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AN ECONOMIC WELFARE ANALYSIS OF AGRICULTURAL SUBSIDIES AND INVENTORY HOLDINGS: AN APPLICATION TO THE HAZELNUT INDUSTRY[1]

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Abstract

This study presents an industry model developed to analyze the link between targeted production subsidies and excess inventory holdings by using equilibrium displacement modelling. 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. Monte Carlo simulation results suggest that the policy is expected to achieve its objectives as it improves the welfare of targeted producers and reduces government inventories. The average 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.

Key words: Applied welfare analysis, Hazelnut, Monte Carlo simulation, Partial equilibrium, Storage
JEL Classifications: Q17, Q18

1. 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[2] 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 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.

2. 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[3]. 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 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 (see Table 1).

Table 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 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.

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.

3. 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[4]. 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 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[5]. 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.

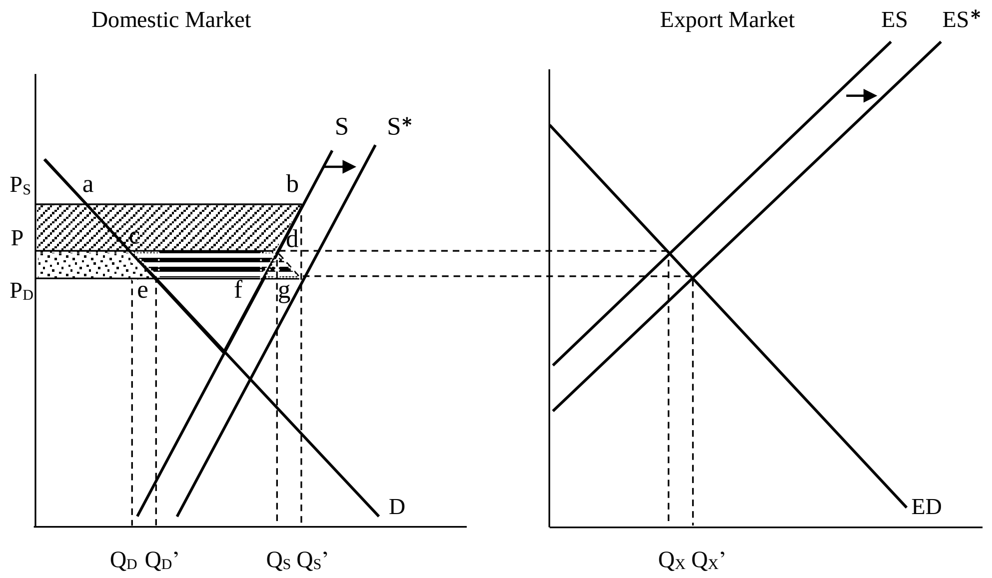
4. Graphical Analysis

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.

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 $PP_d hi$ 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 $PP_d ec$ and by the lined area *cdeg*, respectively. Taxpayers finance the cost of the program illustrated with rectangle $P_sP_d kn$. Thus, the net change in domestic welfare[6] is equal to the sum of welfare increases for licensed producers and domestic consumers (PP_smk + $PP_d ec$), the welfare loss of unlicensed producers (PP_shi), and the government outlays (rectangle $P_sP_d kn$).

Panel A.



Panel B.

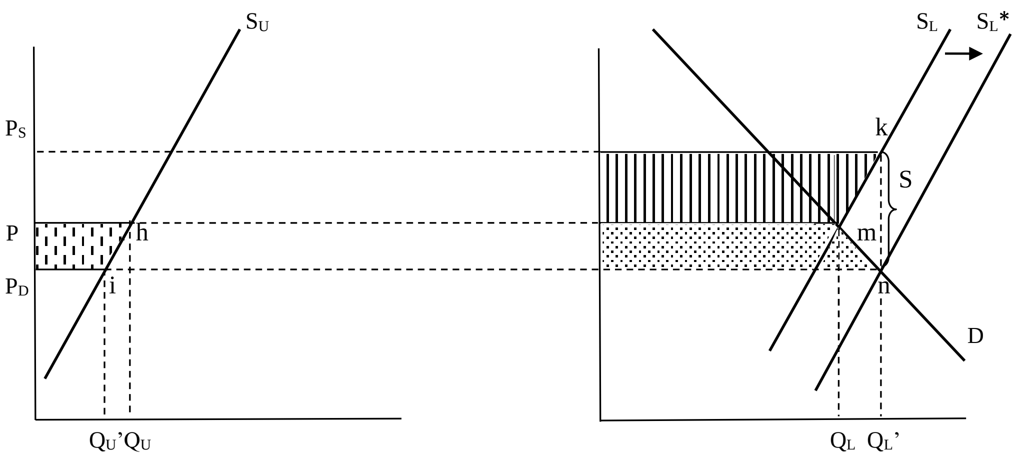


Figure 1. Effects of a Targeted Production Subsidy on Market Price, Production, Consumption, and Exports.

5. 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 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:

$$Q_D = D(P_D) \tag{1}$$
$$Q_X = X(P_D) \tag{2}$$
$$Q_S = \overline{Y}_L A_L + \overline{Y}_U A_U \tag{3}$$
$$A_L = A(P_L) \tag{4}$$
$$A_U = A(P_D) \tag{5}$$
$$P_L = P_D * \overline{P}_{SL} \tag{6}$$
$$where\ \overline{P}_{SL} = 1 + \overline{P}_S / P_D$$
$$INV_E = f(P_D) \tag{7}$$
$$Q_{TS} = Q_S + \overline{INV}_B \tag{8}$$
$$Q_{TD} = Q_D + Q_X + INV_E \tag{9}$$
$$Q_{TS} = Q_{TD} \tag{10}$$

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 2. 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[7] $(\overline{Y}_L, \overline{Y}_U, \overline{P}_S, \overline{INV}_B)$. 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. 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 2 contains the variable values for the effective policy period of 2009-2011.

Table 2. 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	1025	1025	780	943
	beginning inventories (1,000MT)				
INV_E	Ending inventories (1,000MT)	425	350	152	309
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	527	673	711	637
	ending inventories (1,000MT)				
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.

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

$$Q_d^* = -\eta_d \, P_D{}^* \tag{9}$$

$$Q_x^* = -\eta_x \, P_D{}^* \tag{10}$$

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.

$$Q_s^* = k_L A_L^* + k_U A_U^* \tag{11}$$

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.

$$A_L^* = \varepsilon_L P_L^* \tag{12}$$

$$A_U^* = \varepsilon_U P_D^* \quad (13)$$
$$P_L^* = P_D^* + \overline{P}_{SL}^* \quad (14)$$
$$INV_E^* = \eta_{INV} P_D^* \quad (15)$$
$$Q_{TS}^* = k_S Q_S^* + k_B \overline{INV}_B^* \quad (16)$$
$$Q_{TD}^* = k_D Q_D^* + k_X Q_X^* + k_E INV_E^* \quad (17)$$
$$Q_{TS}^* = Q_{TD}^* \quad (18)$$

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 3 with their empirical values.

Table 3. 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.

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[8] as:

$$\Pi Y = \Gamma Z \tag{22}$$

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:

$$Y = EZ \tag{23}$$

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.

5.1. 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 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 2. 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).

$$\Delta PS_i = PQ_{Si}(P_i^* - V_S)(1 + 0.5Q_{Si}^*) \quad \text{for } i = \textit{licensed and unlicensed producers} \tag{24}$$
$$\Delta CS_i = -PQ_{Di}P_D^*(1 + 0.5\, Q_{Di}^*) \quad \text{for } i = \textit{domestic and export market consumers} \tag{25}$$
$$\Delta IS = -PQ_E P_D^*(1 + 0.5\, Q_E^*) \tag{26}$$

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:

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

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 3. 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.

6. Simulation Results and Discussion

The analysis includes deterministic and stochastic simulations of Equation (25). Baseline values in Table 3 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[9].

Reduced-form elasticities simulated for the preceding parameter values are presented in Table 4. 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).

Table 4. 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.

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.

The welfare distribution effects of a 10 percent increase in targeted production subsidy are presented in Table 5. The welfare gains are split between licensed producers, domestic and foreign consumers, and the Turkish treasury due to reduced inventory holdings.

Table 5. 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.

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.

7. 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.

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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[10] treated as a representative for the ROW.

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

Table A1. World Production and Import Share

Years	k_s* (%)	k_m* (%)	η_x^{**}	η_x^{***}
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.

***** Three years average shares of world production and imports to world demand excluding Turkey.

****** Three years average export demand elasticity for Turkey's hazelnut computed using text equation A1with ε_W=0.17

******* Three years average export demand elasticity for Turkey's hazelnut computed using text equation A1 with ε_W=0.51

[1] This research is a part of the doctoral dissertation submitted to Auburn University, USA. It was presented in International Conference on Food and Agricultural Economics held in Alanya, Turkey on April 27-28, 2017.

[2] 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.

[3] 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).

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

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

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

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

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

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

[10] 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.