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IMPACT OF U.S. DUTY DRAWBACK ON THE DEMAND FOR ORANGE JUICE

BY

Mark G. Brown, Sr. Research Economist -- FDOC

Waldir B. Fernandes, Graduate Student -- UF

Thomas H. Spreen, Professor -- UF

Jonq-Ying Lee, Sr. Research Economist – FDOC

FLORIDA DEPARTMENT OF CITRUS

Economic and Market Research Department

P.O. Box 110249

Gainesville, Florida 32611-2049 USA

Phone: 352-392-1874

Fax: 352-392-8634

Email: mgbrown@ufl.edu

www.floridajuice.com

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Mark G. Brown,

Waldir B. Fernandes

Thomas H. Spreen

Jonq-Ying Lee*

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* Mark G. Brown is a research economist with the Economic and Market Research Department, Florida Department of Citrus and courtesy associate professor, Food and Resource Economics Department, University of Florida, 2129 McCarty Hall, P.O. Box 110249, Gainesville, FL 32611-0249, Telephone: (352) 392-1874, extension 501, Fax (352) 392-8634, E-Mail: MGBrown@ifas.ufl.edu. Waldir B. Fernandes is a graduate student, Food and Resource Economics Department, University of Florida. Thomas H. Spreen is professor and chair, Food and Resource Economics Department, University of Florida, Gainesville, FL. Jonq-Ying Lee is a research economist with the Economic and Market Research Department, Florida Department of Citrus and courtesy professor, Food and Resource Economics Department, University of Florida, Gainesville, FL.

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Abstract

A demand system model differentiating goods by origin is developed to examine impacts of duty drawback on U.S. orange juice exports and prices. An empirical analysis suggests that on average duty drawback has increased annual orange juice exports by about 16.5 million SSE gallons or 11% of export sales, and has supported the U.S. price of orange juice by about 2 cents per gallon. Not all benefits of duty drawback go to exporters. Importers who own drawback credits but do not export product may realize benefits by selling their credits to exporters. The analysis suggests these benefits effectively reduce the U.S. orange juice tariff, positively impacting imports and negatively impacting the U.S. price.

Key words: prices, duty drawback, tariff, demand, orange juice.

Impact of U.S. Duty Drawback on the Demand for Orange Juice

Introduction

The impacts of duty drawback on U.S. orange-juice (OJ) exports and prices are examined in this paper. A world supply-demand model is developed to analyze the allocation of OJ by country of origin across world markets for various drawback scenarios.[1] The demand side of the model focuses on the substitution between U.S. and foreign OJ products which are considered to be close but not perfect substitutes, varying by color, viscosity and sugar/acid ratio, among other attributes.

The analysis examines the impact of duty drawback under the short-run assumption that supply is not a function of price. Orange tree populations across producing countries along with weather largely determine OJ production in the current year independent of prices.[2] Production for the next several years also tends to be independent of prices. Trees under three years old generally do not produce a significant amount of fruit to be commercially harvested, and production for the next several years is largely dependent on maturation of the current tree populations (yield per tree tends to increase with age) and tree losses. In upcoming years, higher than average tree losses are expected as a result of diseases in the two largest orange and OJ producing countries in the world, Brazil and the U.S. Trees are being lost to the citrus tristeza virus (CTV) and canker in Florida and citrus chlorosis variegated (CVC) and "sudden death of

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1 OJ tariffs and associated duty drawback have been relatively constant over time, making direct estimation of the impacts of duty drawback through simple regression problematic.

2 OJ prices are assumed to be high enough for growers to maintain groves and tree yields, as has generally been the case historically.

citrus" in Brazil. Tree losses to diseases combined with maturing tree populations may even keep orange production relatively flat or possibly result in production declines in upcoming years (Florida Department of Citrus).

In the long run, prices may have a notable impact on production through planting rates, and following Spreen, Brewster and Brown, extension of our model to the long run is straightforward. The latter study found a strong, positive relationship between tree planting levels in Florida and previous season grower prices. A similar relationship was found for Brazil. Hence, following their study, price levels determined in the short run along with past prices might be used to determine planting levels, which, in turn, might be used to determine future production in a forward recursive manner.

In general, the modeling approach of this study is similar to that taken by Brown, Lee and Spreen to study the impact of OJ advertising in the U.S. market and free-rider effects with respect to imports, and that used by Spreen, Brewster and Brown to study the impact of the U.S. OJ tariff. In each of these studies, an exogenous change in some specific market (a change in advertising or a change in the tariff in the domestic market) initially results in a demand shift in that market, which, in turn, results in supply, demand and price changes for the product in question and closely related goods across world markets. Similarly, duty drawback is viewed as an exogenously determined export subsidy, the elimination of which results in changes in the allocation of OJ across world markets and various prices.

The U.S. Orange-Juice Tariff

Most U.S. imports of orange juice (OJ) are subject to a tariff. For 2003, the most-favored-nation (MFN) tariff rates for frozen concentrated orange juice (FCOJ) and not-from-concentrate orange juice (NFC) are \$.297 per single-strength-equivalent (SSE) gallon and \$.170 per gallon, respectively. The MFN tariff rates declined by 15% from 1994 to 2000 according to the General Agreement on Trade and Tariffs (GATT). No further tariff rate declines are scheduled, but with the trend towards trade liberalization including special trade agreements between blocks of countries, uncertainty exists with regard to what future tariff rates may be. The MFN tariffs apply to Brazil which is the largest producer of OJ in the world and is the dominant supplier of imported OJ to the U.S. market. U.S. OJ imports from Caribbean countries (CBERA), Andean Trade Preference Act countries (ATPA), Israel, African Growth and Opportunity Act countries (AGOA) including South Africa and Canada are duty free. OJ imports from Mexico receive preferential treatment as established by the North American Free Trade Agreement (NAFTA)--- the first 40 million SSE gallons of FCOJ and all NFC from Mexico are subject to reduced tariff rates; presently imports of FCOJ above the 40-million-gallon level are subject to a tariff rate that is the same as the MFN tariff; the NAFTA tariffs on FCOJ and NFC are scheduled to decline to zero by 2008 (Spreen and Mondragon).

Duty Drawback

Some OJ exported from the U.S. is eligible for duty drawback which is a refund of duties or internal revenue taxes. The U.S. Government has offered various drawback provisions since the Tariff Act of 1789. The intention of drawback is to encourage U.S. commerce and manufacturing. Duty on an imported product subsequently exported or used to produce a product for export increases the production cost of the exported product, putting the exporter at a competitive disadvantage in foreign markets. To enable U.S. industry to compete more effectively in foreign markets, the U.S. government offers drawback on duties collected on the imported good eventually exported in some form. Drawback is provided for numerous products, including components used in manufacturing aircraft, automobiles, computers, apparel, footwear, and petroleum, as well as OJ. With the U.S. being a major importer and exporter of OJ, drawback is an important provision for selling OJ in foreign markets---without drawback, duties paid on OJ imports subsequently exported can put sellers at a critical cost disadvantage in export markets.

Drawback law allows one to export a substitute product in lieu of imported product; that is, drawback is allowed even though it is the substitute product, not the imported product that is exported. Substitution drawback provisions apply, but are not unique, to OJ. The definition of substitute product under drawback law depends on whether the exported product was manufactured or not. When the substitute is used in manufacturing export product, the import must also be used in manufacturing. For manufactured OJ products (blends or packaged products), drawback law requires that the import and substitute be the same grade---if the imports are USDA Grade A, then the substituted product exported must be USDA Grade A.

This requirement allows a moderate degree of flexibility in substitution. For example, with the minimum score for USDA Grade A product being 90 points,[3] Grade A imports with 90 score and Grade A exports with 95 score, or vice versa, would meet the substitution requirements.

When an OJ import or its substitute is not used in manufacturing (unused merchandise), the substitute product exported must be commercially interchangeable with the imported product. The definition of commercially interchangeable is based on New York Board of Trade standards for FCOJ futures contracts---e.g., if the imports are Grade A with 93 score, then the substitute must be Grade A with 93 score or close enough to be considered commercially interchangeable. Under these standards, substitution for unused merchandise drawback is defined more narrowly than for manufacturing drawback.[4] As a result of this narrower definition, unused merchandise drawback opportunities are more limited compared to those for manufacturing drawback.

For both manufacturing and unused merchandise, drawback is 99% of the duty with the other 1% used for defraying Customs costs. The Government allows up to three years after importation for drawback to be claimed.

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3 The Grade A score of 90 is for color, defects and flavor; in addition, Grade A product must also satisfy standards for other factors, including ratio, Brix and recoverable oil.

4 Substitution for manufacturing drawback is more lenient than for unused merchandise drawback, since manufacturing drawback is expected to create more U.S. jobs than unused merchandise drawback.

The Conceptual Model

In the short run, suppliers are assumed to allocate a fixed amount of product across world markets to maximize profit under competition.[5] Consider the world demands for OJ by origin, and, for simplicity, assume two origins, the U.S. and the rest of the world (RW).[6] The world demand for each origin's OJ is an aggregate of demands across markets, and is specified as a function of the origin's price and the price of the other origin's product. Formally, these aggregate demands can be written as

(1a) $q_1 = \alpha_1 + \beta_{11} p_1 + \beta_{12} p_2$,

(1b) $q_2 = \alpha_2 + \beta_{21} p_1 + \beta_{22} p_2$,

or, in matrix form,

(1c) $q = \alpha + \beta p$,

where q_s and p_s are the quantity and grower price[7] of OJ produced in region s (s=1 for the U.S. and s=2 for the RW); α_s and β_{sj} are parameters; $q = (q_1, q_2)'$, $p = (p_1, p_2)'$ and $\alpha = (\alpha_1, \alpha_2)'$ are 2x1 column vectors; and $\beta = (\beta_{11}, \beta_{12} / \beta_{21}, \beta_{22})$ is a 2x2 matrix. The parameters β_{11} and β_{22} are expected to be negative, based on the law of demand, and β_{12} and β_{21} are expected to be positive, given OJ from the U.S. and the RW are substitutes. The prices actually paid in the U.S. and RW

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5 Prices and allocation of product are assumed to be determined by industry supply and demand in a workable competitive sense (e.g., Scherer), although the orange industry is not purely competition, notably in Brazil.

6 Defining world demand by origin is a simplification itself. In addition to quality differences in U.S. versus RW OJ products, differences in OJ produced at each origin also exist. For example, Florida OJ production from Valencia oranges tends to have a higher color score than Florida OJ production from early and midseason oranges. In the subsequent model developed, hence, demand could be further disaggregated by say origin and type of OJ. Lack of detailed data to estimate such a disaggregated model, however, precluded doing so in this study.

7 Instead of the grower price, the FOB or some other price in the marketing chain might be used in the analysis, assuming that the margin between the two prices is constant.

differ from p_1 and p_2 by processing, transportation, tariff/drawback and mark-up margins. As will be specified, these margins are embedded in the intercepts α_1 and α_2.[8]

With fixed supplies, changes in U.S. duty drawback or other margin determinants impact prices through the α's . That is, inverting (1c) gives

(2) $p = \gamma + \pi q$,

where $\gamma = - \beta^{-1} \alpha$ and $\pi = \beta^{-1}$. A change in the U.S. duty drawback would result in a change in α and hence γ which would then result in a change in p. If the process of how α changes can be determined and if π can be estimated, then the impact of duty drawback on prices can be estimated. Below, this problem is examined, beginning with the market specific demand specifications underlying (1a) through (1c).

Assuming OJ products from different producing regions are similar but different with respect to quality, consider U.S. and RW demands for two product categories: (a) OJ produced from U.S. oranges allowing for blending needs,[9] and (b) OJ produced from RW oranges. Formally, let q^r_s be the quantity demanded in market r of OJ from supply region s. Likewise, let p^r_j be the retail price in market r for product from supplier j (j and s are used interchangeably). Assuming constant price margins between levels in the marketing chain as in Takayama and Judge; and Spreen, Brewster and Brown, the delivered-in or grower price of OJ in supply region

[8] U.S. duty drawback is viewed as a per-unit subsidy or negative excise tax that, through intercept changes, results in an outward (inward) shift in the RW demand curve facing U.S. (RW) producers. These demand curves indicate relationships between the subsidy plus market price and quantity demanded, with market prices determined by consumer demand. An alternative, equivalent view is based on the subsidy shifting RW supply.

[9] U.S. OJ may not have a consistent quality throughout the production season. For example, OJ produced from early season oranges may have low sugar content or sugar-acid ration, or may not meet color standards. As a result, imports with desired attributes may be required to produce a blended product. In the analysis, the origin specific supplies q_1 and q_2 are assumed to be production after such blending requirements are met. Formally, let q_{01} be OJ produced from U.S. oranges; q_{02} be OJ produced from RW oranges; r be a given percentage of the blend from RW oranges; and 1-r be a given percentage of the blend from U.S. oranges. Then, $q_1 = q_{01} + rq_1$ and $q_2 = q_{02} - rq_1$.

j is denoted by p_j and the margin between the retail price p^r_j and p_j by c^r_j. That is, $p^r_j = p_j + c^r_j$ — this specification is based on the assumptions that the delivered-in price for OJ in the U.S. is the same whether it is sold in the U.S. or the RW, and the delivered-in price for OJ in the RW (Brazil) is likewise the same regardless the market in which it is sold.

With this notation, the demand in market r for product from supplier s can be written as

(3a) $$q^r_s = \alpha^r_s + \sum_j \beta^r_{s,j}\, p^r_j$$

or

(3b) $$q^r_s = \alpha^r_s + \sum_j \beta^r_{s,j}(p_j + c^r_j)$$

or

(3c) $$q^r_s = \alpha^{*r}_s + \sum_j \beta^r_{s,j}\, p_j,$$

where α^r_s is an intercept for demand in market r for the differentiated product defined by supply region s (the α's include the effects of income and other non-price variables); the β's are quantity-price slopes for the different demands, that is, $\beta^r_{s,j} = \partial q^r_s / \partial p^r_j$, indicating the change in the quantity demanded q^r_s for a change in the price p^r_j (the s subscript on $\beta^r_{s,j}$ indicates the product demanded and the j subscript indicates the price of the product impacting this demand); and $\alpha^{*r}_s = \alpha^r_s + \sum_j \beta^r_{s,j}\, c^r_j$, which can be viewed as a transfer-cost dependent intercept (the specification being sought in context of equations (1a) through (2)). Changes in the margins due to changes say in the tariff/drawback levels affect the intercepts α^{*r}_s, and, in turn, prices (p_j).[10]

[10] This analysis is based on the assumption that the tariff is a fixed amount per unit of product, which is the case for U.S. tariffs on OJ, but is not the case for ad valorem tariffs on OJ in Europe. The latter tariffs are 15.2% of the European landed value of OJ. Ad valorem tariffs can be included in equation (3a) by defining the price p^r_j as $\lambda^r (p_j + c^r_{0j}) + c^r_{1j}$ where c^r_{0j} is the cost of transporting the product to the importing country and c^r_{1j} is the cost margin between the retail and import levels. In context to equation (3c), an ad valorem tariff changes both the quantity-price slope and intercept.

The quantity demanded of OJ from each region s is obtained by summing equations (3a) through (3b) over markets (r). The resulting aggregate demand for product from origin s is

(4) $\sum_r q^r_s = \sum_r \alpha^r_s + \sum_j \sum_r \beta^r_{s,j}\, c^r_j + \sum_j \sum_r \beta^r_{s,j}\, p_j$.

In the short run, the supply q_s from each origin is considered to be fixed, in which case a supply-demand equilibrium is given by

(5) $q_s = \sum_r q^r_s$.

For the case of two origins (U.S. and Brazil) and two markets (U.S. and RW), the foregoing results are written more compactly in terms of matrices as follows (a generalization of these results in log changes is provided in Appendix A).

Demand in U.S.

$$\begin{bmatrix} q^1{}_1 \\ q^1{}_2 \end{bmatrix} = \begin{bmatrix} \alpha^1{}_1 \\ \alpha^1{}_2 \end{bmatrix} + \begin{bmatrix} \beta^1{}_{1,1} & \beta^1{}_{1,2} \\ \beta^1{}_{2,1} & \beta^1{}_{2,2} \end{bmatrix} \left[\begin{bmatrix} p_1 \\ p_2 \end{bmatrix} + \begin{bmatrix} c^1{}_1 \\ c^1{}_2 \end{bmatrix} \right]$$

Demand in RW

$$\begin{bmatrix} q^2{}_1 \\ q^2{}_2 \end{bmatrix} = \begin{bmatrix} \alpha^2{}_1 \\ \alpha^2{}_2 \end{bmatrix} + \begin{bmatrix} \beta^2{}_{1,1} & \beta^2{}_{1,2} \\ \beta^2{}_{2,1} & \beta^2{}_{2,2} \end{bmatrix} \left[\begin{bmatrix} p_1 \\ p_2 \end{bmatrix} + \begin{bmatrix} c^2{}_1 \\ c^2{}_2 \end{bmatrix} \right]$$

Supply = Demand

$$\begin{bmatrix} q_1 \\ q_2 \end{bmatrix} = \begin{bmatrix} q^1{}_1 \\ q^1{}_2 \end{bmatrix} + \begin{bmatrix} q^2{}_1 \\ q^2{}_2 \end{bmatrix}$$

Matrix Definitions:

$$q^1 = \begin{bmatrix} q^1{}_1 \\ q^1{}_2 \end{bmatrix}; \quad \alpha^1 = \begin{bmatrix} \alpha^1{}_1 \\ \alpha^1{}_2 \end{bmatrix}; \quad \beta^1 = \begin{bmatrix} \beta^1{}_{1,1} & \beta^1{}_{1,2} \\ \beta^1{}_{2,1} & \beta^1{}_{2,2} \end{bmatrix}; \quad p = \begin{bmatrix} p_1 \\ p_2 \end{bmatrix}; \quad c^1 = \begin{bmatrix} c^1{}_1 \\ c^1{}_2 \end{bmatrix};$$

$$q^2 = \begin{bmatrix} q^2{}_1 \\ q^2{}_2 \end{bmatrix}; \quad \alpha^2 = \begin{bmatrix} \alpha^2{}_1 \\ \alpha^2{}_2 \end{bmatrix}; \quad \beta^2 = \begin{bmatrix} \beta^2{}_{1,1} & \beta^2{}_{1,2} \\ \beta^2{}_{2,1} & \beta^2{}_{2,2} \end{bmatrix}; \quad c^2 = \begin{bmatrix} c^2{}_1 \\ c^2{}_2 \end{bmatrix}; \quad q = \begin{bmatrix} q_1 \\ q_2 \end{bmatrix}.$$

Based on the above definitions, U.S. demands for OJ from the two origins can be written as

(6) $q^1 = \alpha^1 + \beta^1 (p + c^1)$,

while the RW demands OJ from the two origins can then be written as

(7) $q^2 = \alpha^2 + \beta^2 (p + c^2)$,

and the supply-demand equilibrium can be written as

(8) $q = q^1 + q^2 = \alpha^1 + \alpha^2 + (\beta^1 + \beta^2)p + \beta^1 c^1 + \beta^2 c^2$,

or, letting $\beta = \beta^1 + \beta^2$,

(9) $q = \alpha^1 + \alpha^2 + \beta p + \beta^1 c^1 + \beta^2 c^2$.

Result (9) is equation (1c) with $\alpha = \alpha^1 + \alpha^2 + \beta^1 c^1 + \beta^2 c^2$.

Solving equation (9) for p, find

(10) $p = \pi q - \pi\alpha^1 - \pi\alpha^2 - \pi\beta^1 c^1 - \pi\beta^2 c^2$,

where $\pi = \beta^{-1}$. This result is equation (2) with $\gamma = -\pi\alpha^1 - \pi\alpha^2 - \pi\beta^1 c^1 - \pi\beta^2 c^2$.

Note that the relative, not absolute, sizes of the demand slopes determine the impact of the margins on prices p; that is, multiplying all slopes by some number λ yields $\lambda\beta^1$, $\lambda\beta^2$, $\lambda\beta$, $\pi = \beta^{-1}/\lambda$ and hence $-\pi\beta^1 c^1$ and $-\pi\beta^2 c^2$ are unchanged in equation (10).

Substituting result (10) into equations (6) and (7), reduced form demand equations can be written as

(11a) $q^1 = \alpha^1 + \beta^1 (\pi q - \pi\alpha^1 - \pi\alpha^2 - \pi\beta^1 c^1 - \pi\beta^2 c^2 + c^1)$,

(11b) $q^2 = \alpha^2 + \beta^2 (\pi q - \pi\alpha^1 - \pi\alpha^2 - \pi\beta^1 c^1 - \pi\beta^2 c^2 + c^2)$,

or

(11c) $q^1 = \alpha^1 - \beta^1\pi \alpha^1 - \beta^1\pi\alpha^2 + \beta^1\pi q - \beta^1\pi\beta^1 c^1 - \beta^1\pi\beta^2 c^2 + \beta^1 c^1$,

(11d) $q^2 = \alpha^2 - \beta^2\pi\alpha^1 - \beta^2\pi\alpha^2 + \beta^2\pi q - \beta^2\pi\beta^1 c^1 - \beta^2\pi\beta^2 c^2 + \beta^2 c^2$.

Duty drawback is viewed as a per-unit subsidy or negative excise tax embedded in the term $c^2{}_1$, with subscript 1 indicating U.S. produced OJ and superscript 2 indicating the demand in the RW. The short-run impact of eliminating duty drawback on prices is then found by differentiating equation (10), with all $dc^r{}_j = 0$, except $dc^2{}_1$, that is,

(12) $dp = - \pi\beta^2 dc^2$,

or, with $dc^2{}_2 = 0$,

(13) $dp = -\pi \beta_c dc^2{}_1$,

where $\beta_c = [\beta^2{}_{1,1} , \beta^2{}_{2,1}]'$.

(In the short run, the supply from region s is constant, and $dq_s = 0$ in equation (10)).

If grower prices p_1 and p_2 were constant, elimination of the U.S. duty drawback would increase the retail price for U.S. OJ in the RW market (by 99% of the tariff), which would then result in own-price and cross-price effects on RW demands for OJ originating from the U.S. and RW, respectively. Note the elements of β_c, that is, $\beta^2{}_{1,1}$ is the demand slope for U.S. OJ in the RW market with respect to the U.S. OJ price (own-price slope for OJ originating from the U.S.), while $\beta^2{}_{2,1}$ is the demand slope for RW OJ in the RW market with respect to the U.S. OJ price (cross-price slope for OJ originating from the RW). Given fixed supplies, however, these effects of prices on demands would not occur as such, and instead changes in the grower prices as show by equation (13) are generated.

What signs might be expected for result (13)? The signs of the elements of π, the inverse demand price coefficients, are all expected to be negative; hence, the signs of the elements of $-\pi$ would be all positive. Assume that the magnitudes of the own-quantity coefficients (diagonal elements of π) dominate the cross-quantity coefficients (off diagonal elements of π) in absolute value. For vector β_c, the own-price coefficient $\beta^2_{1,1}$ is expected to be negative, while the cross-price coefficient $\beta^2_{2,1}$ is expected to be positive to the extent that the different products are substitutes. For elimination of duty drawback dc^2_1 is positive. Hence the signs of the terms of β_c dc^2_1 are expected to follow those of β_c (again, the first element being negative and the second being positive). Given the signs of the elements of $-\pi$ are all positive with dominating diagonal elements, the first and second elements of the result $-\pi\ \beta_c\ dc^2_1$ or dp_1 and dp_2 would be expected to have negative and positive signs, respectively. That is, the U.S. grower price would decrease while the RW grower price would increase.

Although U.S. OJ total sales remain constant at the fixed U.S. supply level, the allocation of U.S. OJ between the U.S. and RW markets will change according to reduced form equations (11c) and (11d). A similar reallocation occurs with respect to RW OJ, as indicated by these same equations.

Empirical Analysis

Spatial equilibrium models have typically been used to analyze world trade and prices (Takayama and Judge). In these models, a single, homogeneous good is usually traded, with the impacts of transfer costs on trade volumes and region prices dependent on region-specific own-price, demand slopes; there are no cross-price slopes given a homogeneous good. McClain used this modeling approach to analyze world OJ trade; Spreen, Brewster and Brown extended the model by allowing OJ to be differentiated between FCOJ and NFC in the U.S. and Canadian markets only. When goods are further differentiated, as in the present study, cross-price slopes become critical, providing key insight on demand interrelationships. In a single good, spatial equilibrium model of OJ trade, the U.S. either imports, exports, or does not trade. Other than for blending, this model does not allow importing and exporting at the same time. In contrast, a strength of allowing goods to be differentiated as suggested in this study is that importing and exporting can occur simultaneously. It should be recognized, however, that identification of the cross-price slopes can be difficult. The empirical results presented here illustrate both the insight gained in specifying these demand interrelationships and the sensitivity of the results to the magnitudes of the cross-price slopes.

This study examines the impacts of duty drawback on exports and prices using equations (10) through (11d), as well as underlying equations (3b) through (5). Market demand slopes by product origin ($\beta^{r}_{s,j}$) are required to apply the model equations, and the analysis is based on estimates of U.S. and RW demands for U.S. versus Brazil product. Brazil is the largest producer of oranges and OJ in the world, followed by the U.S. In 1999-00, the U.S. and Brazil accounted for 86% of the oranges processed in the world (FAO). Given this concentration, the analysis assumes the demand coefficients for Brazilian product are representative of the RW.

The demands were estimated separately, as the data used varied across markets with respect to time period (in general, over the last 12 to 13 years), observation period (weekly, quarterly and annual) and variables. Log and linear functional forms were used based on fit. Although representative of the demands specified in the previous section, the data do not precisely follow the previous model variables, and notation for the estimated demands is chosen to recognize the differences (e.g., Q and P are used for quantities and prices instead of q and p in the last section).

RW Demand for U.S. OJ and Duty Drawback Impact with Constant Grower Prices

Based on U.S. export data (U.S. Department of Commerce) and the Brazilian FCOJ price data (Foodnews), the estimate of the demand for U.S. OJ in the RW is

$$(14)\quad dQ_{3,t} = \underset{(.719)}{2.405} - \underset{(2.933)}{25.461} dP_{3,t} + \underset{(2.092)}{6.812}\, dP_{4,t},\quad R^2 = .59,$$

where subscript t stands for time; Q_3 is U.S. OJ exports in millions of SSE gallons; P_3 and P_4 are prices in dollars per SSE gallon for U.S. exports and Brazil OJ shipped to Europe (Rotterdam)[11], respectively; and $dQ_{3,t} = Q_{3,t} - Q_{3,t-4}$; $dP_{3,t} = P_{3,t} - P_{3,t-4}$; and $dP_{4,t} = P_{4,t} - P_{4,t-4}$. Fourth differences were taken to account for seasonality. Standard errors are given in parentheses below the coefficient estimates. All coefficient estimates are significantly different from zero at any reasonable level of significance. Quarterly data from the first quarter of 1989 through the fourth quarter of 2002 (56 observations) were used to estimate this equation.

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[11] Europe is the largest market for Brazil OJ.

For analysis of the impact of duty drawback, all demand slopes are expressed on an annual basis, which, in the case of result (14), means the estimated U.S. export demand slope used in the analysis is $\partial q^2{}_l/\partial p_l$ = -102 million SSE gallons per year---a \$1 price change results in a 102 (4 times 25.641) million SSE gallons change in the opposite direction. From equation (3b), the impact of a change in duty drawback ($c^2{}_l$) on exports sales, holding grower prices constant, is then $dq^2{}_l = \partial q^2{}_l/\partial p_l \, dc^2{}_l = -102 \, dc^2{}_l$.

Duty Drawback Subsidy

The duty drawback subsidy ($dc^2{}_l$) is unknown, but the maximum amount is 99% of the FCOJ tariff or \$.29 per SSE gallon; and 99% of the NFC tariff or about \$.17 per gallon. An accurate breakdown of U.S. FCOJ and NFC OJ exports is not available, but based on Florida Citrus Processors Association data for the 2001-02 season, FCOJ and NFC accounted for 77% and 23% of Florida OJ exports, respectively. With Florida OJ exports accounting for 85% of U.S. OJ exports in 2001-02 (U.S. Department of Commerce), it is assumed these percentages also apply to the United States. Imports of FCOJ tend to be substantially larger than exports of FCOJ and duty drawback is likely to be collected on all U.S. FCOJ exported. To date, NFC import levels (and available NFC duty drawback credits) have been relatively low, and it is assumed that an insignificant amount of duty drawback is collected on NFC exports. In this case, an estimate of the FCOJ-NFC weighted duty drawback is \$.22 per SSE gallon (.77 times \$.29 plus .23 times zero).

Not all the benefits of duty drawback, however, go to U.S. exporters. Firms paying the U.S. OJ tariff initially own the duty-drawback credit. Some of these firms may also be exporters in which case collecting duty drawback is part of their internal accounting. Other firms may not export OJ; and, instead of losing their credits, may sell them to exporters for, say, a few cents per SSE gallon (per industry traders). To the extent this occurs, the average duty drawback credit of \$.22 per SSE gallon may overstate the actual effective credit level for impacting prices and exports levels. In the present analysis, the average cost to buy credits is assumed to be \$.02 per SSE gallon, and the resulting estimate of the average effective credit is \$.20 per SSE gallon.

It should also be noted that those firms (importers) that sell their credits may further be reducing the effectiveness of the U.S. tariff for OJ. If they initially pay a \$.29 per SSE gallon tariff and then sell the associated drawback credit for \$.02 per SSE gallon, the net tariff would be \$.27 per SSE gallon. In this case, the after-tariff marginal return of importing increases compared to that for the full tariff, positively (negatively) impacting import levels (U.S. OJ prices), or firms selling credits may simply pocket their gains with little or no impact on their marginal import decisions.

Returning to impact of duty drawback on exports, holding grower prices constant, dq^2_1 is estimated at -102 (.20) = -20 million SSE gallons per year (dc^2_1 is positive with duty drawback viewed as a subsidy or negative tax). That is, elimination of duty drawback would result in an estimated 20 million SSE gallons decrease in U.S. OJ exports. This amount is about 14% of average U.S. OJ exports of 145 million SSE gallons over the last eight seasons ending in 2001-02.

Impact of Duty Drawback with Zero Cross-Price Effects

Given fixed supplies, however, the grower price would not be expected to remain constant with elimination of duty drawback. Consider the impact on price under the assumption of zero cross-price effects between U.S. and RW OJ. In context of equations (6) through (10), this assumption allows the allocation of U.S. OJ to domestic and export markets to be treated in isolation from the RW's allocation of its product. That is, there is one supply-demand equilibrium condition for the U.S. market. Based on equations (4) and (5), this equilibrium can be written as $q_1 = \sum_r \alpha^r_1 + \sum_r \beta^r_{1,1} c^r_1 + \sum_r \beta^r_{1,1} p_1$. Differentiating this equation, and, assuming an unchanged price-margin in the U.S. ($dc^1_1 = 0$) and a fixed supply ($dq_1 = 0$), find that to continue to be in equilibrium requires $0 = \beta^2_{1,1} dc^2_1 + \sum_r \beta^r_{1,1} dp_1$, or $dp_1 = -(\beta^2_{1,1} / \sum_r \beta^r_{1,1}) dc^2_1$. The term $\beta^2_{1,1}$ is the export demand slope which was estimated at-102 million SSE gallons. Based on estimates discussed below, the OJ demand slope in the U.S. is set at -373 million SSE gallons. Hence, under the assumption of zero cross-price effects between U.S. and Brazil OJ, the U.S. grower price is estimated to decrease by -.043 per SSE gallon ($dp_1 = -(-102 / (-102 + -373))(.20) = -\$.043$) in absence of duty drawback. As shown, the impact on price depends on the export share of the aggregate export-domestic market price-slope ($\beta^2_{1,1} / \sum_r \beta^r_{1,1}$). These estimates indicate that export demand is more than twice as elastic as domestic demand (export and domestic FOB elasticities of -.70 and -.30, respectively).

U.S. Demands for OJ

To the extent U.S. and Brazil OJ are substitutes, however, the cross-price effects are not zero. It is assumed that the U.S. market demand for U.S. OJ follows that for NFC (nearly all NFC sold in the U.S. is from the U.S.), while the demand for RW OJ follows that for other OJ which primarily includes reconstituted FCOJ or RECON, and packaged FCOJ (demand data on U.S. versus RW are not available). Using weekly ACNielsen retail sales data for OJ in U.S. grocery store chains doing $2 million or greater business annually, the following relationships were estimated.

U.S. Demand for NFC

$$(15)\quad \log(Q_{1,t}/Q_{1,t-52}) = \underset{(.005)}{.003} + \underset{(.008)}{.162}\log(t/t\text{-}52) \underset{(.077)}{-1.590}\log(P_{1,t}/P_{1,t-52}) \underset{(.054)}{+.309}\log(P_{2,t}/P_{2,t-52})$$

$$\underset{(.083)}{+.371}\log(P_{gj,t}/P_{gj,t-52}) \underset{(.207)}{+.693}\log(x_t/x_{t-52}) \qquad R^2=.63,$$

U.S. Demand for Other OJ

$$(16)\quad \log(Q_{2,t}/Q_{2,t-52}) = \underset{(.003)}{.033} + \underset{(.006)}{.014}\log(t/t\text{-}52) \underset{(.054)}{+.252}\log(P_{1,t}/P_{1,t-52}) \underset{(.038)}{-.693}\log(P_{2,t}/P_{2,t-52})$$

$$\underset{(.059)}{-.137}\log(P_{gj,t}/P_{gj,t-52}) \underset{(.147)}{-.090}\log(x_t/x_{t-52}) \qquad R^2=.51,$$

where subscript t stands for a week; Q_1 and Q_2 are per capita gallons of NFC and other OJ, respectively; P_1, P_2 and P_{gj} are consumer price index (CPI) deflated prices for NFC, other OJ and grapefruit juice, respectively; and x is U.S. per capita disposable income deflated by the CPI. Data from week ending January 7, 1989 through week ending March 15, 2003 (737 observations) were used. The data were 52nd differenced to account for seasonality (52 weeks per year), following Brown and Lee. Standard errors are given in parentheses below the coefficient estimates. All coefficient estimates, except the intercept in the equation for NFC and that for income in the equation for other OJ, are statistically significantly different from zero.

Given the log specifications of demand, the estimated price, as well as income, coefficients are estimated elasticities, $\epsilon^r_{sj} = (\partial q^r_s / \partial p^r_j)(p^r_j / q^r_s)$. To obtain slopes, $\partial q^r_s / \partial p^r_j$ or $\beta^r_{s,j}$, the own- and cross- price elasticity estimates were multiplied by associated market-origin specific gallons (q^r_s) and divided by market-origin prices (p^r_j). (The slopes at the grower and other marketing chain levels are assumed to be the same.) Total U.S. market OJ sales were set at 1,500 million SSE gallons, of which 1,240 million SSE gallons were assumed to be from U.S. production and 260 million SSE gallons from imports, based on domestic production and import trends (USDA). The prices were set at 2001-02 season levels: $5.29 per gallon for NFC and $3.78 per SSE gallon for the other category. The resulting U.S. demand-slope estimates in million SSE gallons per dollar are

$$\beta^1_{1,1} = -373; \quad \beta^1_{1,2} = 102; \quad \beta^1_{2,1} = 12; \quad \beta^1_{2,2} = -47.$$

RW Demand for Brazil OJ

The magnitudes of the own- and cross-price for Brazil exports were obtained from a regression of the log of Brazilian exports Q_{4t} (excluding those to NAFTA countries, primarily the U.S., as reported by ABECitrus) on time and the log of the ratio of the Rotterdam to U.S. export price P_{4t}/P_{5t} (due to multicollinearity, the price variables were not significant when included as separate variables):

$$(17) \quad \log(Q_{4t}) = \underset{(.933)}{15.239} + \underset{(.009)}{.046}\,\text{time} - \underset{(.140)}{.300}\,\log(P_{4t}/P_{5t}) \qquad R^2 = .82.$$

Following the same approach to estimate the U.S. market price slope estimates, the above elasticities were used to estimate the own- and cross-price slopes for RW demand for OJ originating from the RW. Total RW market OJ sales were set at 1,728 million SSE gallons, an estimate of average consumption from 1999-00 to 2001-02 (USDA). The resulting demand slope estimates, along with those for U.S. OJ exported to the RW, are

$$\beta^2_{1,1} = -102; \quad \beta^2_{1,2} = 27; \quad \beta^2_{2,1} = 259; \quad \beta^2_{2,2} = -576.$$

The cross-price slope estimate for U.S. OJ export demand, $\partial q^2_1/\partial p_2$, is 4 times 6.812 or 27 million SSE gallons per dollar, based on equation (14).

Impact of Duty Drawback with Nonzero Cross-Price Effects

Using the RW and U.S. demand slopes shown in equation (10), elimination of the effective duty drawback of \$.20 per SSE gallon is estimated to result in a decline in the U.S. price of \$.023 per SSE gallon (dp_1). Additionally, applying equations (11c,d), U.S. exports are estimated to decline by 16.0 million SSE gallons, while other OJ sales in RW markets originating from the RW are estimated to increase by 3.8 million SSE gallons. Given fixed supply, U.S. (RW) sales in the U.S. increase (decrease) by 16.0 (3.8) million SSE gallons.

How sensitive are these results to the estimated demand slopes? It is likely that the cross-price slopes are the main source of potential error. The initial price decline estimate of -\$.043 per SSE gallon, assuming zero cross-price slopes, versus the estimate of -\$.023 per SSE gallon, based on the cross-price slopes estimated above, suggests that as demand substitution between U.S. and RW increases, the positive impact on price as a result of the duty-drawback subsidy becomes smaller. This relationship is examined further by estimating the without-duty-drawback impact on the price of U.S. OJ for the following scenarios: all cross-prices slopes are 0.00, .25, .50, .75, 1.00, 1.25, 1.50 times the estimated values of this study. These results (Table 1) further show how increased competition from the RW makes duty drawback less effective in supporting the U.S. price and suggest how increased differentiation of U.S. OJ from RW OJ may make drawback more effective in supporting price.

Table 1. Estimated U.S. Price Decreases Without Duty Drawback.

Cross-Price Slope Scenarios (a)	Decrease in U.S. Price
Factor (a)	$ per SSE Ga.
0.00	- 0.043
0.25	- 0.042
0.50	- 0.038
0.75	- 0.032
1.00	- 0.023
1.25	- 0.009
1.50	0.011

(a) Assumed cross price slopes in study times factor.

Impact of Importer Benefits

The benefits that importers obtain from duty drawback are also expected to impact prices and the allocation of OJ across markets, necessitating a final adjustment in the impacts of duty drawback on the U.S. OJ prices and allocation of U.S. OJ across markets. Based on equations (10), (11c) and (11d), we estimate that the combined export and import subsidies (dc^2_1, dc^1_2) of $.20 and $.02 per SSE gallon, respectively, increase the U.S. OJ price by $.019 per SSE gallon and shift 16.5 million SSE gallons of U.S. OJ from the U.S. to RW. The import subsidy partially offsets the export subsidy's impact on the U.S. price by attracting about 1 million SSE gallons of RW OJ to the U.S; in turn, the U.S. export market is slightly more attractive than the domestic market.

The split of duty drawback benefits between imports and exporters notably impacts the results. As more benefits go to importers and less to exporters through bargaining, the impacts on the U.S. OJ price and exports decrease. For example, if the \$.22 per SSE gallon benefit is evenly split between importers and exporters (dc^2 and dc^1_2 each at -\$.11 per SSE gallon), drawback is estimated to decrease (as opposed to increase before) the U.S. OJ price by \$.011 per SSE gallon and increase U.S.OJ exports by 11.2 million SSE gallons.

A Proposed Change in Drawback Law

As previously noted, duty drawback is not generally collected on NFC exports given present drawback rules limiting the degree of import-export substitutability. In recent years, a proposal that would relax these rules has been made (Lanzilloti and Dinopoulos). This proposal would allow FCOJ drawback credits to be used for NFC exports. Analyses by Lanzilloti and Dinopoulos, and Brown suggest that this change would positively impact U.S. grower prices and exports but exact estimates were not provided. Such estimates are made here using the present model.

Extension of FCOJ credits to NFC imports suggests that duty drawback would be collected on most U.S. OJ exports. Assuming the average credit going to exporters is \$.27 per SSE gallon, with \$.02 per SSE gallon going to importers, duty drawback is estimated to increase OJ exports by 22.1 million SSE gallons and support the price of OJ by \$.027 per SSE gallon. In comparison, export and price increases of 16.5 million SSE gallons and \$.019 per SSE gallon, respectively, were estimated above, based on current substitution rules and assumed subsidies of \$.20 per SSE gallon and .02 per SSE gallon for exporters and importers, respectively. That is, we estimate that this relaxation in the substitution rules would increase price support by nearly one cent and increase exports by about 5.6 million SSE gallons.

Other possible relaxations in the substitution law may not be as favorable to some U.S. growers. Consider import-export drawback substitution where the import is not used in manufacturing. Substitution law presently requires that the imports and exports be commercially interchangeable to claim drawback. Suppose, however, that the law allowed greater substitution by only requiring that the imports and exports be the same grade (within a particular grade, product quality may differ as defined by juice score). Such a change in the law may make it more profitable for importers to sell high quality grade A FCOJ (94 to 95 score) in the U.S. and export lower quality grade A product (90 to 93 score) to niche markets in the world, negatively (positively) impacting the high (low) quality product prices in the US. Such a change may increase the influence of foreign importers in determining the split or levels of subsidies going to themselves and exporters, in contrast to the intention of drawback law to benefit U.S. producers.

Concluding Comments

The results of this study support the contention that duty drawback encourages commerce and manufacturing in the U.S. OJ industry, enabling exporters to compete more effectively in foreign markets. It is estimated that duty drawback increases U.S. OJ exports by 16.5 million SSE gallons or about 11% of average exports. Additionally, these findings indicate that duty drawback supports the U.S. OJ price by about 2 cents per SSE gallon. Given that U.S. OJ production is roughly 1.4 billion SSE gallons (USDA), each penny of duty-drawback support is worth $14 million.

and, dividing both sides of (A5) by q_s, and multiplying dq^r_s by the identity q^r_s/q^r_s results in

(A6) $dq_s/q_s = \sum_r (dq^r_s/q^r_s)(q^r_s/q_s)$,

or

(A7) $Dq_s = \sum_r w^r_s Dq^r_s$,

where $w^r_s = q^r_s/q_s$.

Substituting result (A4) into (A7), the supply-demand equilibrium in log changes is

(A8) $Dq_s = \sum_r w^r_s (\sum_j \epsilon^r_{sj} Dp_j + \sum_j \eta^r_{sj} Dz^r_j)$,

or

(A9) $Dq_s = \sum_r (\sum_j \pi^r_{sj} Dp_j + \sum_j \gamma^r_{sj} Dz^r_j)$,

where $\pi^r_{sj} = w^r_s \epsilon^r_{sj}$ and $\gamma^r_{sj} = w^r_s \eta^r_{sj}$. The terms π^r_{sj} and γ^r_{sj} are weighted price and exogenous-variable coefficients somewhat similar to the weighted price coefficients (Slutsky coefficients) in the Rotterdam demand model (Theil), except the weighting schemes differ.

In matrix notation, result (A9) can be written as

(A10) $Dq = (\sum_r \pi^r)Dp + \sum_r \gamma^r Dz^r$

or

(A11) $Dq = \pi Dp + \sum_r \gamma^r Dz^r$

where $Dq = [Dq_s]$; $Dp = [Dp_s]$; $Dz^r = [Dz^r_s]$;$\pi^r = [\pi^r_{sj}]$; $\pi = \sum_r \pi^r$; and $\gamma^r = [\gamma^r_{sj}]$.

Inverting (11), find the log changes in prices as functions of the log changes in quantities and exogenous variables

(A12) $Dp = \pi^{-1} Dq - \sum_r \pi^{-1}\gamma^r Dz^r$.

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