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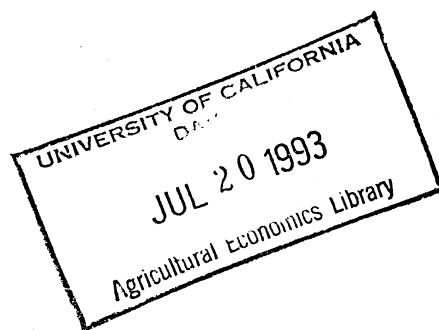
The Rose Garden Agreement and
the U.S. Processed Orange Industry

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Abstract

A partial equilibrium-implicit supply response model is developed to assess likely processed orange production response in the U.S. and Brazil stemming from a trade policy change envisioned under the so-called Rose Garden Agreement, a proposed free trade area involving the U.S. and four South American countries.

The Rose Garden Agreement and the U.S. Processed Orange Industry

Potential multilateral reductions in tariff and nontariff barriers have important implications for citrus-producing and -consuming nations. According to Food and Agriculture Organization (FAO), more than 40% of world citrus production is traded internationally, and the proportion is expected to grow (FAO, 1991). Most of the major citrus-producing and -consuming countries have some form of trade barrier (i.e., tariffs, import quotas, phytosanitary restrictions, production subsidies, etc.). There are numerous ongoing initiatives to reduce tariff and nontariff barriers. The Uruguay Round of the GATT multilateral trade negotiations is seeking to liberalize trade barriers on a wide range of goods and services, including citrus and citrus products. To date, agricultural trade issues have been a stumbling block to a GATT agreement. Failure to reach a GATT agreement could reinforce the development of regional trading blocs, such as the European Community (EC). Although reduction of tariff and nontariff barriers within regionally defined trading areas may be a 'second best' solution to a multilateral GATT agreement, regional agreements can amplify the welfare effects to affected producers and consumers, especially if there is significant trade between regional partners and third-party countries. This is of particular concern to U.S. processed orange producers in light of the ongoing North America Free Trade Agreement (NAFTA), which could give Mexican processed orange producers duty-free access to the U.S. orange-juice market. Several studies have indicated the potential welfare losses U.S. processed orange producers could face with a NAFTA (Spren and Muraro; Krissoff, et al.; Messina and Clouser; U.S. International Trade Commission (USITC), 1991).

More recently, a regional trading bloc that encompasses all the Americas has been proposed and is called Enterprise for the Americas Initiative. Such an agreement could have even more severe welfare implications for U.S. producers of processed oranges. Presently, the U.S. imposes a tariff to limit imports of frozen concentrated orange juice (FCOJ), most of which originates in Brazil. In this paper, a spatial equilibrium with implicit supply model of the world processed orange industry is developed to quantify the impacts of a tariff reduction on U.S. processed orange producers as might occur under the so-called Rose Garden Agreement which establishes a framework to relax trade barriers among the U.S. and Brazil, Argentina, Paraguay and Uruguay. The Rose Garden Agreement is a part of the effort to extend free trade throughout the Americas.

The analysis in this study is based on a model developed to simulate supply and demand in the world processed orange market. The model focuses on the interrelationships among orange-juice prices, tree plantings, production and demand. For the present study, the model was simulated over a 20-year period assuming the U.S. FCOJ import tariff remains in place, and then was simulated assuming a zero tariff. The analysis of the tariff impact was based upon a comparison between the simulation results of the zero tariff case and the tariff maintenance case.

The paper is organized as follows. First, a short background discussion of the world processed orange industry is provided. Next, the basic relationships comprising the model are described and data sources indicated. The simulation results are then discussed, followed by a summary.

Background

World production and consumption of processed orange products are relatively new developments, with most of the growth occurring in the post World War II era. Before that, only a small fraction of the world's orange production was utilized for processed products. Technological improvements made in the production and distribution of citrus juices encouraged substitution of more convenient processed products for fresh citrus consumption. Technological developments have included (1) the development of FCOJ technology; (2) improvements in packaging technology; and (3) bulk transportation systems to move bulk citrus-juice concentrate from production areas to local markets where it is reconstituted and packaged for retail consumption. Today about 40% of the world's orange production is consumed in processed product form, and the trend towards increased processed consumption is expected to continue into the foreseeable future.

The two major producers of oranges in the world today are the U.S. and Brazil. The U.S. and Brazil produced about 21.3 million metric tons of oranges or 46.1% of the world's production in 1989-90 (FAO, 1991). Production in the U.S. accounted for 15.5% of the world's total, while production in Brazil accounted for about 30.6% of the total. A large part of the orange crop in the U.S. and Brazil is utilized to produce juice. In the U.S., most of the oranges and orange juice are produced in Florida, where more than 90% of the orange crop is processed annually (Florida Agricultural Statistics Service (FASS), *Citrus Summary*). On the other hand, most of the orange crop elsewhere in the world is utilized fresh. Producers of orange juice other than Florida

and Brazil include Argentina, Australia, Chile, Cuba, Cyprus, Egypt, Greece, Israel, Italy, Japan, Mexico, Morocco, South Africa, Spain, Tunisia, Turkey and Uruguay. Although comparative data on orange-juice production across countries are not available, import/export data indicate that the magnitude of orange-juice production outside Florida and Brazil is small (U.S. Department of Commerce, Eurostat).

In 1989-90, Brazil and Florida accounted for an estimated 77.2% of world processed orange production, with Brazil accounting for 50.9% and Florida 26.3% (FAO, 1991). For many years, Florida was the largest producer of oranges and orange juice in the world. Brazil emerged as an important producer of oranges and orange juice following severe freezes in Florida. Brazil's industry received its first boost in the 1962-63 crop year, when prices nearly doubled as a result of a major freeze in Florida. Shortly thereafter, modern processing facilities were built in Brazil. Benefitting from additional freezes in Florida, particularly during the 1980's, Brazil has replaced Florida as the largest producer of oranges and orange juice in the world.

The Florida and Brazilian orange-juice industries have developed differently with respect to the marketing of their products. Brazil's industry is export-oriented, as virtually all its orange juice is exported. Brazil's orange juice is exported in the form of bulk FCOJ, which is later packaged into retail product in the importing countries. The U.S. and Europe are Brazil's two principal export markets, accounting for 32.1% and 50.8%, respectively, of its 1990-91 exports (Foreign Agricultural Service). On the other hand, Florida's industry is oriented towards supplying the U.S. market. Florida is a major producer of retail product and, through the Florida Department of Citrus (FDOC) and private industry, has had a major role in marketing orange juice. The FDOC has carried out commodity advertising and promotion activities for a number of years, playing an important role in developing the U.S. orange-juice market.

As alluded to above, the U.S. and Europe are the largest markets for orange juice in the world. According to FAO, the U.S. and Europe accounted for 55% and 35%, respectively, of world orange-juice consumption during the mid 1980s. Other important markets are Canada and Japan. Japan could emerge as a major consuming market in the 1990s as trade barriers limiting orange-juice imports are liberalized.

Theoretical Model

The basic model describing the world orange-juice market consists of two components: a production component and a demand component. The production component of the model deals with supply in the U.S. and Brazil. U.S. orange-juice supply is based upon a model that projects Florida supply and includes estimates of California/Arizona supply. In Brazil, the state of São Paulo is the most important supply region for orange juice. The demand component assumes that total world orange-juice consumption occurs in four regions, the U.S., Europe, Canada and the rest of the world (ROW), which is comprised primarily of Japan. Demand equations are specified for each of these regions.

Integrating the various model components, the model can be summarized as follows. Suppose that the inverse demand equation in market j is

$$P_j = f_j(Q_j)$$

where P_j is the price in market j and Q_j is the quantity demanded in market j . The quantity supplied of agricultural commodities such as oranges is essentially determined by decisions made in previous periods. Let X_1 denote the quantity of orange juice available from Florida in the current period and let X_2 denote orange juice available from Brazil. Let X_{ij} denote the quantity shipped from supply region i (Florida or Brazil) to demand region j at unit transport cost u_{ij} which includes tariffs and other transfer costs.

Following Takayama and Judge, a mathematical programming model whose solution will give the competitive spatial allocation of orange juice in a given year is

$$(1a) \text{ Maximize } \sum_{j=1}^4 \int_0^{Q_j} f_j(Q_j) dQ_j - \sum_{i=1}^2 \sum_{j=1}^4 u_{ij} X_{ij}$$

$$(1b) \text{ Subject to } \sum_{j=1}^4 X_{ij} \leq X_i \quad i = 1, 2$$

$$(1c) \quad \sum_{i=1}^2 X_{ij} \geq Q_j \quad j = 1, \dots, 4$$

$$(1d) \quad X_{ij}, Q_j \geq 0$$

Orange production in a particular season is determined by the distribution and size of the tree population and yield per tree. Let B_{it} be a vector whose elements are the number of trees in age class k located in supply region i in period t . The vector B_{it} evolves according to

$$(2) \quad B_{it} = A_i B_{i,t-1} + v_{it}$$

where A_i is a matrix whose elements are zero except along one diagonal. The nonzero elements are tree survival rates from period $t-1$ to period t . The matrix A_i also moves trees located in region i from age class k to age class $k+1$. The vector v_{it} is a vector whose elements are all zero except the first entry which contains the new plantings of trees in region i .

Given the number and distribution of trees in region i and period t , B_{it} , let Y_i be a vector (conformable for multiplication with B_{it}) whose elements are the yield per tree for age class k . Then

$$X_{it} = B_{it} \cdot Y_i$$

and X_{it} is the total production of oranges in region i in period t .

Weather plays an important role in both tree survival and yields in citrus production. Thus the elements of A_i and Y_i are stochastic. One approach would be to estimate mean yields and tree survival rates and solve the resulting deterministic model. Examination of the distribution of both yields and tree survival suggested that the underlying probability distribution of each of these two vectors is highly skewed. On this basis, a stochastic framework was adopted.

Limited data are available on tree survival, especially in Brazil, so that an ad hoc approach was used to develop an empirical probability distribution for tree survival and yields in both Florida and Brazil. A triangular distribution was used. For more details on the procedure used, see McClain.

Solution to the mathematical programming model generates equilibrium prices in the four major consuming markets and two major supply areas. The demand equations used represent the wholesale level of the market. In Florida, processing cost, picking and hauling cost, and a grower tax are subtracted from the wholesale price, giving on-tree prices. A similar procedure is done for Brazil, the major difference being that Brazil imposes relatively higher marketing costs on its growers.

Planting equations in Florida and Brazil are estimated as a function of on-tree prices and the returns from competing crops. In Florida, the equation which had the highest explanatory power is

$$NP_{1t} = 988.22 + 458.02 PAVG_{1,t-1} - .013 TI_{1,t-1}$$

where $PAVG_{1,t-1}$ is the three-year moving average of on-tree prices and $TI_{1,t-1}$ is total tree inventory in Florida in period t .

Sugarcane competes for land with citrus in Brazil. Preliminary analysis of the data suggested that the price of sugarcane needed to be included in the Brazilian planting equation. Another problem in Brazil is that orange juice is priced in U.S. dollars, but Brazilian growers are paid in cruzados. The hyperinflation experienced in Brazil complicates exchange-rate conversion. Thus a price ratio was used to reflect the relative profitability of citrus and sugarcane.

The new planting equation used for Brazil (NP_2) was

$$NP_2 = 12,076.6 - 54.18 \left(\frac{PS_{t-1}}{PO_{2,t-1}} \right)$$

where PS_{t-1} is the price of sugarcane in São Paulo state in year $t-1$ and $PO_{2,t-1}$ is the on-tree price of oranges in São Paulo state in year $t-1$. The empirical model is a mathematical programming model with stochastic elements. Monte Carlo simulation techniques were used to implement the model empirically. Draws from both the yield distributions and tree survival distributions for Florida and Brazil provided the basis for one 20-year simulation. This process was repeated 100 times and the results averaged to give expected prices, production, trade and tree inventory in each producing country. The simulation and equivalent unconstrained optimization problem were conducted in GAUSS.

Empirical Model

Data from a number of different sources were used in the analysis. Data on the Florida orange-tree population, boxes of fruit per tree by age category, and processed utilization or that part of the orange crop used in juice production were obtained from the FASS (*Commercial Citrus Inventory, Citrus Summary, Boxes of Fruit per Tree*). Tree plantings and losses were estimated from the tree population data. Data on Florida juice yields (gallons of juice per box) were provided by the Florida Citrus Processors Association.

Data on the Brazilian tree population, boxes of fruit per tree, gallons of juice per box and processed versus fresh utilization were obtained from the Instituto de Economia Agricola and the Agricultural Attache, São Paulo, Brazil.

Data on Brazil's FOB and on-tree prices were provided by the Agricultural Attache. Florida's FOB price was determined by adding the U.S. tariff and transportation cost to the Brazilian FOB price. Florida on-tree price data were provided by FASS.

Data on Brazil's exports to the different world markets were provided by the Bank of Brazil. U.S. export data were provided by the U.S. Department of Commerce and, in the case of exports to Canada, Statistics Canada. Domestic demand data were obtained from A. C. Nielsen Marketing Research Company.

In this analysis, it is assumed that production outside Brazil and the U.S. is absorbed by the world market at the projected price levels. The price levels depend on sensitivity of demand to price and growth in demand over time (the increase in quantity demanded with prices constant), along with growth in Brazilian and U.S. supply. Constant price elasticity demand equations were used. The price elasticities used in the present study are -1.1 at the retail level for the U.S., -.5 at the FOB Santos level for Europe and -.4 at the FOB Santos level for Canada and the ROW. The U.S. elasticity was estimated from retail scantrack data; the European elasticity was estimated from Brazilian price and shipment data; the elasticity for Canada and the ROW is based on research which suggests that sales in these markets are slightly less sensitive to price than in Europe (McClain).

Estimating future demand growth is difficult and depends upon numerous factors. Factors affecting growth in demand include population and income growth, consumer trends, and efforts to expand sales and open up new markets through advertising and promotion. Based on recent FAO demand studies, U.S. and Canadian orange-juice demand appears to be growing at about 1.5% per year, while demand in Europe and ROW appears to be growing faster at roughly 3% and 4%, respectively.

The model was validated using the 1990-91 season as a reference. Demand equation intercepts were adjusted to force simulated results to reference season values. The model was then simulated to obtain orange-juice supply and demand estimates for a 20-year period. Simulation results for FOB and on-tree prices, tree plantings, orange production, orange-juice production and demand were obtained. The simulation results

indicate a cyclical tendency with respect to prices and tree plantings. The cyclical tendency is directly related to the three to four years required for a newly planted tree to start bearing fruit and the planting equations, which indicate plantings are related to recent past on-tree prices, in the case of Florida, and the previous season's on-tree price relative to the price of sugarcane, in the case of Brazil. Essentially, the planting equations and the rest of the model satisfy the well-known conditions for cobweb behavior: (1) production responds some time after the decision on how much to produce; (2) the production decision is based on present or recent past prices and returns which are used as predictors of uncertain future values; and (3) prices are determined by current production and market demand (French and Bresseler).

In order to assess the potential impact of the proposed Rose Garden Agreement, several assumptions were made. It was assumed that FCOJ import tariffs for the affected countries would be zero. Within the context of this model, the U.S. is the only affected market since Canada's FCOJ import tariff is already zero.

It is assumed that the Rose Garden Agreement will have no direct policy impact on supply, such as reducing or eliminating production subsidies or their equivalent. Brazil, for example, has provided production subsidies in the past to encourage orange production (USITC, 1987). This model cannot explicitly incorporate the effects of past or present production subsidies, so these kinds of policy impacts were ignored. Also, it should be noted that while Mexico is an increasingly important supplier of orange juice to the U.S. market, it was not included as a supply source because of its relatively small size compared to Brazil and Florida.

Given the aforementioned assumptions, the model was resimulated for a 20-year period. Results of this simulation were then compared to the initial simulation and are discussed in the next section.

Results

Results of the analysis are shown in Table 1. As expected, producer prices, production and gross revenues for Florida processed orange producers were significantly lower under a hypothetically simulated Rose Garden Agreement. Under the Agreement, producer prices were projected to average \$5.12 per box (1990 dollars), 17.3% below the baseline average. In contrast, producers in Brazil were projected to receive an annual average of \$3.97 per box under the Agreement, 21.8% above the baseline projection. Lower producer prices for Florida and higher producer prices for Brazil are easily rationalized. With no U.S. FCOJ import tariff, Brazil

reallocates FCOJ from third-party markets (Europe, Japan, etc.) to the U.S. until the prices from each market equalize. Increased U.S. orange-juice supply implies lower orange-juice prices, and consequently lower prices to U.S. producers.

A Rose Garden Agreement policy would also result in a shifting of production from Florida to Brazil. Lower producer prices in Florida would discourage tree plantings, which would result in lower production levels relative to current policy. The opposite would be true with Brazil. Florida production was projected to fall by an average of 1.9% over the 20-year simulation horizon, while production in Brazil would increase by 4.4%. Production adjustments for Florida and Brazil appear to be relatively small. However, it should be noted that it takes three to four years for trees to bear fruit and up to ten years for trees to reach peak levels of productivity. As such, production adjustments occur slowly. Tree plantings over the projection period provide a better indication of the production adjustments likely to occur under this policy scenario. In Florida, tree plantings were reduced by 14.8% annually, while tree plantings in Brazil increased 6.7%.

Finally, gross revenues for Florida processed oranges were 18.8% lower under the Rose Garden Agreement scenario. Brazilian processed orange producers gained by an annual average of 27.2%.

Summary

Regional trade agreements, while offering broad political and economic benefits to trade partners, can severely impact specific industries, particularly if trade involves significant third parties not covered by the agreement. Such is the case with the U.S. processed orange industry and the Rose Garden Agreement. The Rose Garden Agreement results in Brazil allocating a greater portion of its orange juice to the U.S. market and away from third-party markets than would be expected otherwise. Consequently, U.S. processed orange prices and producer revenues are lower.

While the model was simulated under restrictive conditions, the results, taken broadly, are consistent with expectations, suggesting the usefulness of the model in assessing changes in tariff policy. In this analysis, no attempt was made to measure the gains and losses in producer and consumer surplus associated with a Rose Garden Agreement tariff policy. Future research may wish to incorporate producer-consumer surplus analysis, comparing gains and losses in regional trade agreements to gains and losses under multilateral agreements. In

this context, the real cost and/or benefits of regional trade agreements on affected industries can be better evaluated.

Table 1. Average annual simulated processed orange producer prices, production, tree plantings and on-tree returns, under baseline and tariff-reduction scenarios, for São Paulo, Brazil, and Florida.

Item	Scenario		Percent Change
	Baseline	U.S. Tariff Reduction	
-- \$ per box (1990 dollars) --			- % -
Producer Prices			
Brazil	3.26	3.97	21.8
Florida	6.19	5.12	-17.3
----- million boxes -----			
Production			
Brazil	294	307	4.4
Florida	210	206	-1.9
----- 1,000 trees -----			
Tree Plantings			
Brazil	9,287	9,909	6.7
Florida	2,872	2,448	-14.8
-- million \$ (1990 dollars) --			
Producer Returns			
Brazil	958	1,219	27.2
Florida	1,300	1,055	-18.9

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