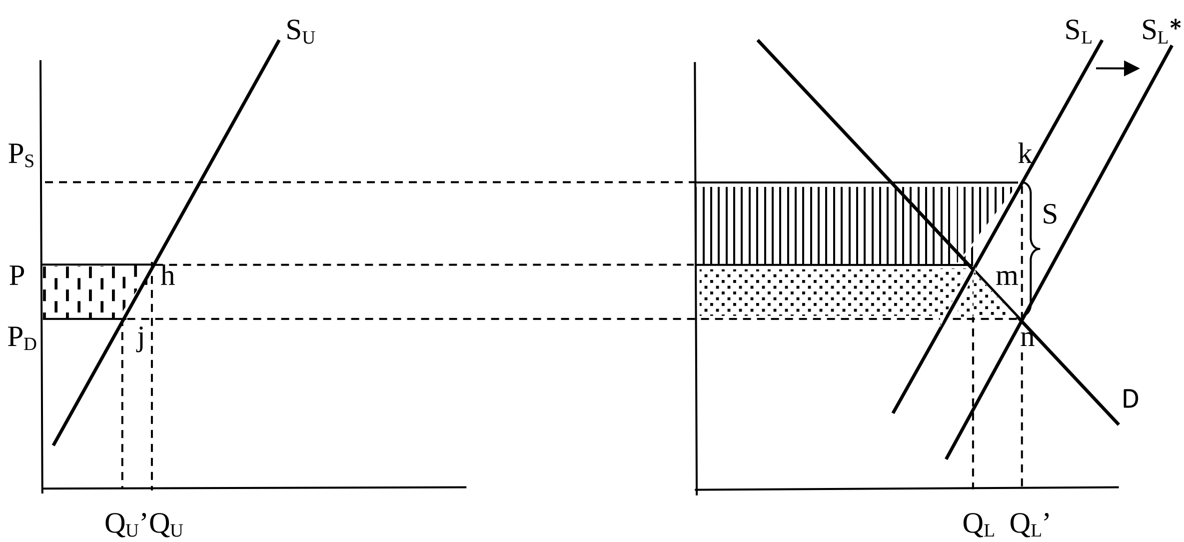


Figure 1.1. Effects of a targeted production subsidy on market price, production, consumption, and exports.

Essay 2: Food Safety Policies and Export Responses: An Outlook on Almonds and Hazelnuts in the European Union Market

Introduction

International trade has become less restricted with reductions in traditional border-related trade barriers such as tariffs and quotas, but has been significantly influenced by the regulatory standards such as sanitary and phytosanitary (SPS) measures (Disdier and van Tongeren, 2010; Wilson, 2000). The World Trade Organization (WTO) Agreement on the Application of SPS Measures recommends international standards for member countries and this agreement allows member countries to set their own standards to address their concerns about environmental protection, as well as animal, plant, and human safety as long as they are non-discriminatory between trading countries and are based on scientific justification (Josling *et al*, 2004). Although explicitly designed to achieve legitimate policy objectives, SPS measures nevertheless have the potential to impede trade to protect domestic producers by imposing fixed and variable compliance costs to foreign suppliers.

A contrasting view in the applied trade literature suggests that standards and regulations may instead have a stimulating impact on trade via supply and demand channels. The restrictive regulations may cause an expansion of export supply of an industry by promoting scale of economies or by increasing research and development investments (Maertens and Swinnen, 2008; Blind, 2004). SPS measures may also enhance consumer demand as they provide information on quality assurance and confidence in imported products (Bao and Qiu, 2012; Masakure *et al*., 2009; Disdier *et al*., 2008; Moenius, 2006; Fontagne *et al*., 2005). The trade promoting effects of stringent SPS measures are conditioned on the exporting countries' ability to cope with restrictive regulations in the relevant industry which influences competition among existing and potential exporters. Certain countries may gain a competitive advantage and increase their market shares; however, higher compliance costs may also discourage potential exporters from entering the market.

The argument between these contrasting views of food safety gets more complex with different dynamics of particular industries, regulations, and country groups. The direction of SPS measures' impact on trade is undetermined (e.g., positive or negative effect) and trade effects may vary across different industries and exporters (Bao and Chen 2013). Thus, several studies suggest a better understanding of the impacts of regulations and standards on international trade requires further rationalization and close analysis of the dynamics of particular standards, products, and countries to conclude with more reliable policy implications (Li and Beghin, 2012; Anders and Caswell, 2009; Dankers, 2007; Jaffee and Henson, 2004).

Despite the substantial body of research covering the impacts of SPS measures on trade, current literature provides very limited information about the trade determinants of the tree nut industry. The tree nut market has attracted less attention even though the industry's supply value has increased almost three-fold, reaching $33 billion, during the last decade (International Nut Council, 2014). To date, very few researchers have empirically examined the impact of national and international food safety regulations on trade flows in the tree nut market[11] (e.g., Atici, 2013; Wu, 2008; Gray et al, 2006). These studies focused on specific country evaluation for a certain aspect of food standards. The present study offers a more comprehensive theoretical and

[11] Atici (2013) investigates the effect of aflatoxin standards on quantity traded between Turkey and EU-12 countries for hazelnuts without addressing EU amendments in 2010. Wu (2008) and Gray et al (2006) study the relationship between the EU food standards and the EU-USA trade flows where the former research provides a qualitative analysis on USA's almond and pistachio industries and the latter presents a cost-benefit analysis on the U.S. federal marketing order imposing new standards for the pistachio industry.

empirical outlook on determinants of the tree-nut trade.

This article derives a micro-founded gravity trade model at the commodity level to investigate the factors affecting world exports of hazelnuts and almonds to the EU, as well as to discuss the interaction between food safety regulations, and export responses of nut producers. The analysis examines restrictions on trade, imposed by the EU sanitary measures (i.e., Aflatoxin standards), for almond and hazelnut imports, and estimates the magnitude of export changes emerging from amendments to EU food safety standards during the last decade. A major hypothesis to be investigated is whether food safety standards act as barriers or catalysts in the EU tree nut market. The hypothesis is extended to examine the effects of foodstuff regulations on exports in developing versus developed countries. Particular attention will be given to the relationship between the aflatoxin standards and existing trade, as well as new trade creation for the EU versus non-EU exporters. Further, the paper compares short-term and long term impacts of these regulations on trade flow.

The empirical findings of the present study suggest more flexible standards would significantly increase the volume of existing trade and stimulate new trade creation in developing and developed country markets. However, where such policy changes are made, new exporters will typically need a year to adapt to the changes. These findings contrast with those of a recent study by Xiong and Beghin (2012), which suggested that restrictive EU standards had no impact on groundnut exports from a group of African countries that were generally considered to be among the least developed countries in the world, according to the World Bank. Results further indicate that intra-EU trade is positively affected by the harmonization of food standards as it facilitates trade integration and reduces trade friction among the member states. Overall, the present study highlights the importance of a detailed economic analysis at the standard, product, and market levels to provide a better view of the role of food safety standards in global agricultural trade.

The paper continues with a brief review on worldwide aflatoxin regulations for tree-nuts. A summary of the characteristics of the global almonds and hazelnuts markets are presented in the next section. The following section provides an outline of the empirical framework used to analyze the impact of EU aflatoxin regulations, and also presents a description of variables and data sources used in the analysis. After the estimation results are discussed, the paper concludes with policy recommendations and a summary of findings.

A Closer Look at Worldwide Aflatoxin Regulations in Tree-nut Industry

Aflatoxins are hazardous substances produced by certain species of molds which contaminate a variety of agricultural commodities particularly common in storable crops (e.g. corn, wheat, almonds, hazelnuts, peanuts, pistachios). This group of toxins may colonize on the growing crop or during post-harvest storage with varying toxicity and frequency levels. Scientific evidence suggests Aflatoxins B1, B2, G1, and G2 are the major harmful compounds which typically exist together in foodstuffs. Among others Aflatoxin B1 is the one of the most deleterious naturally-occurring human liver carcinogen known (Bbosa et al, 2013).

Public authorities worldwide adopt regulatory standards on aflatoxin maximum residue limits (MRL) due to the adverse health effects on humans or animals and plants. MRLs are often substance, product, and country specific. At the international level, the World Health Organization (WHO) and Food and Agriculture Organization (FAO) sponsor the secretariat for the Codex Alimentarius which contains international standards of maximum allowable levels for foodstuff additives and contaminants. Codex suggests up to10 mg/kg is an acceptable limit for edible tree nuts and 15 mg/kg for tree-nuts for further processing. It is a recommended global benchmark for food standards by World Trade Organization however; countries have the right to set their own limits in presence of harmful risks. Thus, there is a wide range of limits applied for the aflatoxin standards across the nations.

Table 1 presents the total aflatoxin levels in a group of developed countries in the world. Canada, Australia, and Hong Kong adopted international standards suggested by Codex Alimentarius. USA and Japan impose 20 mg/kg, a higher MRL than the Codex. The EU has one of the strictest aflatoxin standards for food in the world that have been amended a number of times over the recent decades. Member countries maintained their national MRL for foodstuffs with a wide range from 0 to 40 mg/kg before 2002 (see Table 2). The EU set common food standard imposed for all member countries in 2002. The MRL for the total aflatoxin level were determined as 10 mg/kg and 4 mg/kg for processed and edible tree-nuts, respectively. The harmonized levels were more restrictive than Codex. Yet, harmonization relaxed the standards for the some of the member states including Germany, France, and UK as the top nuts consumers imposing more restrictive levels than prior to the harmonization. The commission made substantial adjustments on the aflatoxin standards and aligned harmonized aflatoxin levels for certain tree-nuts to the international standards in 2010 while remaining the rest unchanged. According to new regulation the MRL of total aflatoxins for shelled and edible hazelnuts, almonds, Brazil nut, and pistachios are set to 15 mg/kg and 10 mg/kg, respectively. The policy changes were reflected to import notifications for nuts products. The EU border authorities reported significant reduction of border notifications (41 percent) as regards aflatoxins in nuts and nut products in 2010 compared to the preceding year. The EU Rapid Alert System for Food and Feed (RASFF 2010) report relates this reduction to the change in aflatoxin levels for a group of tree-nuts in 2010.

Stylized Facts in the Global Hazelnut and Almond Trade

Almonds and hazelnuts are among the highly traded tree-nuts in the global markets. World production and exports for these nuts have been growing in quantity and value over the recent decades. Figure 1 depicts major almond producers in the world. The US has by far the largest production share with an increasing growing trend. The almond production has increased by 234% in quantity mainly due to the supply increases in the US between 1995 and 2013. Accordingly, world almond exports are dominated by the US which accounts for 80 percent of the total exports on average followed by the EU around with a share of 14 percent (See Figure 2). Australia and other countries have lower but increasing export shares. Overall there is a tremendous increase (450 percent) in world almond exports for the same period. Global hazelnut production has relatively modest increase of 25 percent between 1995 and 2013. Turkey is the main hazelnut supplier in the world, followed by the EU producers (Figure 3). Despite the modest increase in production, world hazelnut exports have been more than doubled (124 percent). The relatively small exporters such as the US, Georgia, Chile, and Azerbaijan have been increasing their export shares since mid-millennium, thus they have been significantly contributing to the expanding hazelnut market (See Figure 4).

The EU has been the largest market for almond and hazelnut exports for decades and EU accounts for 65 percent of world imports on average. However, world exports shift to the new markets and the share of EU has decreased by 35 percent since 1995 (see figure 5). Although the EU market expanded by around 122 percent during the same period, trade between EU exporting countries and other EU members (intra-EU trade) for almonds and hazelnuts has been surged by 232 percent.

Figure 6 presents the pattern of the intra-EU trade for the periods of pre-harmonization

(1995-2001), harmonization (2002-2009), and amendment to the international standards (2010-2013). Intra-EU trade dropped by 3 percent in the pre-harmonization period while it surged by 61 percent during the harmonization era followed by a modest increase after international standards are in effect (44 percent).

The Analytical Framework

This section presents the theoretical trade model at the product level along with the discussions on econometric specification for estimation and detailed data descriptions.

Gravity Trade Model at the Product level

Gravity trade model is defined as a reduced form equation derived from a partial equilibrium of demand and supply functions (Bergstrand, 1985, 1989). Following Peterson *et al* (2013), the paper derives a commodity specific gravity trade model for almond and hazelnut markets. Consider a commodity which is differentiated by the origin and is weakly separable in consumer demand and defined by the constant elasticity of the substitution (CES) utility function.

$$U_{ijt}^{k} = \left[\sum_{j=1} \left(\beta_{ijt}^{k}\right)^{\frac{1}{\sigma_k}} \left(c_{ijt}^{k}\right)^{\frac{\sigma_k - 1}{\sigma_k}}\right]^{\frac{\sigma_k}{\sigma_k - 1}} \qquad (1)$$

where the subscripts *i*, *j*, *t* and superscript *k* denote importer and exporter countries, year, and products, respectively. Sigma is elasticity of substitution between varieties of product *k* from different origins. β_{ijt}^{k} is the consumer preference parameter of product *k* shipped from exporter *j* to importer *i* in year *t*. c_{ijt}^{k} is the consumption of importer *i* in product k from exporter *j*. Maximizing equation 1 with respect to quantity subject to income constraint yields M_{ijt}^{k} import expenditure for product *k* exported by country *j*.

$$M_{ijt}^{k} = \frac{\beta_{ijt*}^{k}\left(p_{ijt}^{k}\right)^{1-\sigma_k} E_{it}^{k}}{{\pi_{ikt}}^{1-\sigma_k}} \quad (2)$$

where p_{ijt}^{k} is the nominal c.i.f price for product *k* originated from exporter *j* at year *t*, ${\pi_{ikt}}^{1-\sigma_k}$ is the importer *i*'s ideal price index for product *k* which equals to $\left[\sum_{j=1} \beta_{ijt}^{k}\left(p_{ijt}^{k}\right)^{1-\sigma_k}\right]^{\frac{1}{1-\sigma_k}}$.

The producer prices are linked to equation (2) by adding the pass-through equation (Baldwin and Taglioni, 2006)

$$p_{ijt}^{k} = \mu_{ij}^{k} p_{it}^{k} T_{ijt} \quad (3)$$

where μ_{ij}^{k} is mark-up between countries *j* and *i* and is assumed to equal one (Dixit-Stiglitz monopolistic competition), p_{it}^{k} is the nominal producer price, and T_{ijt} is trade cost factor for all costs required for product *k* to be sold in country *i*. Imposing market clearance equals country *j*'s total exports to the consumer expenditure across the import markets including its own expenditure and yields the equation 4 for the bilateral trade flows at the product level.

$$M_{ijt}^{k} = \frac{\beta_{ijt*}^{k}\left(T_{ijt}\right)^{1-\sigma_k} E_{it}^{k} Y_{jt}^{k}}{{\pi_{ikt}}^{1-\sigma_k} \varphi_{jkt}} \quad (4)$$

here E_{it}^{k} is expenditure of product *k* in country *i*, Y_{jt}^{k} is country *i*'s output of traded product *k*, φ_{jkt} is exporter *j*'s constant elasticity of transformation (CET) price index which equals to $\left[\sum_{i=1} \frac{\beta_{ijt}^{k}\left(T_{ijt}^{k}\right)^{1-\sigma_k} E_{it}^{k}}{{\pi_{ikt}}^{1-\sigma_k}}\right]$. Taking logarithm of both sides of the equation 4 yields:

$$\ln \mathrm{M}_{ijt}^{k} = \ln \beta_{ijt}^{k} + (1-\sigma_k) \ln T_{ijt} + \ln S_{jkt} + \ln \varphi_{jkt} + (1-\sigma_k) \ln \pi_{ikt} \quad (5)$$

where E_{it}^{k} is approximated by exporter price index[12] and S_{jkt} is domestic supply for product *k* in

[12] Feenstra (2004), Disdier and Marette (2010), and Herrera (2013) excluded GDP variables in theoretical gravity estimations. These studies suggest country specific fixed effects are more consistent alternative proxies for expenditure on products in question.

country *j*, a proxy for unobserved Y_{jt}^{k} due to limited availability of national grower prices[13].

Trade Costs and Multilateral Resistance Terms

Economics literature commonly defines trade costs as costs associated for a good to be sold to the final consumer excluding cost of production. This includes both direct and indirect measures, manmade and natural factors such as all transportation and distribution costs, border-related barriers, regulatory standards, information costs, geographical and cultural hurdles. Despite being sparsely and inaccurately available[14] trade cost data, direct measures (e.g. transportation and distribution costs, border-related barriers) can be incorporated in the trade model estimations while indirect trade costs have to be inferred. The gravity trade model provides a theoretically consistent inference by "linking trade flows to observable variables and unobservable trade costs" (Anderson and van Wincoop, 2004).

Trade cost function is assumed to behave as in Krugman's iceberg costs metaphor and is specified in multiplicative form consists of time invariant geographical and cultural proxies and time-varying policy variables. Detailed variable definitions are presented in Data section.

$$T_{ijt} = f\begin{pmatrix} Distance, Border, Colony, Landlocked, \\ Commercial\ code, Trade\ integration, Policy\ Standards \end{pmatrix} \qquad (6)$$

Anderson and van Wincoop (2003) suggest bilateral trade rests not only the absolute trade costs between nations but depends on relative trade costs approximated by the price index defined in equation 4. $\pi_{ikt}{}^{1-\sigma_k}$ is called inward multilateral trade resistance term and interpreted

[13] Other studies also incorporated domestic production in the gravity model estimation (e.g. Xiong and Beghin, 2012, Paterson et al, 2013).

[14] Anderson and van Wincoop (2004) provides a detailed survey on trade cost and sources of inaccuracy for the available trade cost data.

as "buyers' incidence" since it describes importer i's bilateral resistance on trade from exporter *j* for product *k.* $\pi_{ikt}{}^{1-\sigma_k}$is also defined as "market potential measure" (Baldwin and Taglioni, 2006; Head and Mayer, 2004). φ_{jkt} is the CET price index known as "outward multilateral resistance" term in the trade literature and interpreted as "the average seller incidence".

The gravity model in equation 5 is augmented by lagged policy variables to account for dynamic impacts of trade integration and maximum residue levels following Cheng and Wall (2005), and Olivero and Yotov (2012). The authors emphasize that the policy variables cannot fully adjust in a single year. Shepherd and Wilson (2013) further suggest that lagging the policy variables one period reduces the likelihood of endogeneity problem as they noted lagged standards are less likely to have endogenous relationship with current trade flows.

Empirical Estimation

A number of highlights are required to derive a consistent econometric estimate of the gravity model derived in the previous section. Baldwin and Taglioni (2006) summarize frequent mistakes in gravity estimations and provide theoretically elegant solutions under their well-known "medals" metaphor. Excluding the multilateral resistance terms from the estimation equation creates inconsistent results due to the correlation between omitted terms and the trade cost parameters which directly enter into φ_{jkt} and $\pi_{ikt}{}^{1-\sigma_k}$ (Gold medal mistake). Hence, the econometric specification contains time, product, exporter, and importer fixed effects to approximate the unobserved resistance terms (Keith, Mayer, and Reis, 2010; Haq, Meilke, and Cranfield, 2012). The analysis further adopted country-pair fixed effects in the estimation to account for the potential endogeneity problem for policy variables such as trade integration agreements and food safety standards a method suggested by Baier and Bergstand (2007) and

Anderson and Yotov (2011). Un-deflated direction specific trade values are used as a dependent variable in order to address potential biases called “silver” and “bronze” medal mistakes by the recent trade literature.

Several leading research points out the importance of the appropriate treatment for zero trade values, particularly the case in the highly-disaggregated trade data[15]. The main concern is the systematic selection bias due to the endogenous zero trade values caused by unobserved trade costs. For instance, countries having high trade barriers are more likely to have zero bilateral trade. Following Helpman, Melitz, and Rubinstein (2008) and Santos Silva and Tenreyro (2006,2010), the present study employs the two main stream specifications, Heckman two stages procedure and Poisson pseudo maximum likelihood (PPML) regression model, for comparison and robustness purposes.

Santos Silva and Tenreyro (2006) pioneered a conventional method of PPML which offers a variety of desirable properties such as consistent estimates of non-linear gravity models with the presence of fixed effects; ability of incorporating zero values in the estimation; efficient address of the inherent heteroskedastic trade relations. However, Burger *et al* (2009) argues PPML estimates would be biased in the case of over-dispersed trade data which has a large number of zero trade values with having a higher variance than the mean. Equation 7 is estimated by PPML approach to quantify the determinants of bilateral trade in almond and hazelnut industries.

[15] See Santos-Silva and Tenyero (2006) and Helpman, Melitz, and Rubinstein (2008) for a detailed discussion of consistent treatment of zero trade values.

$$E(M_{ijt}^{k}|X_{ijt}^{k}) = \exp\left[\alpha_0 + \alpha_1 \ln Dist_{ij} + \alpha_2 \ln S_{jkt} + \alpha_3 MRL_{ikt} + \alpha_4 \text{lag}(MRL)_{ikt} + \alpha_5 Colonial_{ij} + \alpha_6 Landlocked_{ij} + \alpha_7 Brdr_{ij} + \alpha_8 Intg_{ijt} + \alpha_9 lag(Intg)_{ijt} + \alpha_{10} Ccode_{ij} + \alpha_{11} Euexp_{ij} + \alpha_{12} MRL * HZL + \gamma_{ij} + \gamma_i + \gamma_j + \gamma_t + \gamma_k\right]\varepsilon_{ijt}^{k} \quad (7)$$

where X_{ijt}^{k} is the matrix of all independent variables under consideration, $Dist_{ij}$ is the bilateral geographical distance, S_{jkt} is the domestic production of exporting country *j* at time *t*, MRL_{ikt} is the policy variable for food safety standards (in levels) imposed by the destination country *i* at year *t*, $Colonial_{ij}, Landlocked_{ij}, Brdr_{ij}, Intg_{ijt}, \alpha_9 Ccode_{ij}$ are dummy variables which equal 1 if the country share a common language, colonial ties, common border, common trade agreement, and same commercial codes, respectively. $Euexp_{ij}$ is an indicator variable which accounts for intra-EU trade after harmonization. MRL*HZL is an interaction term measures the relative impact of food safety standards on hazelnut trade. γ_i, γ_j, γ_t, and γ_k are importer and exporter country specific dummies, time and product fixed effects that account for the outward and inward multilateral trade resistance in the order of appearance. γ_{ij} denotes trading country-pair dummies.

Helpman, Melitz, and Rubinstein (2008) developed a two stage estimation model for international trade with heterogeneous firms. The model accounts for zero trade values and provides an additional aspect on the relationship between trade determinants and existing and new trade creation separately. The model predicts the impact of the trade barriers on the propensity to new trade creation (extensive margin) in the first stage and describes the relationship between the intensity of existing trade flows (intensive margin) and the explanatory variables in the second. A potential challenge of two stage estimation methods is to identify a proper exclusion restriction that has impact on the decision to trade but not correlated with the intensive margin equation.

Heckman two stage maximum likelihood procedure is applied to Equation 8. All variables are included in selection and outcome equations except the commercial codes of each country ($Ccode$) is the excluded variable in the outcome equation. $Ccode$ is assumed to be a fixed factor in firms cost function as the firms bear the cost of compliance to the import market commercial codes that does not depend on the quantity of the exports.

$$\ln \mathrm{M}_{ijt}^{k} = \delta_0 + \delta_1 \ln Dist_{ij} + \delta_2 \ln S_{jkt} + \delta_3\, MRL_{ikt} + \delta_4 \,\mathrm{lag}(\,MRL)_{ikt} + \delta_5 Colonial_{ij} + \delta_6 Landlock_{ij} + \delta_7 Brdr_{ij} + \delta_8 Intg_{ijt} + \delta_9 lag(Intg)_{ijt} + \delta_{10} Ccode_{ij} + \delta_{11} Euexp_{ij} + \delta_{12} MRL * HZL + \gamma_i + \gamma_j + \gamma_t + \gamma_k + \varepsilon_{ijt}^{k} \quad (8)$$ [16]

Both specifications are estimated with robust standard errors accounting for arbitrary patterns of heteroscedasticity. The error terms are clustered and allowed to correlate within trading country pairs to avoid the understated standard errors (Moulton, 1990). Equation 8 is estimated for developed and developing country samples in order to address the impact of food safety standards on different country groups.

Data Descriptions

The product–line gravity models are estimated for the hazelnut and almond industries at the six digits level of Harmonized System (HS-6) during the period of 1995-2013 which includes three stages of EU regulations; pre-harmonization, harmonization, and alignment with Codex standards. The trading partners consist of major exporters of hazelnut and almonds and EU-28, Switzerland, Norway as importers. Table 3 provides the list of developed and developing

[16] Country-pair dummies are excluded in the Heckman selection model estimation due to conversion problems.

exporting countries included in the analysis. The central policy variable of interest (MRL) is incorporated in levels (part per billion) for each importer country. FAO 2003 survey reveals that majority of recent EU member states adopted harmonized standards before officially joining the union except Malta and Slovakia which imposed 4 ppb and 20 ppb, respectively.

Commodity specific policy and trade data are preferred for the empirical analysis to account for the well-known discussion on aggregation bias which assumes identical substitution elasticities and trade costs across industries. In their seminal work, Anderson and van Wincoop (2004) suggest researchers should select "sufficiently disaggregated levels at which firms truly compete." Carrere and de Melo (2011) confirm that gravity estimations provide explicit policy implications "at the most disaggregated product level possible."[17]

In addition, despite having lack of generalization, employing direct maximum residue levels provides more reliable industry specific policy implications as they are clearly defined and characterize the relative importance of the standards on trade versus other non-tariff measures such as count and frequency indexes that suffer from the aggregation of various policies having heterogeneous impacts (Li and Beghin, 2012; Chen and Novy, 2011). For instance, the EU border data reveals that majority of the rejections (94 percent) for nut products is due to mycotoxins between 2002 and 2008 (Henson and Olale, 2010). Among others, the Food and Agriculture Organization 2004 (FAO) report addresses the aflatoxin regulations as the primarily important factor in the global nut trade.

Detailed variable definitions and descriptive statistics are presented in Table 4 and 5, respectively. Summary statistics reveal that 51 percent of the dependent variable has zero trade

[17] Chen and Novy (2011) offer the analysis of trade barriers at the highly disaggregated levels as an important future research.

values as expected in highly disaggregated trade analysis. The large difference between the mean and the standard errors of imports indicates the over-dispersion problem in PPML estimations.

Data for bilateral trade values comes from UN COMTRADE. The database allows estimating the policy effects as it provides edible and shelled hazelnut and almond trade data separately. The harmonized system codes used for the data are 080211, 080212, 080221, and 080222 for edible and shelled almonds and hazelnuts, respectively.. Domestic production statistics is obtained from FAOSTAT. The MRL data are collected from European Commission Regulations No. 466/2001 and No. 165/2010 and the survey of worldwide regulations for mycotoxins in food and feed (FAO, 1995 and 2004). Geographical and cultural variables (common border, distance, colonial ties, and land-locked) are extracted from the CEPII database. Quality of Governments database provides the commercial codes for each country. Finally, trade integration data comes from the NSF-Kellogg Institute Data Base on Economic Integration Agreements updated with world trade organization trade agreements dataset.

Econometric Results and Discussion

Gravity trade equations 7 and 8 are estimated by PPML and Heckman ML to quantify the determinants of bilateral trade in the almond and hazelnut industries[18]. Table 6 presents the estimation results obtained with time, product, origin, and destination specific fixed effects. The first column shows PPML estimation results. Columns 2-3 list the Heckman ML coefficients for

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[18] The PPML and Heckman models were re-estimated after dropping the lagged policy and trade agreement variables. The resulting parameters, presented in Table A2, did not vary significantly from the estimations reported in Table 6.

outcome and selection equations. The corresponding marginal effects are presented in columns 4-5. All statically significant variables have expected signs, according to economic priors in both specifications, with the exception of contiguity in PPML. PPML coefficients are directly interpreted as trade elasticities with respect to corresponding variables. However, marginal effects are computed for Heckman ML model to identify the magnitude of the impact of variables on bilateral trade flows. Marginal effects are estimated by taking the average of the marginal effects for each individual values. Corresponding standard errors are calculated using delta method. The statistically significant correlation and selection coefficients in the Heckman ML estimations imply that addressing zero trade values is required to obtain unbiased estimates of gravity models.

Commercial codes: The selection equation contains an excluded variable that is only associated with the fixed trade cost of new partnerships, and is thus excluded from the outcome equation. The commercial code variable is positive and statistically significant at a 1 percent level. Countries with the same commercial codes are 8 percent more likely to establish new trade partnerships than those with different commercial codes.

Maximum residue levels: The coefficients for the food policy variables have positive and statistically significant effects on bilateral hazelnut and almond imports in all specifications. The coefficient for MRL estimated by PPML (column 1 in Table 6) suggests relaxing food standards by 1 ppb results in a 2.2 percent increase in bilateral imports in the current year. The combined change is a 2.6 percent increase, once the exporter countries adopted new regulations. The Heckman ML approach allows for the decomposition of the policy impacts for new trade creation and intensity of existing trade. Despite having a statistically significant positive effect on the extensive margin, the change in standards has a relatively larger impact on existing exporters. Conditional marginal effects, (i.e., $E(Trade|z > 0)$), reported in columns 4 and 5 of Table 6, indicate that a 1 ppb increase in MRL results in an approximate 0.2 percent increase in existing trade, while the increase is only 0.01 percent for the extensive margin. The statically significant lagged-MRL variable in selection equation (Table 6, column 3) suggests that food safety standards have a dynamic structure and that it requires additional time for new exporting countries to adjust to the updated standards. Overall, less restrictive food standards have a limited impact on potential producers in terms of initiating new exports to the EU markets.

Domestic production: The coefficient estimates for domestic production are positive and significant at a 1 percent level with similar magnitudes across all methods of estimation, suggesting domestic production capacity is a key determinant of the international hazelnut and almond trade. The trade elasticity with respect to production is 1.11 for local producers that are currently exporting to the EU markets; whereas, it is highly inelastic (0.11) for new entrants. This implies more abundant supply leads to more exports from existing traders than new entrants in the EU markets. For instance, holding other factors constant, a 10 percent increase in domestic supply results in a 12 percent increase in bilateral trade between the existing trade partners, while increasing the probability of trade by 1 percent for new exporters in the EU markets.

Geographical and cultural barriers: Bilateral distance is the only trade impeding geographical factor that has statistically and economically significant estimates in both specifications. The estimated elasticities by the Heckman ML indicate a 1 percentage change in bilateral distance alters existing imports by 0.5 percent and the probability of new partnership by 0.08 percent. Countries sharing a common border tend to trade more than those that are not contiguous, as expected, in the Heckman model. The coefficient for landlocked countries is negative and statistically significant at a 5 percent level, suggesting that being a landlocked partner deteriorates existing trade by 17 percent.

Intra-EU trade and trade integration: The statistically significant coefficient for the EU exporter variable in the Heckman model indicates that EU harmonization policies foster intra-EU trade, as harmonizing standards is expected to reduce trade friction by removing SPS differences and integrating markets. This finding is in agreement with the findings of de Frahan and Vancauteren (2006) who argue that EU harmonization policies have positive impact on intra-EU trade in the food sector. Following harmonization, existing EU exporters tend to trade 44 percent more than during pre-harmonization era, while new trade partnerships are 11 percent more likely to be established after harmonization, holding other factors constant. Trade integration variable accounts for countries that have either a free trade agreement or custom or economic unions. The coefficients of trade integration are only statistically significant for lagged values in the selection equation in the Heckman ML model. This would imply the trade integration enhance new trade establishment following the initial year of trade agreement.

Developed versus Developing countries: The Heckman ML specification (equation 8) is estimated for subsets of developed and developing countries in effort to identify the impact of food safety standards on different country groups. Table 7 and Table 8 present the estimation results, including average marginal effects in existing trade and new trade partnership equations for developing and developed countries, respectively. The policy variable coefficients in both estimations confirm that food safety standards are an economically important factor in the hazelnut and almond trade.

The positive and statistically significant coefficients for policy variables, in both selection and outcome equations suggest developed country exporters experience a less negative impact where stricter regulations are in place. A 1 ppb decrease in maximum residue levels decreases existing trade from exporters in developed countries by 1 percent, and new trade establishments by only 0.1 percent. Whereas, the trade impediment due to a 1 ppb decrease in MRL reduces developing country exports from developing countries by 1.6 percent. Therefore, the relatively large magnitude of the impact of MRL on exporters in emerging economies indicates that trade in developing countries is more sensitive to changes in SPS measures.

Hazelnut versus Almonds: The interaction variable for hazelnuts and MRL is included in the gravity estimations in order to address the impact of food safety standards on different products. The negative and statistically significant coefficient in the outcome equation suggests less restrictive food safety standards increases almond trade to a greater extent than the hazelnut trade. In other words, a 1 ppb increase in maximum residue levels results in expansion in existing almond trade, which is 8 percent greater than hazelnut exports to the EU.

Marginal effects at representative values: As previously stated, the hazelnut and almond markets are highly concentrated with a dominant producer country followed by some small-scale suppliers. Marginal effects for the outcome and selection equations are estimated at 10^{th}, 50^{th} and 90^{th} percentiles in effort to examine how the effects of explanatory variables vary with the size of the suppliers. Findings reported in Table 9 suggest that policy variables, domestic production, and natural trade barriers have a larger impact on dominant suppliers than other exporters in terms of absolute values. However, the estimated marginal effects of trade determinants on suppliers do not significantly vary depending on the size of the supplier. For instance, large-scale suppliers are 8 percent more negatively affected by the stringent food regulations compared to the small size exporters. Geographical distance has the largest variance between producers in 10^{th} and 90^{th} percentiles. Bilateral distance reduces exports from major producer countries by 18 percent more than the trade from small-scale producers.

Concluding Comments

A theoretically consistent reduced form gravity model is derived at the product level to evaluate commodity specific trade flow and is applied to the hazelnut and almond markets in effort to examine the factors affecting world exports to the EU. The model is estimated for panel data that covers hazelnut and almond exports to the EU-28, Switzerland, and Norway from 1995 to 2013.

The paper contributes to the current literature by addressing a variety of important aspects of trade determinants in rapidly expanding hazelnut and almond markets. The relationship between domestic production factors, natural and manmade trade barriers, and bilateral imports are investigated in a dynamic setting. Particularly, the discussion of the role of specific food safety standards (i.e., EU aflatoxin standards) on world almond and hazelnut exports is revisited to determine the intensity of existing trade and new trade partnerships in developing versus developed countries affected by these standards. The study also examines the impact of the harmonization of food standards on intra-EU trade flow. Because the hazelnut and almond industries are highly concentrated markets, marginal effects of trade factors are estimated to evaluate differences in trade structure between large and small-scale suppliers.

Additionally, the scarcity of over-identification variables that have an impact on the decision to trade, but are not correlated with the intensive margin equation in two stage estimation models, is a challenging matter in empirical estimations. The paper introduces commercial codes for countries as a potentially successful excluded variable in gravity estimations.

Findings suggest less restrictive aflatoxin standards significantly increase the volume of existing trade and new trade creation in all estimates for the hazelnut and almond industries. Results further indicate that harmonization of food standards promotes market integration and intra-EU trade as EU exporters increase their trade with other member states in comparison to trade during the pre-harmonization period.

Contrary to the suggestions in literature that food safety standards have an insignificant or positive effect on developed countries (i.e., Anders and Caswell, 2009; Disdier, Fontagne, and Mimouni, 2008), the analysis indicates restrictive SPS measures have a significant and negative impact on exporters from developed country in hazelnut and almond markets. Furthermore, the magnitude of the impact of stringent standards was greater (more negative) for exports from emerging economies. These findings also contrast with those of a recent study by Xiong and Beghin (2012), which suggested that restrictive EU standards had no impact on groundnut exports from a group of African countries that were largely classified as among the least developed countries in the world, according to the World Bank.

The estimated marginal effects of trade determinants on suppliers did not significantly vary depending on the size of the supplier, with limited variability in effect between suppliers in the 10th and 90th percentiles, respectively. The impact of the explanatory variables varied by less than 10 percent between large and small-size suppliers, except for the geographical distance between trading partners, which showed an 18 percent decrease in trade for large producers relative to smaller producers.

Overall, this research provides a comprehensive analysis of the role of food safety standards, as well as domestic production factors, and natural and manmade trade barriers on world hazelnut and almond export to EU markets. These findings imply that global tree-nuts trade would significantly expand if the EU harmonizes its food standards at the international level for other tree-nut products. The results of this study should be considered in the establishment of new policies for other tree-nut industries (e.g. walnuts, cashews, and pecans) as, to date, the EU's food standards remain unchanged at more restrictive levels than international standards.

Table 2.1. Worldwide Aflatoxin Standards for Tree-nuts

Country	Processed* (mg/kg)	Edible nuts* (mg/kg)
Australia	15	15
Canada	15	15
Hong-Kong	15	15
Japan	20	20
USA	20	20
International Standards (Codex)	15	10
EU-2002	10	4
EU-2010**	15	10
Switzerland and Norway***	EU	EU

*Total aflatoxin levels for Aflatoxins (B1,B2,G1,G2)

**Maximum residue limits for hazelnut, almond, Brazil nut, pistachio

***Countries following EU standards

Table 2.2. Total Aflatoxin levels for Tree-Nuts in European Countries before 2002

IMPORTER	B1,B2,G1,G2
Austria	5
Belgium	10*
Switzerland	5
Germany	4
Denmark	4
Spain	10
Finland	5
France	2*
England	4
Ireland	30
Italy	10
Netherland	10*
Portugal	40*
Sweden	5
Greece	10
Cyprus	5
Bulgaria	5
Czech Rep.	10
Hungary	10*
Poland	0
Romania	0
Norway	5

Source: FAO (1995)

* Total aflatoxin levels derived from reported B1 levels.

Table 2.3. Average Export Shares of Major Hazelnut and Almond Exporters Included in the Analysis, 1995-2013

Hazelnut	World Share (%)	Almond	World Share (%)
Turkey	74.28	**USA**	**77.69**
Italy	**9.35**	**Spain**	**13.14**
USA	**5.28**	**Australia**	**2.89**
Georgia	4.55	**Italy**	**1.71**
Azerbaijan	3.01	Chile	1.29
Spain	**1.72**	Turkey	0.93
France	**1.34**	China	0.03

Note: Countries in bold characters are classified as developed economies according to WTO.

Source: Author's own calculation from UN Comtrade data.

Table 2.4. Variable definitions

Imports **(M_{ijt}^{k}):** annual bilateral import values (in nominal USD) for each product between exporter *j* and importer *i* (in logs).

MRL*:* importers' maximum acceptable limits for harmful substance (aflatoxins) measured in parts per billion.

Supply (S_{jkt})*:* annual hazelnut and almond production (in metric tons) in an exporting country (in logs)

Distance ($dist_{ij}$): the weighted distance based on the country population (in km) between importer *i* and exporter (in logs).

Border ($brdr_{ij}$): a binary variable that equals one if importer *i* and exporter *j* are neighbors that meet a common physical boundary, and zero otherwise.

Landlocked: a binary variable that equals one if both exporting country *j* and importing country *i* have no coastline or direct access to sea, and zero otherwise.

Colonial-ties: a binary variable that equals one if country *j* and country *i have past colonial link*, and zero otherwise.

Commercial code ($ccode_{ij}$)**:** a binary variable that equals one if the importing country *i* and exporting country *j* share the same legal origin for their company laws, and zero otherwise. There are five commercial codes across the globe (i.e., English Common Law, French Commercial Code, Socialist/ Communist Laws, German Commercial Code, Scandinavian Commercial Code).

EU Exporters**:** a binary variable that equals one if the exporting country *i* is an EU member and the year is greater than 2001, and zero otherwise.

Table 2.4. Cont'd

***Trade agreement ($Intg_{ijt}$)*:** a binary variable that equals one if exporting country *j* and importing country *i* belong to a common regional trade agreement (i.e. Free trade agreement, Custom or economic union), and zero otherwise. Preferential trade agreements are assigned as zero.

***MRL*HZL*:** is an interaction term between the binary variable for hazelnuts and maximum residue levels.

Table 2.5. Descriptive Statistics

Variables	N	Mean	Std. Dev.	Min	Max
Imports (million $)	15238	2.32	16.71	0	432
Distance (km)	15238	4995	4547	474	17625
Production (thousand tons)	15238	155	1.47	2.8	1842
MRL (ppb)	14258	8.68	6.17	0	40
Colonial ties	15238	0.04	0.18	0	1
Landlocked	15238	0.10	0.30	0	1
Border	15238	0.05	0.22	0	1
Trade agreement	15238	0.41	0.49	0	1
EU Exporters	15238	0.22	0.41	0	1
Commercial code	15238	0.25	0.43	0	1

Note: The dependent variable has 7450 positive observations. MRLs for Croatia, Estonia, Latvia, Lithuania, Malta, Slovakia, and Slovenia are missing before 2002.

Table 2.6. Gravity Estimates of Impact of the EU Aflatoxin Regulations on Hazelnut and Almond Trade Flows, 1995-2013

	PPML	**Heckman ML**			
		Coefficient estimates		Marginal effects	
Dependent Variable	Imports (1)	ln(Imports) (2)	Selection (3)	ln(Imports) (4)	Selection (5)
ln(Distance)	-1.532**	-0.653**	-0.308**	-0.470**	-0.083**
	(0.67)	(0.29)	(0.15)	(0.23)	(0.04)
ln(Production)	1.235***	1.349***	0.397***	1.114***	0.107***
	(0.08)	(0.05)	(0.03)	(0.05)	(0.01)
MRL	0.204***	0.175***	0.025***	0.160***	0.007***
	(0.03)	(0.03)	(0.01)	(0.03)	(0.00)
Lagged-MRL	0.043***	0.014	0.019***	0.002	0.005***
	(0.01)	(0.01)	(0.01)	(0.01)	(0.00)
Land-locked	0.377	-0.851**	-0.126	-0.776**	-0.034
	(0.41)	(0.43)	(0.16)	(0.39)	(0.04)
Colonial-ties	0.425	-0.184	-0.405	0.057	-0.109
	(0.46)	(0.36)	(0.27)	(0.26)	(0.07)
Border	-1.068*	1.250***	0.639**	0.870***	0.172**
	(0.62)	(0.32)	(0.27)	(0.28)	(0.07)
Trade agreement	0.318	0.142	-0.008	0.146	0.002
	(0.34)	(0.29)	(0.11)	(0.29)	(0.03)
Lagged- Trade agreement	-0.463***	0.226	0.238**	0.085	0.064**
	(0.15)	(0.22)	(0.11)	(0.21)	(0.03)
Commercial code	2.148***	-	0.285***	-	0.077***
	(0.35)		(0.09)		(0.02)
EU Exporters	0.732	0.588**	0.372***	0.367	0.100***
	(0.52)	(0.26)	(0.11)	(0.23)	(0.03)

MRL*HZL	0.038	-0.076***	0.006	-0.079***	0.002
	(0.02)	(0.02)	(0.01)	(0.02)	(0.00)
Estimated corr. coeff.		0.864***			
		(0.03)			
Estimated corr. coeff.		0.462***			
		(0.07)			
N	12898	13456			
R^2	0.71				

Standard errors in parentheses.***, **, and * indicate significance at 1%, 5%, and 10% levels, respectively. Time, exporter, importer, and product fixed effects are not reported.

Table 2.7. Gravity Estimates of Impact of the EU Aflatoxin Regulations on Developing Country Exports, 1995-2013

	Heckman ML			
	Coefficient estimates		Marginal effects	
Dependent Variable	ln(Imports) (2)	Selection (3)	ln(Imports) (4)	Selection (5)
ln(Distance)	-1.897*** (0.72)	-0.521* (0.31)	-1.375** (0.59)	-0.140* (0.08)
ln(Production)	1.012*** (0.26)	0.509*** (0.14)	0.502** (0.24)	0.137*** (0.04)
MRL	0.205*** (0.06)	0.050*** (0.01)	0.155*** (0.05)	0.013*** (0.00)
Lagged-MRL	0.022 (0.02)	0.015 (0.01)	0.007 (0.02)	0.004 (0.00)
Land-locked	-0.255 (0.47)	-0.184 (0.19)	-0.070 (0.41)	0.050 (0.05)
Colonial-ties	0.461 (0.95)	0.085 (0.40)	0.376 (0.75)	0.023 (0.11)
Border	-2.297** (1.07)	-0.931* (0.49)	-1.364* (0.86)	-0.250* (0.13)
Trade agreement	0.481 (0.45)	0.098 (0.17)	0.382 (0.45)	0.026 (0.05)
Lagged- Trade agreement	-0.069 (0.26)	0.177 (0.15)	0.246 (0.27)	0.048 (0.04)
Commercial code	-	0.184* (0.10)	-	0.050* (0.03)
Estimated corr. coeff.		0.682*** (0.14)		
Estimated selection coeff.		0.909*** (0.05)		
N	5844			

Standard errors in parentheses. ***, **, and * indicate significance at 1%, 5%, and 10% levels, respectively. Time, exporter, importer, and product fixed effects are not reported.

Table 2.8. Gravity Estimates of Impact of the EU Aflatoxin Regulations on Developed Country Exports, 1995-2013

	Heckman ML			
	Coefficient estimates		Marginal effects	
Dependent Variable	ln(Imports) (2)	Selection (3)	ln(Imports) (4)	Selection (5)
ln(Distance)	-0.269 (0.38)	-0.312 (0.20)	-0.143 (0.33)	-0.081 (0.05)
ln(Production)	1.204*** (0.08)	0.429*** (0.03)	1.031*** (0.07)	0.111*** (0.01)
MRL	0.105*** (0.03)	0.016** (0.01)	0.099*** (0.03)	0.004** (0.00)
Lagged-MRL	0.011 (0.01)	0.022*** (0.01)	0.003 (0.01)	0.006*** (0.00)
Colonial-ties	0.398 (0.36)	0.190 (0.35)	0.321 (0.28)	0.049 (0.09)
Border	1.827*** (0.33)	1.114*** (0.30)	1.377*** (0.31)	0.287*** (0.08)
Trade agreement	-0.134 (0.38)	0.078 (0.15)	0.165 (0.38)	0.020 (0.04)
Lagged- Trade agreement	0.485* (0.27)	0.253 (0.16)	0.382 (0.26)	0.065 (0.04)
Commercial code	-	0.088* (0.05)	-	0.023* (0.01)
Estimated corr. coeff.		0.367*** (0.07)		
Estimated selection coeff.		0.834*** (0.03)		
N		7612		

Standard errors in parentheses.***, **, and * indicate significance at 1%, 5%, and 10% levels, respectively. Time, exporter, importer, and product fixed effects are not reported. Landlocked was omitted in the estimation.

Table 2.9. Average Marginal Effects at Representative Values by Export Country Supply Size

	Ln (Imports)			Selection		
Dependent Variable	10th (1)	50th (2)	90th (3)	10th (4)	50th (5)	90th (6)
ln(Distance)	-0.481** (0.22)	-0.513** (0.23)	-0.589** (0.25)	-0.080** (0.04)	-0.092** (0.05)	-0.072** (0.04)
ln(Production)	1.061*** (0.05)	1.101*** (0.05)	1.200*** (0.04)	0.103*** (0.01)	0.119*** (0.01)	0.094*** (0.00)
MRL	0.109*** (0.02)	0.111*** (0.02)	0.118*** (0.02)	0.007*** (0.00)	0.009*** (0.00)	0.007*** (0.00)
Lagged-MRL	0.001 (0.01)	0.001 (0.01)	0.006 (0.01)	0.005*** (0.00)	0.006*** (0.00)	0.005*** (0.00)
Land-locked	-0.708* (0.38)	-0.721* (0.38)	-0.753* (0.40)	-0.034 (0.04)	-0.039 (0.05)	-0.030 (0.04)
Colonial-ties	0.082 (0.24)	0.041 (0.25)	-0.059 (0.29)	-0.106 (0.07)	-0.122 (0.08)	-0.095 (0.06)
Border	0.764*** (0.28)	0.830*** (0.28)	0.989*** (0.28)	0.167** (0.07)	0.192** (0.08)	0.151** (0.06)
Trade agreement	0.142 (0.30)	0.141 (0.30)	0.149 (0.30)	-0.002 (0.03)	-0.003 (0.03)	-0.002 (0.03)
Lagged-Trade agreement	0.036 (0.22)	0.060 (0.22)	0.112 (0.21)	0.062** (0.03)	0.072** (0.03)	0.056** (0.03)
Commercial code	-	-	-	0.075*** (0.02)	0.086*** (0.03)	0.068*** (0.02)
EU Exporters	0.319 (0.23)	0.356 (0.23)	0.449 (0.24)	0.097*** (0.03)	0.112*** (0.03)	0.088*** (0.03)

Standard errors are calculated by Delta method and reported in parentheses.

***, **, and * indicate significance at 1%, 5%, and 10% levels, respectively

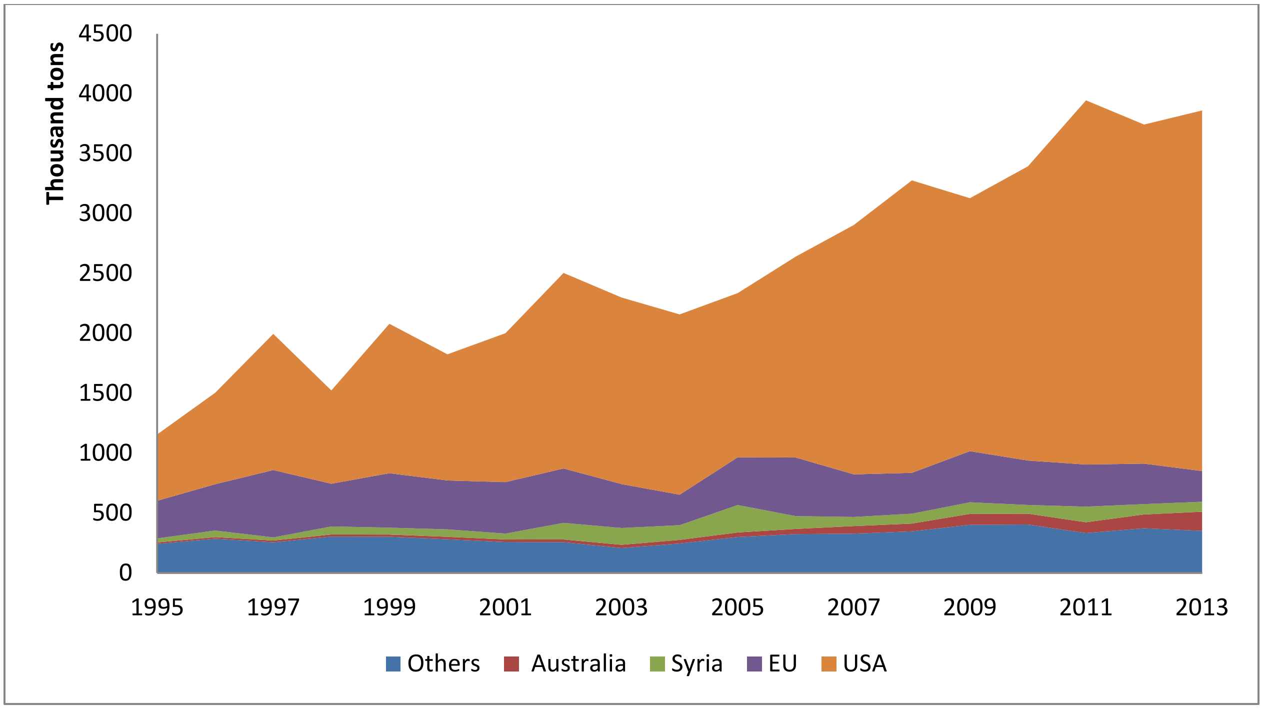

Figure 2.1. World Almond Production (in MT)

Source: Author’s own calculation from FAOSTAT database.

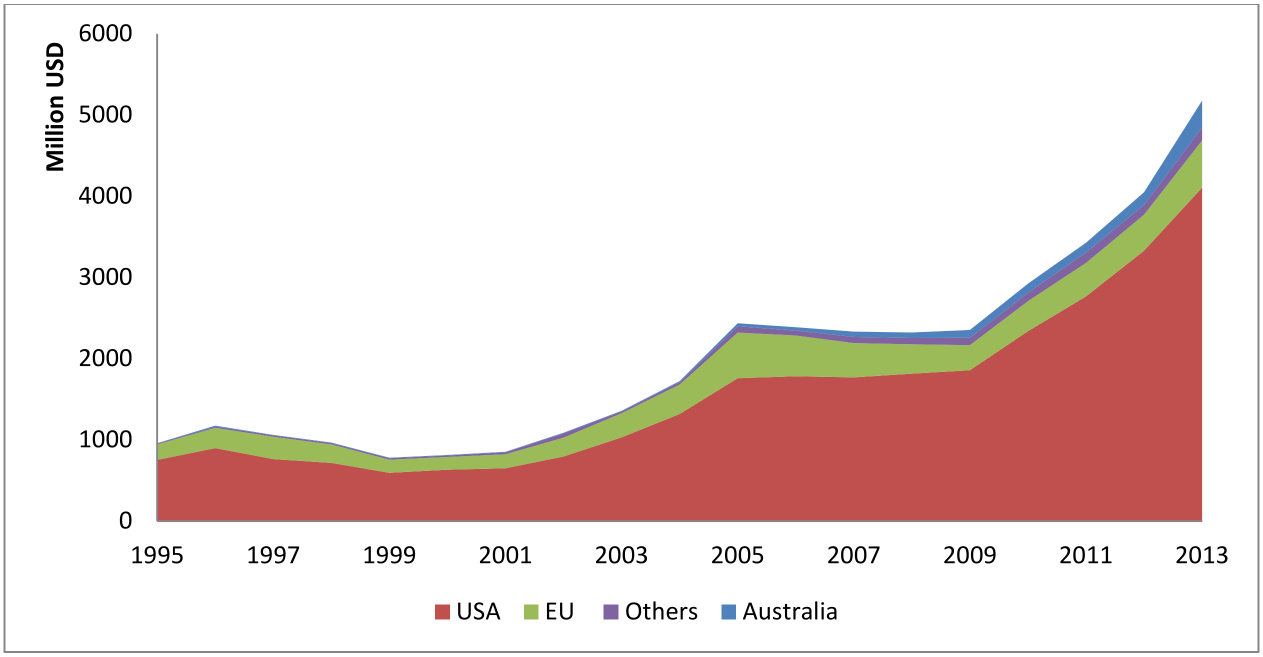

Figure 2.2. World Almond Exports

Source: Author's own calculation from UN Comtrade database

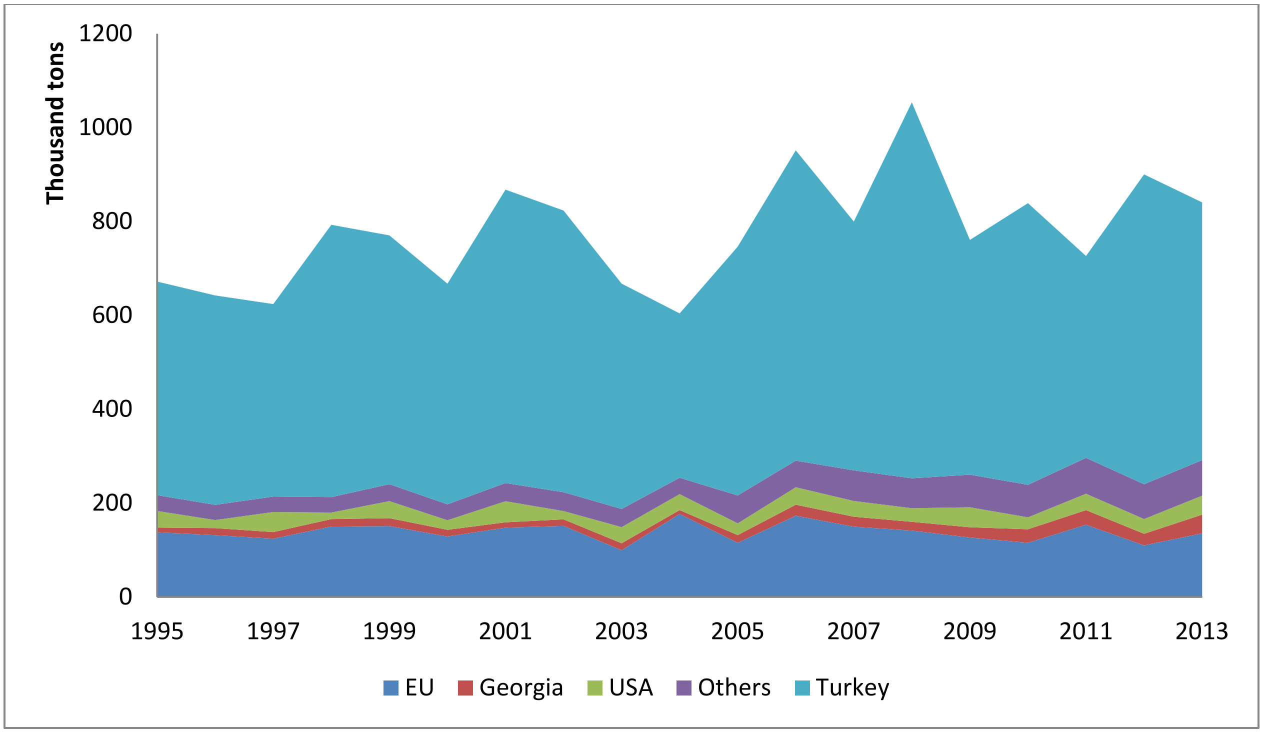

Figure 2.3. World Hazelnut Production (in MT)

Source: Author's own calculation from FAOSTAT database.

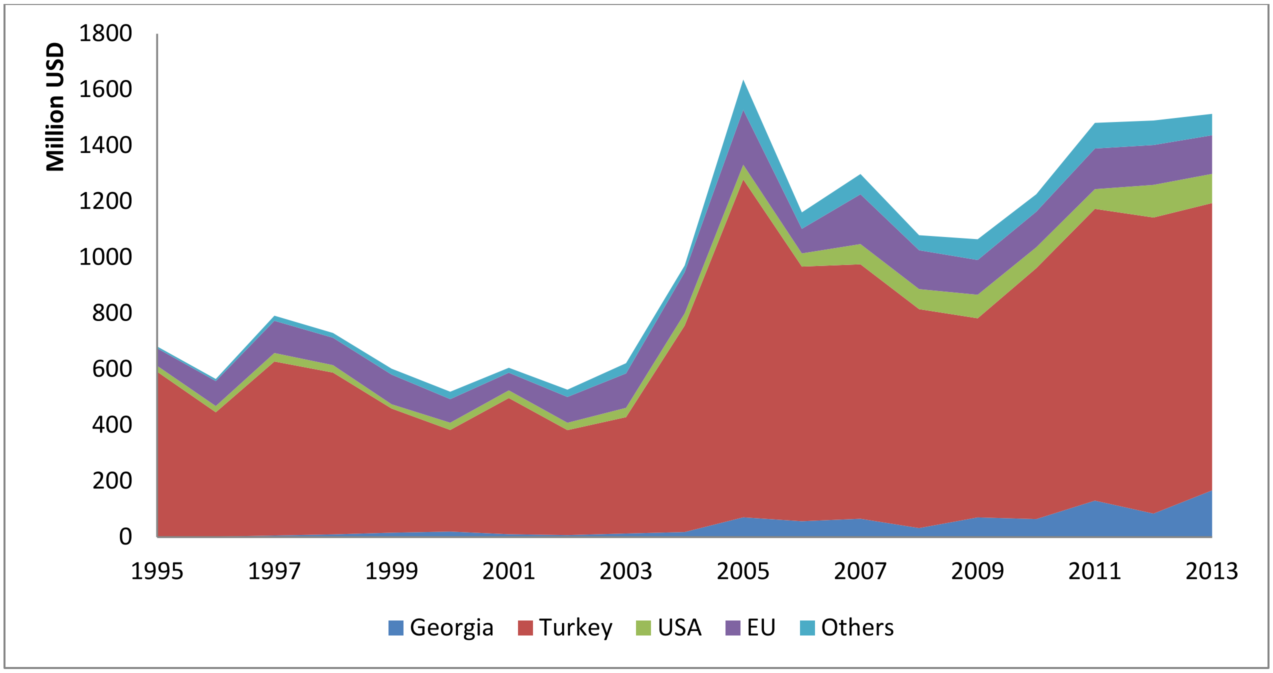

Figure 2.4. World Hazelnut Exports

Source: Author's own calculation from UN Comtrade database

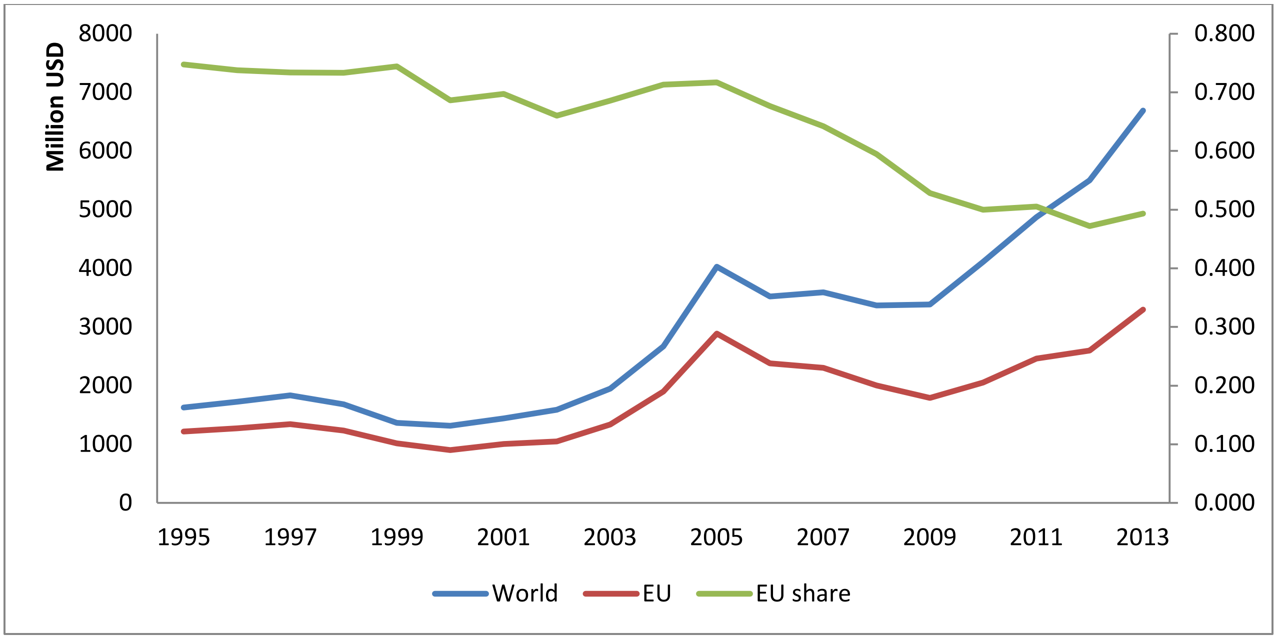

Figure 2.5. **Almond and Hazelnut Exports to the EU and World Markets**

Source: Author's own calculation from UN Comtrade database

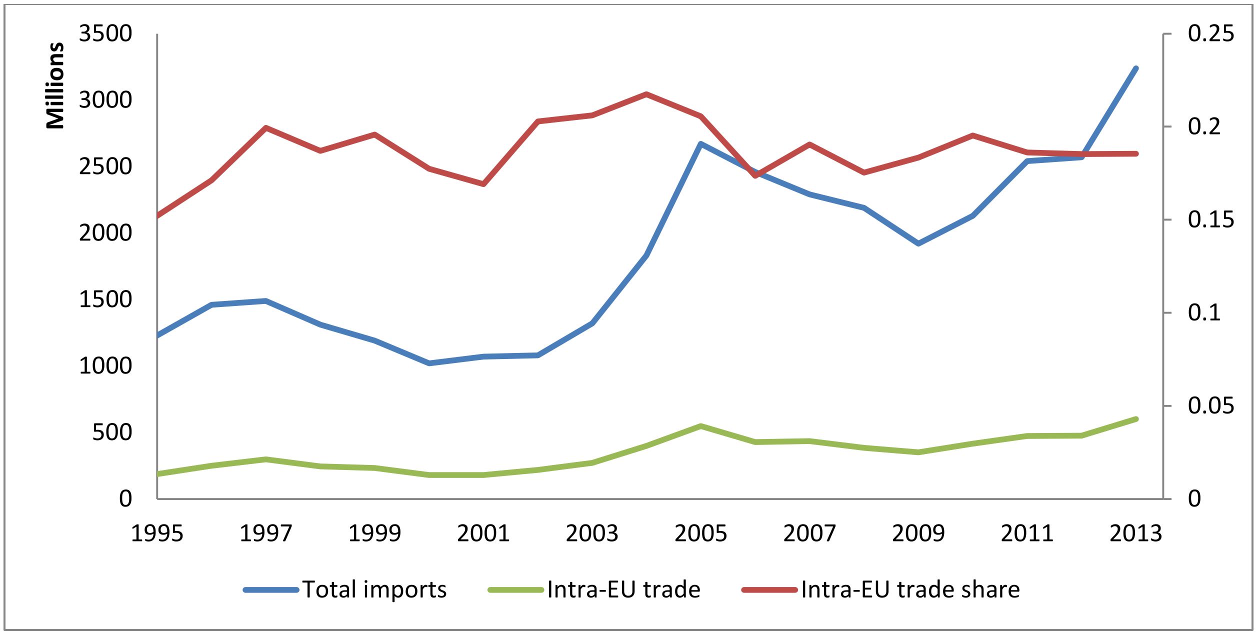

Figure 2.6. EU Hazelnut and Almond Imports by origin (USD)

Source: Author's own calculation from UN Comtrade database

Essay 3. Demand Elasticities for Hazelnuts and Almonds in International Trade

Introduction

Almonds and hazelnuts are among the most highly traded tree-nuts in the international market. World production and exports of these nuts have significantly expanded during the last decade. For example, combined industry supply values surged from $6 billion to $12 billion between 2006 and 2014 (International Nut Council, 2014). Global consumption has also followed an increasing trend particularly for almonds. This increase in world demand should stimulate competition among existing traders as well as encourage new countries to participate in the global market. A comprehensive analysis of the global almond and hazelnut trade would provide valuable information concerning the demand structure of the world markets. Particularly, knowledge of demand interrelationships among trading partners would provide a better analytical view of a variety of policy implications for domestic and global governing organizations (e.g., welfare implications of supply and demand shifters, federal or private promotion program evaluations, global anti-trust disputes). However, world demand for almonds and hazelnuts has received little attention in the applied literature, as studies have mainly focused on country-specific evaluations (e.g., Alston and Sexton, 1991; Alston et al., 1993b; Yavuz et al, 2005).

This study attempts to provide a better view of global consumer preference for almonds and hazelnuts from various sources by taking into account both economic factors such as prices and expenditures as well as non-economic factors such as seasonality effects. The article also addresses whether almonds should be included in a hazelnut demand system, or vice versa (separability), which is a critical step in the investigation of the demand structure of these tree nuts. Findings of the study are anticipated to inform national and international policy makers, growers, and marketers in their effort to develop effective strategies for addressing industry concerns (e.g., trade disputes), as well as expanding sales and market shares for almonds and hazelnuts. Particularly, the demand elasticities estimated in this article can be used to quantify the impacts of various policies and regulations (e.g., Sanitary and Pyhto-Sanitary measures, export subsidies).

The primary objective of this study is to estimate world demand elasticities for almonds and hazelnuts. To accomplish this objective, the present study uses a generalized differential demand model (Eales, Durham, and Wessells, 1997) to investigate factors that affect the demand in the world hazelnut and almond markets. Differential demand modelling has many desirable properties, such as being derived from consumer utility theory without imposing any functional form specification (Barten and Bettendorf, 1989). Furthermore, this approach allows researchers to examine how nut producers in different countries vary the quantity of nuts they export in relation to changes in prices and incomes, along with any preference variables that cause a shift in demand curve by providing theoretically consistent estimates of corresponding elasticities (Xie, Kinnucan, and Myrland, 2009).

The paper continues with a review of the existing literature on hazelnut and almond demand estimates. The following sections provide a description of the data used in the analysis and outline the analytical framework which contains differential demand model derivations, formal separability tests for almonds and hazelnuts, and the empirical estimation procedures. Then, model diagnostics, including tests for theoretical restrictions and model assumptions will be presented. The estimated conditional Marshallian price elasticities and expenditure elasticities will be reported and discussed in the next section. Final section concludes.

Literature Review

The applied literature provides an analytical view of the demand structures for almonds and hazelnuts, generally in the form of country specific evaluations. In an early study, Dhaliwal (1972) investigated demand interrelationships among the tree-nuts in the US market and found that almonds and hazelnuts were separable from other tree-nuts, but they followed complementary behavior. Bushnell and King (1986) estimated demand elasticities for US almonds in eight different destinations including the domestic market. Their elasticity estimates ranged between (-0.41) and (-0.30) for the US market; (-3.31) and (-0.36) for seven other major export markets. They found significant competition between the almond and hazelnut industries, contrary to findings of Dhaliwal (1972). Alston and Sexton (1991) confirmed that there was a strong relationship between the hazelnut and almond markets, while stating that Spanish almonds had a greater impact on US almond prices than hazelnuts from Turkey, on a pound per pound basis. Their findings suggest demand for US almonds is price inelastic (-0.83) and a percent increase in Turkish hazelnut exports leads to a 0.6 percent decrease in US almond prices.

In a follow up study, Alston et al. (1995b) provided a detailed analysis of the US almond industry. The authors examined the effects of prices and income on almond demand in the US, Canada, Japan, and major almond consumer countries in the EU. Alston et al. (1995b) only incorporated hazelnuts as a substitute product[19] in their preferred single equation demand model. The findings of their study suggested that the hazelnut and almond markets were significantly related in most countries, and were substitutes in Canada and major almond consumer countries in the EU (e.g., Germany, Netherland, and Italy). Their results were in line with previous

[19] Alston et al. (1995b) estimated a partial demand system for the US, consisting of demand for almonds, hazelnuts, pecans, walnuts, and peanuts. Their finding suggested that alternative tree-nuts were not good substitutes for US almonds.

research (e.g., Bushnell and King 1986; Alston and Sexton, 1991; Alston et al. 1993b), except for the fact that they reported a more price elastic domestic demand for US almonds than the previous studies. The estimated demand elasticity for the US market (-1.05) was higher than almond demand in most European countries, which followed an inelastic pattern in general[20]. The authors proposed a single efficient world almond market[21] and mainly argued that the single equation approach would be a better alternative over demand systems due to different characteristics of demand structures across countries.

Among the few studies on hazelnut demand, Yavuz et al. (2005) attempted to identify the Turkish hazelnut industry structure by estimating a system of equations including domestic and export demand functions. They found a statistically insignificant substitution effect between almonds and hazelnuts with an estimated export demand elasticity of 0.46 for Turkish hazelnuts. Marongiu (2005) examined the link between the Turkish hazelnut industry and the international market, reporting highly inelastic export demand (-0.11) for Turkish hazelnuts. Bozoglu (2009) reported the EU hazelnut import demand elasticity for Turkish hazelnuts to be 0.23.

This research departs from the current literature by employing a generalized differential demand system approach (Eales, Durham, and Wessells, 1997) to explore the economic (i.e., price and income) and non-economic factors (i.e., seasonality) that affect global almond and

[20] Russo et al. (2008) found almond price elasticity of US domestic demand to be -0.48, suggesting US demand had become less price elastic over time.

[21] A number of industry reports suggested that US and Spanish almonds were not necessarily competitive products in many European markets due to being highly distinct varieties (USDA FAS-Spain, 2003, 2007).

hazelnut demand. One critical step in investigating the demand structure of the almond and hazelnut markets is to address whether these nuts are separable products. Namely, should almonds be considered in a hazelnut demand system or vice versa? Hence, the analysis here presents a formal test for a weak separability assumption in world almond and hazelnut demand.

Methodology and Data Descriptions

This study utilizes the differential demand system approach to investigate factors affecting world hazelnut and almond demand. Among other appealing characteristics, differential demand systems do not suffer from the restrictive Armington (1969) assumptions- namely, homothetic preferences and constant elasticity of substitution across varieties. In addition, differential demand models are derived from consumer utility theory and allow researchers to statistically test the theoretical restrictions (i.e., homogeneity and symmetry) without imposing any functional form specification (Barten and Bettendorf, 1989). Furthermore, this approach is useful for examining how nut exporters in different countries respond to changes in prices and incomes along with any preference variables that cause a shift in the demand curve by providing theoretically consistent estimates of corresponding elasticities.

The most widely used differential demand models in the literature are the Rotterdam, Almost Ideal Demand System (AIDS), the Central Bureau of Statistics (CBS), and the National Bureau of Research (NBR) models. Theil (1965) and Barten (1964) developed the Rotterdam model by taking the logarithmic differential of the Marshallian demand function. Applying the Slutsky equation and multiplying both sides by the income share for good *i* yields the Rotterdam model:

$$w_i dlnq_i = \theta_i d\ lnQ + \sum_{j=1}^{i} \pi_{ij}\ d\ lnp_j \quad (1)$$

where w_i is budget share, $d\,lnQ$ is the Divisia volume index ($d\,lnQ = \sum_j(\bar{w}_j\,dlnq_j)$), $dlnq_j$ and $dlnp_j$ are the logarithmic differential of the price and quantity for good i, respectively. θ_i and π_{ij} denote demand parameters, where θ_i is the marginal expenditure share for good i, and π_{ij} is a compensated price effect. The Rotterdam model shows how budget shares change in response to changes in prices and income.

Deaton and Muellbauer (1980) derived the AIDS model from a cost or expenditure function, representing Price Independent Generalized Logarithm (PIGLOG) preferences. The AIDS model provides an arbitrary first order approximation of any demand system, and it satisfies the axiom of choice exactly. Furthermore, the AIDS model allows researchers to test theoretical restrictions. Replacing the logarithmic price terms in the AIDS model with their logarithmic differentials, and Stone's price index with the Divisia price index, yields the AIDS model in differential form:

$$dw_i = \beta_i d\ln(\frac{x}{P}) + \sum_{j=1}^{i} \gamma_{ij}\, d\,lnp_j \quad (2)$$

where x is the nominal expenditure ($x = \sum_j p_j * q_j$) and $d\,lnP$ is the Divisia price index ($d\,lnP = \sum_j \bar{w}_j\, dlnp_j$). The parameters of the AIDS model in first difference form are invariant to unit of measure and model estimation does not suffer from simultaneity as it does in the levels form[23].

Keller and van Driel (1985) developed the CBS model which incorporates the Working's model (1943) into the Rotterdam model. Working's model defines the expenditure share for good *i* as:

$$w_i = \alpha_i + \beta_i\, lnE \quad (3)$$

[23] Hereafter, the AIDS refers to the AIDS model in first differenced form.

Multiplying equation (3) by E and differentiating with respect to E yields marginal shares:

$$\frac{\partial p_i q_i}{\partial E} = \alpha_i + \beta_i\,(1 + lnE)\ or\ \theta_i = w_i + \beta_i \quad (4)$$

Equation (4) calls for the *i*th marginal share to differ from corresponding income share by β_i. Solving for α_i, and replacing θ_i in equation 1, yields the CBS model as:

$$w_i dlnq_i = (\beta_i + w_i)d\ lnQ + \sum_{j=1}^{i} \pi_{ij}\ d\ lnp_j \quad (5)$$

The NBR model (Neves, 1987) can be derived from the AIDS model by substituting $\beta_i = \theta_i - w_i$ in equation (2) to obtain:

$$dw_i = \ \theta_i d\ lnQ + \sum_{j=1}^{i} \gamma_{ij}\ d\ lnp_j \qquad (6)$$

The NBR model modifies the Rotterdam model to permit price effects to vary with income. Table 1 and 2 present the theoretical restrictions and price and income elasticity formulas for the differential demand models used in this study.

Barten (1993), and Eales, Durham, and Wessells (1997) developed a generalized differential demand model[25], where the Rotterdam, AIDS, CBS, and NBR models are nested by exploiting the similarities between the models. In addition to being a model in its own right, the generalized model is more flexible with its two nesting parameters than previous models. Thus, the generalized model is a useful approach to test the adequacy of alternative demand

[25] Despite having similar features, Eales, Durham, and Wessells (1997) specified their model with an AIDS dependent variable; whereas, Barten's model, known as the synthetic demand model, is specified with the Rotterdam dependent variable (i.e.,$w_i dlnq_i$). Therefore, the nesting restrictions of the two specifications vary to yield the four nested models.

specifications that may well represent the true data-generating process (Matsuda, 2005).

The generalized differential system of Eales, Durham, and Wessells (1997) is defined as:

$$dw_i = (\beta_i + \varphi_1 w_i) d\, lnQ + \sum_{j=1}^{i} \left[\gamma_{ij} + \varphi_2 w_i (\delta_{ij} - w_j)\right] d\, lnp_j \quad (7)$$

where β_i and γ_{ij} are the income and price coefficients to be estimated. δ_{ij} denotes Kronecker delta, $d\, lnQ_t$ indicates the Divisia volume index, which measures the change in real expenditure. φ_1 and φ_2 are switching parameters that produce the nested models. The switching parameter φ_1 indicates the difference between the marginal budget shares of the Rotterdam model and the AIDS and CBS models. φ_2 measures the difference between the price coefficients of the Rotterdam model and the NBR and AIDS models. The restrictions on switching parameters to yield nested models are presented in Table 3.

Weak Separability in Almond and Hazelnut Demand

This study tests the hypothesis that the commodities in question (i.e., hazelnut and almond) are weakly separable goods in demand. Almonds and hazelnuts from eight different sources are tested for separability in the nut demand system. The unrestricted utility function can be stated as

$$U(q) = U(q_1, q_2, q_3, q_4, q_5, q_6, q_7, q_8) \quad (8)$$

The hypothesis indicates the following utility function where hazelnuts are weakly separable from almonds:

$$U(q) = U'[h(q_1, q_2, q_3, q_4), a(q_5, q_6, q_7, q_8)] \quad (9)$$

The required restrictions can be derived from:

$$\frac{\sigma_{ik}}{\sigma_{jk}} = \frac{\epsilon_i}{\epsilon_j} \quad (10)$$

where σ_{ik} denotes the Allen-Uzawa elasticity of substitution, which is the compensated cross-price elasticity divided by the expenditure share ($\sigma_{ik} = \mu^*_{ik}/w_i$). $\in_i$ denotes the expenditure elasticity for good *i*. Substituting compensated cross price elasticity and expenditure elasticity formulas presented in Table 2 into equation (10) yields the separability restrictions for the generalized model as:

$$\gamma_{ik} = \frac{\left(\beta_i + w_i(\varphi_1 + 1)\right)}{\left(\beta_j + w_j(\varphi_1 + 1)\right)}\left(\gamma_{jk} - w_j w_k(\varphi_2 - 1)\right) + w_i w_k(\varphi_2 - 1) \quad (11)$$

Following Moschini, Moro, and Green (1994) and Eales and Wessells (1999), the necessary and sufficient restrictions for separability between almonds and hazelnuts are:

$$\frac{\sigma_{35}}{\sigma_{45}} = \frac{\in_3}{\in_4}, \frac{\sigma_{25}}{\sigma_{45}} = \frac{\in_2}{\in_4}, \frac{\sigma_{15}}{\sigma_{45}} = \frac{\in_1}{\in_4}$$

$$\frac{\sigma_{36}}{\sigma_{46}} = \frac{\in_3}{\in_4}, \frac{\sigma_{26}}{\sigma_{46}} = \frac{\in_2}{\in_4}, \frac{\sigma_{16}}{\sigma_{46}} = \frac{\in_1}{\in_4}$$

$$\frac{\sigma_{37}}{\sigma_{47}} = \frac{\in_3}{\in_4}, \frac{\sigma_{27}}{\sigma_{47}} = \frac{\in_2}{\in_4}, \frac{\sigma_{17}}{\sigma_{47}} = \frac{\in_1}{\in_4}$$

$$\frac{\sigma_{46}}{\sigma_{45}} = \frac{\in_6}{\in_5}, \frac{\sigma_{47}}{\sigma_{45}} = \frac{\in_7}{\in_5}, \frac{\sigma_{48}}{\sigma_{45}} = \frac{\in_8}{\in_5}$$

$$\frac{\sigma_{38}}{\sigma_{48}} = \frac{\in_3}{\in_4}, \frac{\sigma_{28}}{\sigma_{48}} = \frac{\in_2}{\in_4}, \frac{\sigma_{18}}{\sigma_{48}} = \frac{\in_1}{\in_4} \quad (12)$$

The separability restrictions in equation (12) are tested at the mean shares as non-linear parametric restrictions. Hence, the separability test in the generalized model is local, except for the cases where the Rotterdam is the preferred model, in which case the separability test will be global (Eales and Wessells, 1999).

Empirical Estimation

This study assumes almonds and hazelnuts are weakly separable from other tree nuts and differentiated by the country of origin. However, almonds and hazelnuts are tested for separability before estimating demand elasticities. The quantity dependent differential system is preferred over inverse demand models because tree-nuts are storable products and exporters can adjust quantity supplied based on expected prices during the marketing year (Alston *et al*, 1995b).

The generalized model in Equation 7 is extended to include a constant term to assess the change in budget shares due to variation in tastes and quarterly dummy variables to account for seasonal preference shifts. The nut demand system consists of eight equations[26] (almonds from the United States, Spain, Australia, and the Rest of the World; hazelnuts from Turkey, Georgia, the U.S, the European Union) in the augmented form, specified as:

$$dw_{it} = \alpha_i + (\beta_i + \varphi_1 \bar{w}_{it}) d\, lnQ_t + \sum_{k=1,2,4} \varphi_{ik} S_{ik} + \sum_{j=1}^{8} (\gamma_{ij} + \varphi_2 \bar{w}_{it} (\delta_{ij} - \bar{w}_{jt})) \, d\, lnp_{jt} + \varepsilon_{it} \quad (13)$$

here $\alpha_i, \varphi_{ik}, \beta_i$, and γ_{ij} are estimation parameters, S_{ik} denotes the seasonal dummy variable used for good *i* in quarter *k*. The indicator variable for quarter 3 (i.e., harvest season) is excluded to avoid singularity. All variables in the generalized differential demand system are specified as discrete changes and approximated by replacing logarithmic differentials with log differences in model estimations (e.g., $d\, lnp_{jt} = \log(\frac{p_{jt}}{p_{jt-1}})$). Budget shares (w_{it}) are also replaced with the moving average of the market share of good *i* ($\bar{w}_{it}$), measured in two consecutive periods (Zhang and Kinnucan, 2014).

The generalized model in Equation (13) is estimated using the iterated seemingly

[26] Data for the hazelnut exports from the ROW is not readily available. Therefore, hazelnut demand system excludes the ROW exports which represents on average less than 5 percent of the total world hazelnut exports.

unrelated regression (ITSUR) method to determine whether the alternative demand specifications nested within the generalized model are appropriate for the data. The demand system consists of eight equations[28]. There are 13 parameters to be estimated in each equation. The number of observations (38) is less than the number of system parameters to be estimated (91), causing a degrees of freedom problem in the system estimation. However, Zellner (1962, pp. 351) proposed that Ordinary Least Squares estimators are identical to SUR estimators if the explanatory variables are all the same in the system equations[29], which is a common occurrence in demand system estimation. Thus, the number of explanatory variables in each equation must be less than the number of observations in order to estimate the demand system[30] (Edgerton, 1997, pp. 72).

Theoretical restrictions are tested to identify whether these restrictions are compatible with the data. Then, following Eales and Wessells (1999), the separability restrictions in Equation (12) are tested for the restricted preferred model to determine if almonds are separable from hazelnuts. Depending on the outcome of this test, almond and hazelnut demand systems are re-estimated to calculate the price and expenditure elasticities.

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[28]The equation for almonds from the ROW is dropped from the system due to the adding-up condition that leads to singularity in the contemporaneous covariance matrix. The generalized model is re-estimated after dropping the equation for Australian almonds. The parameters in both estimations are not significantly different from each other.

[29]For detailed explanations see Zellner (1962, 1963).

[30] Among others, Eales and Wessells (1999), Mutondo and Henneberry (2007), and Henneberry and Mutondo (2009) estimated demand systems having more system coefficients to be estimated than the number of observations.

Data Descriptions

The augmented model is estimated using quarterly data from 2005 (Q3)–2014 (Q4) concerning export quantity (in kg) and free-on-board prices (F.O.B). The harmonized system codes used for the data are 080211, 080212, 080221, and 080222 for edible and shelled almonds and hazelnuts, respectively. Almonds and hazelnuts in their shells weight more than shelled nuts; therefore, the quantity and prices for almonds and hazelnuts in their shells are converted to kernel-basis quantity and prices in effort to standardize data using the following conversion factors:
1:3.03 for almonds and 1:2 for hazelnuts, provided by the U.S Department of Agriculture. Quantity and price data are collected for hazelnuts from Turkey, Georgia, the United States (US), and the European Union (EU) and almonds from the US, Spain, Australia, and the Rest of the World (ROW).

Quarterly export values and quantities are obtained from the national statistics institutes (i.e., TurkSTAT, EuroSTAT, and GeoSTAT) with the exception of almond data from Australia and US, which are provided by the Australian Department of Agriculture and US International Trade Commission. The imputed prices per kilogram are calculated by dividing the FOB value by the export quantity, for each quarter, at the wholesale level. All prices are converted to US dollars by quarterly exchange rates from the Bank of International Settlements database.

Annual hazelnut and almond trade values and world market shares for each exporter country are presented in Tables 4 and 5, respectively. The world trade statistics reveal that hazelnut exports almost doubled in value from 2006–2014. Despite having the largest market share, Turkey has been facing a significant export share loss in the global hazelnut trade. However, all other exporting countries, and particularly Georgia, gained more market shares during the same period.

Table 5 shows world almond export values and market shares by country of origin. The world almond market has grown by 140 percent between 2006 and 2014. The US has a relatively stable market share accounting for nearly 80 percent of total world exports on average. The EU and ROW exporters have been losing their market share to Australian almonds, as Australia boosted its market share by more 400 percent and thus became an important almond exporter during the same period.

Results and Discussions

This section discusses the results of model diagnostics, and tests for the weak separability and the compatibility of the theoretical restrictions with the data. Parameter estimates of the differential systems as well as estimates of the price and expenditure elasticities for the products in question are presented.

Test Results and Model Selection

Tests for heteroscedasticity and serial correlation indicate that neither is an issue. A possible exception is the equation for Turkey where the D.W. statistic is in the inconclusive region (Table 8). Additional tests failed to reject the null that the residuals are normally distributed. The test on nesting parameters (φ_1 and φ_2) for model selection indicates that the Rotterdam, AIDS, and NBR models are too restrictive for the almond and hazelnut data. The CBS model is not rejected at a 1 percent significance level (Table 6). Therefore, the CBS model is preferred over the competing functional forms. Homogeneity and symmetry are simultaneously tested for the CBS specification and the results suggest that the theoretical restrictions are compatible with the data.

Before proceeding to the final demand elasticity estimations, the separability restrictions in Equation (12) are simultaneously tested for the restricted CBS model[32]. The computed Chi-square values in Wald (18.40) and Likelihood ratio tests (18.39) are well below the critical value at a 5 percent level (24.99)[33]. This result indicates that the null hypothesis of separability cannot be rejected at a 5 percent level and that almonds and hazelnuts are weakly separable nuts. Therefore, demand for each good is estimated separately. Table 8 reports misspecification test results as well as the estimated model parameters for the restricted CBS model. The analysis continues with an examination of the world demand for almonds and hazelnuts, following the same procedures that were previously discussed, with the exception of imposing separability restrictions.

Hazelnut Demand Elasticities

The generalized model in Equation (13) is utilized to estimate the world hazelnut demand system, which consists of four equations[34] (i.e., Turkey, the EU, Georgia, and the US). Test results suggest the Rotterdam and NBR models are too restrictive, while it appears that the CBS and AIDS models are appropriate demand specifications for modeling the world hazelnut

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[32] The separability restrictions are also tested for the unrestricted model before performing model selection test. The results suggest the null cannot be rejected at a 5 percent significance level. Following Eales and Wessells (1999), results of separability restrictions tested for the restricted CBS model are reported.

[33] Table 7 presents the test results for separability and theoretical restrictions.

[34] The equation for hazelnuts from Georgia was dropped from the system to avoid singularity in the covariance matrix. The generalized model was then re-estimated after dropping the equation for European hazelnuts instead. The resulting parameters did not vary significantly from the estimations reported in Tables 10 and 11.

demand as the computed Wald values (1.10 and 0.44, respectively) are comfortably below the critical value (5.99). Table 9 reports the results of model selection test in hazelnut demand estimation. Theoretical restrictions are found to be compatible with the data in both models. The normality and homoscedasticity assumptions are satisfied at a 1 percent level. The Durbin-Watson test results indicate that there is no serial correlation problem in the system equations. The explanatory power (R^2) varies from 0.39 to 0.85 in equations with Georgia having the lowest and the US having the highest R^2. The estimated model parameters, including misspecification test results, are reported in Tables 10 and 11 for the CBS and AIDS models, respectively.

The estimated constant terms in the hazelnut demand system indicate statistically insignificant trend effects for the US and Georgia. The negative and statistically significant constant term in the Turkish equation suggests that consumer preferences for hazelnuts from Turkey may weaken over time. Six out of 12 parameters for quarterly dummy variables are statistically significant at a 5 percent significance level or better. This implies seasonality may be a key factor in hazelnut demand analysis, particularly for the US and Turkey, as the majority of the quarterly indicator variables in these equations is statistically significant at a 5 percent level or better.

The conditional price elasticities and expenditure elasticities of the AIDS model[35] are calculated based on the formulas presented in Table 2. All uncompensated own-price elasticities are negative and statistically significant at a 5 percent level or better, except for the elasticity of Georgian hazelnuts which is positive, but statistically insignificant at a 5 percent level. World demand for hazelnuts from the EU is more price sensitive relative to the hazelnuts from Turkey

[35] The estimated price and income elasticities of the CBS model are similar to the elasticities of the AIDS model and will be provided upon request.

and the US, as the computed Marshallian own-price elasticities are -1.93, -0.69, and -0.88 for the EU, Turkey, and the US, respectively.

World demand elasticity for hazelnuts from all sources is calculated as -0.76[36], which is the sum of each country's own price elasticities weighted by their mean value shares during the period of analysis.

The majority of the conditional cross-price elasticities are statistically significant at a 5 percent level or better (7 out of 12). The cross-price effects between the US and Georgia as well as between the US and the EU are all negative, suggesting a complementary behavior between the US and Georgian and European hazelnut exports. The equation for Georgian hazelnuts includes cross-price elasticities that are all statistically significant and are higher than other cross-price elasticities in terms of absolute value. This suggests that hazelnut exports from Georgia are more affected from price changes in other exporting countries. The cross-price effects between hazelnuts from Turkey and the EU are 1.072 and 0.007, indicating a reduction in the Turkish price has a greater impact on the European price than vice versa. This pattern applies to the cross-price relationship between Turkish and US and Georgian hazelnuts as Turkey is the dominant hazelnut exporter, accounting for more than 70 percent of the global trade.

The conditional expenditure elasticities are all positive and statistically significant at a 5 percent significance level or better except for the expenditure elasticity of hazelnuts from the EU, which is negative and statistically insignificant. This indicates an increase in world expenditure on hazelnuts has no impact on hazelnut demand from the EU, but benefits the other exporting countries. In particular, hazelnuts from Georgia and Turkey are income elastic at 1.24

[36] The elasticity calculation excludes Georgia due to being statistically insignificant. If Georgia was considered in the calculation, the world demand elasticity would be slightly elastic at -1.05.

and 1.17, respectively; whereas the expenditure elasticity for hazelnuts from the US is inelastic at 0.56. Thus, an increase in world hazelnut market size due to income benefits the hazelnuts from Georgia to a greater extent than hazelnuts from other sources. Table 12 presents uncompensated price and expenditure elasticities for the world hazelnut market.

Almond Demand Elasticities

World almond demand is investigated by estimating the augmented differential model (Equation 13) for the US, Spain, Australia, and ROW equations[38]. Each of the nested demand specifications are tested against the generalized model. The Wald test and Likelihood ratio statistics suggest that the AIDS, CBS, and NBR models are too restrictive for the almond data, while the Rotterdam model cannot be rejected at a 1 percent level (Table 13). The normality and homoscedasticity assumptions are satisfied at a 1 percent level. The Durbin-Watson test results indicate that there is no autocorrelation problem in system equations as the DW values are effectively higher than the critical values and out of the inconclusive region. Test results for theoretical restrictions show that homogeneity and symmetry assumptions are compatible with the almond data. The system equations have high explanatory power as R^2 ranges from 0.82 to 0.92. Therefore, the Rotterdam model is utilized to estimate world almond demand elasticities. Table 14 reports the estimated Rotterdam model parameters including misspecification test results.

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[38] The equation for almonds from the ROW is dropped to avoid singularity problem in the variance-covariance matrix. The generalized model is re-estimated replacing the ROW equation with the Australian almond equation. Estimated parameters are robust to the dropped equation.

The estimated intercepts indicate insignificant trend effects for the rest of the world and Australia equations, while the statistically significant constant terms in the US and Spain equations suggest that structural change may exist for almonds from the US and Spain. Controlling for seasonality would be important as the majority of the estimated coefficients of quarterly indicator variables (7 out of 12) are statistically significant. This is particularly true for Spanish almonds, where each quarter has a statistically significant effect.

The conditional Marshallian price elasticities and expenditure elasticities of the Rotterdam model are calculated according to the formulas reported in Table 2. All of the uncompensated own-price elasticities are negative and statistically significant at a 1 percent significance level, with the exception of Australian almonds, which is negative and statistically insignificant at a 5 percent level. The estimated Marshallian price elasticities suggest that world demand for almonds from the US is more price sensitive in comparison to almonds from other countries, as the demand for US almonds is elastic at -1.07, contrary to inelastic demand for almonds from Spain (-0.64) and the rest of the world (-0.55). World demand for almonds from all sources is calculated in the same manner as in the world hazelnut demand and found to be almost unitary elastic at -0.95[39].

The uncompensated cross-price elasticities are generally significant at a 5 percent level or better (7 out of 12). The cross-price effects in the US almond equation are all negative, indicating a complementary relationship between US almonds and almonds from other countries. The equation for Spain includes statistically significant and positive cross-price elasticities alone.

[39] Australian almond price elasticity is statistically insignificant and is therefore, excluded in the world demand elasticity calculation. World almond demand elasticity would slightly change to -0.97 if all elasticity estimates, regardless of statistical significance, are considered in the calculation.

This result suggest that Spanish almonds face more competition in global markets, as a 1 percent decrease in prices in the US, Australia, and the ROW will decrease the uncompensated quantity demand for Spanish almonds by 0.13, 0.17, and 0.34 percent, respectively. That is, consumers would prefer to increase their demand for almonds from other origins, rather than pay higher prices for Spanish almonds. Although, none of the cross-price elasticities are statistically significant in the Australian equation, almonds from Spain and the ROW have statistically significant cross-price effects with almonds from Australia (0.17 and -0.43, respectively) at a 5 percent level or better. The ROW equation includes negative and statistically significant cross-price elasticities with almonds from the US and Australia (-0.02 and -0.43, respectively), but a positive and a statistically significant cross-price effect with almonds from Spain (0.89) at a 10 percent level or better. This finding indicates almonds from ROW are only competing with Spanish almonds in the international trade. A 1 percent decrease in Spanish almonds price will decrease the almond demand from the ROW by 0.89 percent, a much greater reduction compared to the otherwise.

The conditional income elasticities are all positive and statistically significant at a 5 percent level or better, except for Australian almonds having a negative and statistically insignificant expenditure elasticity. The conditional expenditure elasticities are found to be highly inelastic for almonds from Spain (0.003) and the rest of the world (0.12), but elastic for almonds from the US (1.36). An increase in world income on almonds has an infinitesimal impact on almond demand from Spain, but benefits almond exports from the US and ROW. The US gains the most benefit from an increase in world expenditure on almonds followed by the ROW. The conditional Marshallian price elasticities and expenditure elasticities for the world almond are reported in Table 15.

Summary and Conclusion

The differential demand system approach is used to fit data for world almond and hazelnut demand to provide a comprehensive discussion of global consumer preferences for almonds and hazelnuts from various sources. This approach takes into account both economic factors, such as prices and expenditures, as well as non-economic factors, such as seasonality effects. Separability concerns for these two nuts are investigated using a generalized demand system approach (Eales and Wessells, 1999), which allows researchers to identify the appropriate demand model among the alternative specifications nested within the generalized model. The CBS model is preferred over other specifications as competing models are too restrictive. The test results for weak separability restrictions imposed on the CBS model suggest that almonds and hazelnuts are separable goods in demand. Accordingly, world demand for almonds and hazelnuts are estimated as separate demand systems.

World demand for hazelnuts is estimated using a four equation demand system consisting of Turkey, Georgia, the US, and the EU. The estimated Marshallian price elasticities indicate that world demand for hazelnuts from Turkey and the US is inelastic and less price-sensitive relative to hazelnuts from the EU. Furthermore, the cross-price effects in the equation for Turkish hazelnut are smaller in comparison to the respective cross-price elasticities in other equations, indicating price changes in Turkish hazelnuts have a greater impact on other suppliers than vice versa. The calculated expenditure elasticities suggest that an increase in world expenditure on hazelnuts has an insignificant impact on exports from the EU, but benefits other exporting countries. In particular, hazelnuts from Georgia gains the most benefit from an increase in world income on hazelnuts as it is found to be expenditure elastic and hazelnuts from the US benefits the least associated with its inelastic demand with respect to income.

World almond demand is investigated by estimating the Rotterdam model for almonds from the US, Spain, Australia, and ROW. The Marshallian price elasticity for US almonds is found to be elastic alone. The uncompensated demand for almonds from Spain and the ROW are inelastic and less price-sensitive compared to US almonds. The estimated cross-price effects suggest that a complementary relationship between US almonds and almonds from other countries. However, almonds from Spain are found to face more competition in global markets.

The conditional expenditure elasticity for US almonds is computed as the only income elastic demand, implying that if world expenditures on almonds were to increase, world demand for US almonds would increase more than the demand for almonds from elsewhere. Although, US almonds gain the most benefit from an increase in world income, followed by almonds from ROW, an increase in world expenditure on almond has no economically significant impact on almonds from Spain and Australia.

World demand for hazelnuts and almonds from all sources is estimated to be inelastic with almonds having relatively higher price elasticity. The more elastic demand for almonds suggests that removal or reduction of trade barriers to international markets would stimulate the world demand for almonds to a greater extent than demand for hazelnuts. In addition, more elastic demand implies that global markets are more likely to absorb supply increases with less reduction in producer prices as suggested by Xie et al. (2008). Accordingly, supply shocks may result high price volatility for hazelnuts, which has less elastic demand.

Overall, this article contributes to the literature in many ways. Despite being among the most highly traded tree-nuts, with a $12 billion industry supply value in 2014, world demand elasticities for almonds and hazelnuts cannot be found in the literature. This study is the first to investigate global demand for almonds and hazelnuts using a differential demand system approach. Demand interrelationships among world nut suppliers are highlighted by estimating price and expenditure elasticities. This paper also presents the first test of separability between world demand for almonds and hazelnuts by employing a differential demand approach. Further research may concentrate on expanding the hazelnut demand analysis, particularly by considering data for hazelnuts from Chile and Azerbaijan, two emerging exporting countries in the global markets.

Table 3.1. Theoretical Restrictions on the Functional Forms Used in Demand Estimation

Demand Structure	Homogeneity	Symmetry	Adding-up
Rotterdam	$\sum_{j=1}^{n} \pi_{ij} = 0$	$\pi_{ij} = \pi_{ji}$	$\sum_{i=n}^{n} \theta_i = 1$ $\sum_{j=1}^{n} \pi_{ij} = 0$
AIDS	$\sum_{j=1}^{n} \gamma_{ij} = 0$	$\gamma_{ij} = \gamma_{ji}$	$\sum_{i=1}^{n} \beta_i = 0$ $\sum_{i=1}^{n} \gamma_{ij} = 0$
CBS	$\sum_{j=1}^{n} \pi_{ij} = 0$	$\pi_{ij} = \pi_{ji}$	$\sum_{i=1}^{n} \beta_i = 1$ $\sum_{i=1}^{n} \pi_{ij} = 0$
NBR	$\sum_{j=1}^{n} \gamma_{ij} = 0$	$\gamma_{ij} = \gamma_{ji}$	$\sum_{i=1}^{n} \theta_{i_i} = 0$ $\sum_{i=1}^{n} \gamma_{ij} = 0$
Generalized Model	$\sum_{j=1}^{n} \gamma_{ij} = 0$	$\gamma_{ij} = \gamma_{ji}$	$\sum_{j=1}^{n} \gamma_{ij} = 0$ $\sum_{j=1}^{n} \beta_i = -\varphi_1$

Table 3.2. Elasticities for the Functional Forms Used in Demand Estimation

Model	Price	Expenditure
Rotterdam	$\mu_{ij} = \frac{\pi_{ij} - \theta_i w_j}{w_i}$	$\epsilon_i = \frac{\theta_i}{w_i}$
AIDS	$\mu_{ij} = \frac{\gamma_{ij} - \beta_i w_j}{w_i} - \delta_{ij}$	$\epsilon_i = \frac{\beta_i}{w_i} + 1$
CBS	$\mu_{ij} = \frac{\pi_{ij} - w_j(\beta_i + w_i)}{w_i}$	$\epsilon_i = \frac{\beta_i}{w_i} + 1$
NBR	$\mu_{ij} = \frac{\gamma_{ij} - \theta_i w_j}{w_i} - \delta_{ij} + w_j$	$\epsilon_i = \frac{\theta_i}{w_i}$
Generalized Model	$\mu_{ij} = \frac{\gamma_{ij} - \beta_i w_j}{w_i} + \delta_{ij}(\varphi_2 - 1) - (\varphi_1 + \varphi_2)w_j$	$\epsilon_i = \frac{\beta_i + \varphi_1 w_i + w_i}{w_i}$

Table 3.3. Restrictions on Nesting Parameters of the Generalized Demand Model

Demand Model	Restrictions	
	φ_1	φ_2
Rotterdam	0	0
AIDS	-1	1
CBS	0	1
NBR	-1	0

Table 3.4. World Hazelnut Exports and Market Shares by Exporting Country

	Total Exports	Market Shares (%)			
Year	(million USD)	Georgia	Turkey	USA	EU
2006	1147	4.9	79.4	4.1	7.7
2007	1279	5.1	71.1	5.7	13.9
2008	1063	3.0	73.7	6.7	13.1
2009	1049	6.7	67.8	8.0	11.8
2010	1206	5.3	74.4	6.2	10.5
2011	1463	8.9	71.3	4.8	9.9
2012	1471	5.7	72.0	7.9	9.7
2013	1531	10.9	67.1	6.8	10.2
2014	1974	9.3	68.0	5.3	12.1
Average	1354	6.6	71.7	6.2	10.6

Source: Own calculation from UN Comtrade data.

Table 3.5. World Almond Exports and Market Shares by Exporter Country

	Total Exports	Market Shares (%)			
Year	(million USD)	Australia	Spain	USA	ROW
2006	2386	1.7	15.3	74.7	8.3
2007	2331	2.8	13.6	75.8	7.7
2008	2320	2.9	12.1	78.2	6.8
2009	2352	4.1	10.5	78.9	6.5
2010	2922	3.8	10.5	80.0	5.7
2011	3426	3.5	9.9	80.7	5.9
2012	4048	3.8	9.0	82.2	5.0
2013	5175	6.4	9.2	79.3	5.1
2014	5704	6.9	11.0	77.9	4.2
Average	3407	4.0	11.2	78.6	6.1

Source: Own calculation from UN Comtrade data.

Table 3.6. Model Selection Tests in the Generalized Demand Model Estimation

Demand Model	Wald Value	Likelihood Ratio	Result[i]
Rotterdam	23.39	29.41	Reject
AIDS	34.98	34.98	Reject
CBS	2.68	2.68	Fail to reject
NBR	52.37	52.39	Reject

[i]The critical value at 5 percent level is 5.99 in all tests.

Table 3.7. Separability and Theoretical Restriction Tests in the CBS Model: Unrestricted versus Restricted Model

Restriction	Wald Statistics	Likelihood Ratio	Critical Chi^2 at 5 percent level[1]	Result
Homogeneity and Symmetry	31.26	31.25	41.33	Fail to reject
Separability	18.40	18.39	24.99	Fail to reject

[1]Degrees of freedom for the tests are 28 and 15, respectively.

Table 3.8. Parameter Estimates and Model Specification Tests for the CBS Model

Variables	US (Hazelnut)	Georgia	EU	Turkey	US (Almond)	Spain	Australia	ROW
Constant	0.002	0.017**	0.007**	0.038**	-0.101**	0.021**	0.012	0.004**
	(-0.003)	(0.005)	(0.003)	(0.016)	(0.020)	(0.005)	(0.007)	(0.002)
d ln(p_{us_h})	-0.018	0.006	0.004	-0.004	-0.001	0.003	0.005	0.001
	(0.011)	(0.013)	(0.008)	(0.016)	(0.004)	(0.012)	(0.008)	(0.006)
d ln(p_{ge_h})	0.006	0.024	0.038**	-0.047	-0.009	-0.014	0.014	-0.012
	(0.013)	(0.031)	(0.014)	(0.033)	(0.007)	(0.018)	(0.008)	(0.009)
d ln(p_{eu_h})	0.004	0.038**	-0.084**	0.044**	0.000	0.002	0.002	-0.004
	(0.008)	(0.014)	(0.015)	(0.017)	(0.004)	(0.013)	(0.008)	(0.008)
d ln(p_{tr_h})	-0.004	-0.047	0.044**	-0.010	-0.050**	0.043*	0.002	0.017
	(0.016)	(0.033)	(0.017)	(0.052)	(0.021)	(0.023)	(0.023)	(0.012)
d ln(p_{us_a})	-0.001	-0.009	0.000	0.050**	0.056**	0.000	0.006	-0.003
	(0.004)	(0.007)	(0.004)	(0.021)	(0.026)	(0.007)	(0.010)	(0.003)
d ln(p_{sp_a})	0.003	-0.014	0.002	0.043*	0.000	-0.056**	-0.002	0.030**
	(0.012)	(0.018)	(0.013)	(0.023)	(0.007)	(0.022)	(0.010)	(0.010)
d ln(p_{au_a})	0.005	0.014	0.002	0.002	0.006	-0.002	-0.010	-0.053**
	(0.008)	(0.013)	(0.008)	(0.023)	(0.010)	(0.013)	(0.019)	(0.006)

Table 8. Cont'd

$dln(p_{row\_a})$	0.005	-0.012	-0.005	0.022**	-0.003	0.024**	-0.017**	0.022**
	(0.005)	(0.008)	(0.007)	(0.010)	(0.003)	(0.009)	(0.005)	(0.008)
d ln Q	-0.017*	-0.034**	-0.012	-0.037	0.259**	-0.078**	-0.054**	-0.029**
	(0.009)	(0.015)	(0.009)	(0.049)	(0.061)	(0.014)	(0.022)	(0.007)
Q1	-0.033**	-0.035**	-0.023**	-0.108**	0.272**	-0.046	-0.020	-0.007*
	(0.005)	(0.008)	(0.004)	(0.026)	(0.032)	(0.008)	(0.012)	(0.004)
Q2	-0.009**	-0.029**	-0.005	-0.075**	0.123**	-0.024**	0.021*	-0.003
	(0.004)	(0.007)	(0.004)	(0.023)	(0.028)	(0.007)	(0.011)	(0.003)
Q4	0.040**	0.005	0.002	0.018	-0.047	0.010**	-0.027**	-0.002
	(0.004)	(0.007)	(0.004)	(0.024)	(0.029)	(0.007)	(0.011)	(0.003)
R^2	0.93	0.70	0.82	0.80	0.90	0.85	0.74	0.82
Normality[1]	0.36	0.86	0.58	0.39	0.51	0.04	0.51	0.43
DW	2.48	2.20	2.63	2.10	2.50	2.32	2.58	2.92

Note: White test Chi-square values are 37 and the associated probabilities are 0.42 for system equations; therefore, test statistics are failed to reject the null hypothesis of homogeneity at 5 percent level.

Standard errors in parentheses.**, and * indicate significance at 5 percent or better and 10 percent levels, respectively.

[1]Computed p-values are reported. Normality assumption is failed to reject in system equations at 5 percent level except equation for Spain.

[2] The critical DW values are 0.628 and 2.186.

Table 3.9. Model Selection Tests in the Hazelnut Demand Estimation

Demand Model	Wald Test	Likelihood Ratio	Result[i]
Rotterdam	20.56	20.63	Reject
AIDS	0.44	0.45	Fail to reject
CBS	1.10	1.12	Fail to reject
NBR	19.31	19.38	Reject

[i]The critical value at 5 percent level is 5.99 in all tests.

Table 3.10. Parameter Estimates and Model Specification Tests of the Hazelnut Demand Estimation (the CBS Model)

Variables	US	Georgia	EU	Turkey
Constant	-0.001	0.029	0.042**	-0.070**
	(0.013)	(0.023)	(0.014)	(0.027)
d ln(p_{us})	-0.027	-0.025	-0.006	0.057
	(0.020)	(0.031)	(0.022)	(0.038)
d ln(p_{ge})	-0.025	0.229	0.120**	-0.325**
	(0.031)	(0.107)	(0.058)	(0.103)
d ln(p_{eu})	-0.006	0.120**	-0.208**	0.094
	(0.022)	(0.058)	(0.061)	(0.064)
d ln(p_{tr})	0.057	-0.324**	0.094	0.174
	(0.038)	(0.103)	(0.064)	(0.128)
d ln Q	-0.02	0.008	-0.127**	0.139**
	(0.027)	(0.047)	(0.030)	(0.055)
Q1	-0.072**	-0.027	-0.115**	0.214**
	(0.027)	(0.048)	(0.030)	(0.056)
Q2	-0.02	-0.059*	-0.033	0.112**
	(0.019)	(0.033)	(0.021)	(0.039)
Q4	0.100**	-0.031	0.014	-0.084**
	(0.014)	(0.024)	(0.016)	(0.029)
R^2	0.85	0.41	0.63	0.69
Normality[1]	0.75	0.9	0.58	0.72
DW[2]	2.46	1.83	2.41	1.93
Homogeneity and Symmetry[3]	8.65			

Note: White test Chi-square values are 37 and the associated probabilities are 0.42 for system equations; therefore, test statistics are failed to reject the null hypothesis of homogeneity at 5 percent level.

Standard errors in parentheses.**, and * indicate significance at 5 percent or better and 10 percent levels, respectively.

[1]Computed p-values are reported. Normality assumption is failed to reject in system equations at 5 percent level.

[2] The critical DW values are 0.841 and 1.825.

[3] Computed Chi^2 is reported for the system. The critical value at 5 percent level is 14.07.

Table 3.11. Parameter Estimates and Model Specification Tests of Hazelnut Demand (the AIDS Model)

Variables	US (Hazelnut)	Georgia	EU	Turkey
Constant	-0.004	0.029	0.043**	-0.067**
	(0.012)	(0.023)	(0.014)	(0.027)
d ln(p_{us})	-0.004	-0.025	-0.009	0.023
	(0.020)	(0.031)	(0.022)	(0.038)
d ln(p_{ge})	-0.019	0.229	0.104**	-0.377**
	(0.031)	(0.107)	(0.059)	(0.129)
d ln(p_{eu})	-0.009	0.120**	-0.117**	0.021
	(0.022)	(0.058)	(0.062)	(0.064)
d ln(p_{tr})	0.003	-0.324**	0.021	0.333**
	(0.038)	(0.103)	(0.064)	(0.129)
d ln Q	-0.016	0.008	-0.126**	0.129**
	(0.026)	(0.031)	(0.031)	(0.055)
Q1	-0.065**	-0.027	-0.115**	0.205**
	(0.026)	(0.048)	(0.031)	(0.056)
Q2	-0.016	-0.059*	-0.035	0.108**
	(0.018)	(0.033)	(0.021)	(0.039)
Q4	0.100**	-0.031	0.012	-0.078**
	(0.014)	(0.024)	(0.016)	(0.029)
R^2	0.85	0.41	0.62	0.68
Normality[1]	0.80	0.91	0.99	0.64
DW[2]	2.52	1.83	2.39	1.98
Homogeneity and Symmetry[3]	9.99			

Note: White test Chi-square values are 37 and the associated probabilities are 0.42 for system equations; therefore, test statistics are failed to reject the null hypothesis of homogeneity at 5 percent level.

Standard errors in parentheses.**, and * indicate significance at 5 percent or better and 10 percent levels, respectively.

[1]Computed p-values are reported. Normality assumption is failed to reject in system equations at 5 percent level.

[2] The critical DW values are 0.841 and 1.825.

[3] Computed Chi^2 is reported for the system. The critical value at 5 percent level is 14.07.

Table 3.12. Marshallian Price Elasticities and Expenditure Elasticities for World Hazelnut Demand

Country	Own-price Elasticities	Cross-price Elasticities				Expenditure Elasticities
		U.S.	Georgia	E.U	Turkey	
U.S.	-0.879**	-	-0.463	-0.173	0.938	0.557**
	(0.066)		(0.294)	(0.116)	(0.608)	(0.265)
Georgia	4.416*	-0.363**	-	1.920**	-7.208**	1.235**
	(2.581)	(0.172)		(0.910)	(3.432)	(0.112)
E.U	-1.931**	-0.019	1.022**	-	1.072**	-0.144
	(0.255)	(0.032)	(0.240)		(0.304)	(0.276)
Turkey	-0.693**	0.022**	-0.506**	0.007	-	1.170**
	(0.032)	(0.004)	(0.041)	(0.005)		(0.012)

Note: The elasticities and corresponding standard errors were computed at their mean values. Standard errors in parentheses.**, and * indicate significance at 5 percent or better and 10 percent levels, respectively.

Table 3.13. Model Selection Tests in the Almond Demand Estimation

Demand Model	Wald Test	Likelihood Ratio	Result[i]
Rotterdam	2.41	2.40	Fail to reject
AIDS	36.92	36.97	Reject
CBS	12.20	12.22	Reject
NBR	7.30	7.33	Reject

[i]The critical value at 5 percent level is 5.99 in all tests.

Table 3.14. Parameter Estimates and Model Specification Tests for Almond Demand (the Rotterdam Model)

Variables	US	Spain	Australia	ROW
Constant	-0.047**	0.028**	0.014	0.005*
	(0.012)	(0.009)	(0.008)	(0.003)
d ln(p_{us})	-0.032*	0.016	0.013	-0.041**
	(0.018)	(0.014)	(0.012)	(0.008)
d ln(p_{es})	0.016	-0.081**	0.022	0.022*
	(0.014)	(0.025)	(0.022)	(0.012)
d ln(p_{au})	0.013	0.022	-0.015	-0.007
	(0.012)	(0.022)	(0.024)	(0.013)
d ln(p_{row})	0.003	0.044**	-0.020**	0.025**
	(0.004)	(0.010)	(0.007)	(0.009)
d ln Q	1.018**	0.003	-0.027	0.051**
	(0.029)	(0.023)	(0.020)	(0.018)
Q1	0.106**	-0.078**	-0.015	-0.010**
	(0.016)	(0.013)	(0.012)	(0.004)
Q2	0.006	-0.035**	0.032**	-0.004
	(0.017)	(0.013)	(0.013)	(0.004)
Q4	0.018	0.027**	-0.045**	0.003
	(0.016)	(0.013)	(0.012)	(0.004)
R^2	0.92	0.87	0.82	0.84
Normality[1]	0.21	0.03	0.99	0.31
DW[2]	2.41	2.22	2.47	2.63
Homogeneity and Symmetry[3]	5.18			

Note: White test Chi-square values are 37 and the associated probabilities are 0.42 for system equations; therefore, test statistics are failed to reject the null hypothesis of homogeneity at 5 percent level.

Standard errors in parentheses.**, and * indicate significance at 5 percent or better and 10 percent levels, respectively.

[1]Computed p-values are reported. Normality assumption is failed to reject in system equations at 5 percent level.

[2] The critical DW values are 0.841 and 1.825.

[3] Computed Chi^2 is reported for the system. The critical value at 5 percent level is 14.07.

Table 3.15. Marshallian Price Elasticities and Expenditure Elasticities for World Almond Demand

Country	Own-price Elasticities	Cross-price Elasticities				Expenditure Elasticities
		U.S.	Spain	Australia	ROW	
U.S.	-1.068**	-	-0.171**	-0.051	-0.067**	1.357**
	(0.005)		(0.086)	(0.057)	(0.030)	(0.143)
Spain	-0.642**	0.133**	-	0.169**	0.338**	0.003**
	(0.176)	(0.036)		(0.046)	(0.093)	(0.001)
Australia	-0.519	1.282	0.933	-	-0.673	-1.023
	(0.488)	(1.126)	(0.868)		(0.589)	(0.911)
ROW	-0.555**	-0.019*	0.885**	-0.427**	-	0.115**
	(0.135)	(0.011)	(0.221)	(0.104)		(0.028)

Note: The elasticities and corresponding standard errors were computed at their mean values. Standard errors in parentheses.**, and * indicate significance at 5 percent or better and 10 percent levels, respectively.

Appendix

Global hazelnut trade statistics shows that Turkey is the largest hazelnut exporter and the rest of the world (ROW) is a net hazelnut importer. Thus, the ROW total demand is defined as the sum of ROW supply and imports. Equation (A1) presents the ROW's imports.

$Q^{W}_{M} = Q^{W}_{D} - Q^{W}_{S}$ (A1)

where Q^{W}_{M} is the ROW's imports; Q^{W}_{D} is the ROW's total demand; Q^{W}_{S} is the ROW's total supply. Taking the total derivative of equation (A1) and converting it into percentage changes to yield:

$k_M \, \eta_W = \eta_W - \varepsilon_W \, k_S$ (A2)

where η_W is the import demand elasticity; ε_W is supply elasticity; k_M is the import share (i.e., Q^{W}_{M} / Q^{W}_{D}); k_S is the supply share (i.e., Q^{W}_{S} / Q^{W}_{D}) Solving (A2) for η_W gives the following formula to calculate the export demand elasticity of Turkey.

$\eta_W = \eta_X = \frac{\eta_W - \varepsilon_W \, k_S}{k_M}$ (A3)

The export demand elasticity is calculated as the average value of η_W for the period of 1961-2011 (Table A1). The demand and supply elasticities used in equation (A3) are the US domestic supply and demand elasticities[42] treated as a representative for the ROW.

The implicit assumption is that consumer preferences and production technologies are similar worldwide.

[42] The only known study for ROW supply and demand elasticity is Gopinath and Saito (2006), which estimates the US domestic supply and demand elasticities as 0.17 and -0.33, respectively.

Table A1. World Production and Import Share

Years	k_s [a] (%)	k_m [a] (%)	η_x [b]	η_x [c]
1961-63	48	52	-0.80	-1.12
1964-66	42	58	-0.70	-0.95
1967-69	38	62	-0.64	-0.84
1970-72	41	59	-0.67	-0.90
1973-75	37	63	-0.63	-0.83
1976-78	34	66	-0.58	-0.76
1979-81	37	63	-0.62	-0.82
1982-84	33	67	-0.58	-0.75
1985-87	38	62	-0.63	-0.84
1988-90	36	64	-0.62	-0.81
1991-93	36	64	-0.61	-0.81
1994-96	35	65	-0.60	-0.78
1997-99	37	63	-0.62	-0.83
2000-02	34	66	-0.58	-0.76
2003-05	37	63	-0.63	-0.83
2006-08	40	60	-0.67	-0.90
2009-11	37	63	-0.63	-0.83
Average	38	62	-0.63	-0.84

Source: Calculated data from FAOSTAT and USDA.

[a] Three years average shares of world production and imports to world demand excluding Turkey.

[b] Three years average export demand elasticity for Turkey's hazelnut computed using text equation A1with $\varepsilon_W = 0.17$

[c] Three years average export demand elasticity for Turkey's hazelnut computed using text equation A1 with $\varepsilon_W = 0.51$

Appendix 2

Table A2. Gravity Model Estimations (MRL in Logarithm and Lagged Variables Excluded)

	PPML (MRL in logs)	Heckman (MRL in logs)	Heckman (Lags dropped)	PPML (Lags dropped)
LN(IMPORTS)				
ln(Distance)	-1.282*	-0.629**	-0.797***	-2.251***
	(0.74)	(0.30)	(0.29)	(0.56)
ln(Production)	1.193***	1.374***	1.366***	1.247***
	(0.07)	(0.05)	(0.05)	(0.08)
ln(MRL)	1.122***	0.186**	0.165***	0.294***
	(0.16)	(0.07)	(0.04)	(0.02)
Lagged-ln(MRL)	0.313**	0.019	-	-
	(0.15)	(0.04)		
Land-locked	0.909**	-0.924**	-0.746*	0.287
	(0.44)	(0.43)	(0.42)	(0.42)
Colonial-ties	-0.225	-0.195	-0.277	1.396***
	(0.82)	(0.36)	(0.36)	(0.74)
Border	-0.878	1.311***	1.166***	-1.641***
	(0.70)	(0.33)	(0.32)	(0.52)
Trade agreement	-0.027	0.051	0.336	-0.093
	(0.41)	(0.28)	(0.26)	(0.29)
Lag-Trade agreement	-0.517***	0.186	-	-
	(0.14)	(0.21)		
EU Exporters	0.623	0.498**	0.599**	0.885*
	(0.50)	(0.23)	(0.26)	(0.52)
Commercial code	1.963***	-	-	-1.466***
	(0.39)			(0.11)

Table A2. Cont'd

<u>SELECTION</u>				
ln(Distance)		-0.272*	-0.308**	
		(0.15)	(0.15)	
ln(Production)		0.393***	0.400***	
		(0.03)	(0.03)	
ln(MRL)		0.039	0.051***	
		(0.03)	(0.01)	
Lagged-ln(MRL)		0.058**	-	
		(0.02)		
Land-locked		-0.137	-0.096	
		(0.16)	(0.16)	
Colonial-ties		-0.378	-0.380	
		(0.26)	(0.26)	
Border		0.636**	0.621**	
		(0.25)	(0.25)	
Trade agreement		-0.038	0.188**	
		(0.11)	(0.09)	
Lag-Trade agreement		0.224**	-	
		(0.11)		
EU Exporters		0.339***	0.370***	
		(0.10)	(0.10)	
Commercial code		0.280***	0.290***	
		(0.09)	(0.08)	
Estimated corr. coeff.		0.479***	0.477***	
		(0.07)	(0.07)	
Estimated corr. coeff.		0.884***	0.871***	
		(0.03)	(0.03)	
Observations	12898	13456	14258	13734
R^2	0.66			0.69

Standard errors in parentheses.***, **, and * indicate significance at 1%, 5%, and 10% levels, respectively. Time, exporter, importer, and product fixed effects are not reported.

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