Appendix 5-1

Equations (1) and (2) depict the decision process. For each orange juice f = frozen concentrate and n = not-from-concentrate in each importing country (i, j, or k), consumers demand the

$$(1) D_f^{ij} = a_f^{ij} + \sum_k b_f^{ijk} P_f^{ijk} + c_f^j \, avgP_n^j$$

$$(2) D_n^{ij} = a_n^{ij} + \sum_k b_n^{ijk} P_n^{ijk} + c_n^j \, avgP_f^j$$

where D_f^{ij} and D_n^{ij} represent country i's demand for concentrate produced in country j for all i's and j's. P_f^{ijk} and P_n^{ijk} are market prices inclusive of import tariffs where relevant. (When $j = k$ the price represents the own price of demand and when $k \neq j$ the price represents cross prices.) In addition, demand depends on the average consumer price, avg P_n^j or avg P_f^j (weighted by value of the domestic and import shares in the base equilibrium), of the substitute product, which is either n or f. Other demand shifters such as income and population growth are assumed fixed.

The supply of product n and f is a function of its own and cross prices:

$$(3) S_f^j = a_f^j + b_f^j P_f^j + d_f^j P_n^j$$

$$(4) S_n^j = a_n^j + b_n^j P_n^j + d_n^j P_f^j$$

Where P_f^j and P_n^j are prices in the producer's domestic market. We assume producers of frozen concentrate and NFC base their production decisions on own and cross prices. Other supply shifters such as juice yields are assumed fixed.

Also, prices of imported products deviate from domestic prices depending on transportation costs (*TC)* and whether there are any tariffs (τ). In particular, we specify tariffs as ad valorem equivalents:

$$(5) P_f^{ij} = P_f^j (1 + \tau_f^{ij}) + TC_f^{ij}$$

$$(6) P_n^{ij} = P_n^j (1 + \tau_n^{ij}) + TC_n^{ij}$$

for all i where $i \neq j$ in equations 5 and 6.

World markets clear when net trade of juice across all countries equals 0:

$$(7) \sum_i T_f^{ij} = S_f^j - \sum_i D_f^{ij}$$

$$(8) \sum_i T_f^{ij} = S_n^j - \sum_i D_n^{ij}$$

domestically produced juice (either f or n) and similar but not identical foreign produced juices.[1] The linear consumer demand functions can be expressed as:
The equilibrium solution reproduces all prices and quantities observed circa 1999. We call this our base solution that is assumed to be a longrun equilibrium. When tariffs are reduced or removed, the model generates a new equilibrium by recalculating domestic supply and demand

[1] Brazil and Mexico's demand functions are specified with domestic price as the only right-hand-side variable since imports are limited.

levels, re-balancing world trade, production, consumption, and prices in the process. The pattern of prices and quantities observed in the base solution can then be compared to the pattern that emerges from the simulation exercise.

The model requires own- and cross-price elasticity estimates for the supply and demand equations. We specified the overall demand elasticities equal to –0.4 (table 5-11). This is in line with demand elasticity estimates found in the recent literature (Zabaneh, 1999; Goodrich and Brown, 1999). Our search of the literature did not find estimates of cross-price elasticities between U.S. and Brazilian products, supply elasticities, or elasticities of substitution or transformation. Thus, these estimates are based on our understanding of the industry and markets. The elasticity of substitution between NFC and FCOJ was set equal to –1 (in countries that consume both juices). The small size of the elasticity of substitution between NFC and FCOJ is based on the observation that industrialized consumers perceive NFC to be a relatively higher quality product and that consumers would be reticent to substitute for FCOJ. We assume a high elasticity of substitution (-5) between juice from different countries and the domestic product. Given the limited empirical evidence and lack of data for estimation, we specified the values of the fundamental parameters of the model to be equal across countries.

We assumed supply to be inelastic (0.3 for the United States and the European Union and 0.5 for Brazil, Mexico, and rest-of-world). With orange juice being a derived product from oranges, and orange trees generally having a commercial life span of approximately 25 to 30 years, there is likely to be little production responsiveness to yearly price movements resulting from trade liberalization. Over a longer time period (several years) orange growers can adjust the planting of orange trees commensurate with market conditions. Depending on the age distribution of trees and alternative uses of the land, the adjustment period may take longer or shorter. We define the long run as a time period sufficient to allow orange growers to adjust plantings and enter or exit the industry.

The remaining model parameters are calculated based on the assumptions of weak separability and homotheticity for the demand side and from a similar representation of the individual firm's profit maximization problem for the supply side and stylized facts about the juice market for the 1998-2000 marketing years (Florida Department of Citrus, 1997; U.S. Dept of Agriculture, 2000a). This approach follows the methodology described in Alston and James (2002).