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Possible Trade and Welfare Effects of  
EEC Tariff and "Reference Price"  
Policy on the European-Mediterranean  
Market for Winter Oranges

Pinhas Zusman, Abraham Melamed, and Itzhak Katzir

A variable import levy is a new type of import-regulating mechanism introduced recently by the European Economic Community. This device, pertinent to many agricultural imports, involves the application of "countervailing charges" as an automatic regulator whenever import prices fall below predetermined "reference prices."

The purpose of this study is to examine the operation and the possible implications of this mechanism, coupled with the regular EEC import duties, with reference to the European market for Mediterranean winter oranges.

A spatial equilibrium model is used in the analysis. This model consists of two varietal groups of oranges as distinguished by the regulations of the EEC—four exporting regions and seven importing regions. The problem dealt with is too complex to allow for a straightforward application of the traditional programming techniques. Thus, a "market simulating" procedure is adopted. The model is solved for the estimated equilibrium values of the market endogenous variables—that is, import prices, f.o.b. prices, and patterns of trade and tariffs—under various sets of possible policy variables projected for 1970. The results have been used to analyze the potential changes in consumers' welfare due to the possible changes in the EEC import policy.

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# POSSIBLE TRADE AND WELFARE EFFECTS OF EEC TARIFF AND "REFERENCE PRICE" POLICY ON THE EUROPEAN- MEDITERRANEAN MARKET FOR WINTER ORANGES<sup>1</sup>

## INTRODUCTION

THE EVOLVING AGRICULTURAL trade policy of the European Economic Community (EEC) aims at stabilizing, at high levels, the internal prices of farm products. In this endeavor, there is an increasing reliance on various measures designed to maintain certain "minimum import prices."

For many products, the earlier protective devices, such as fixed custom duties and import quotas, have been replaced by a single type of import control—a variable import levy. Thus, basic grains, sugar, rice, and olive oil have a single levy equal to the difference between the internal price level and the lowest representative world price. Pork, poultry, and eggs have two levies. One is based on the difference between prices of feed grains on the world market and prices within EEC; the other is equal to the difference between a minimum import price (gate price) and the lowest representative world price. (For a concise description of the EEC trade policy, see 19.)

A similar (though not exactly alike)

<sup>1</sup> Submitted for publication April 11, 1969.

mechanism has been recently applied to imports of fruits and vegetables. A system of "countervailing charges" or "compensatory levies," based on a set of "reference prices," has supplemented the high tariffs already applicable to imports of fruits and vegetables.

The essential feature of this mechanism, which was first envisaged as a short-run stabilization device, is the imposition of countervailing charges as an automatic regulator whenever import prices fall below the predetermined reference prices. The system applies at present, with various degrees of effectiveness, to most fruits and vegetables.

The objectives of the present study are to examine the operation and effects of the combined application of high-import duties and a mechanism of reference prices on the market for winter oranges. The analyzed system is complex: There are several exporting and importing regions and two varietal groups of oranges; the incorporation of the reference price mechanism introduces additional complexities which render accepted solution procedures ineffective. It was,

TABLE 1  
EXPORTS, IMPORTS, AND SHIPMENTS OF FRESH WINTER ORANGES, 1963-64

Exporters	Importers									Total exports
	France	West Germany	The Netherlands	Belgium-Luxembourg	United Kingdom	Scandinavia	Switzerland and Austria	East Europe	Non-European countries	
<i>1,000 metric tons</i>										
Italy.....	*	50		3	1	21	58	11		144
Greece.....		3					3	40		46
Spain.....	271	396	105	85	126	91	69	37	1	1,181
Algeria.....	121	9			7			12		149
Morocco.....	177	102	44	2	18	6		55	8	412
Tunisia.....	22					1		1		24
Israel.....	6	66	24	18	124	83	14	13	18	366
Cyprus.....		2	2		22		1	16	7	50
Lebanon.....								14	79	93
Turkey.....		1					2	6	2	11
Egypt.....		1						1	3	5
United States†.....	3		17	9		5				34
<b>Total imports.....</b>	<b>600</b>	<b>630</b>	<b>192</b>	<b>117</b>	<b>298</b>	<b>207</b>	<b>147</b>	<b>206</b>	<b>118</b>	<b>2,515</b>

\* Blanks indicate no exports.

† Only exports to European countries are listed.

SOURCES: 43, 37, and 36.

therefore, necessary to develop alternative methodological approaches to the analysis of the equilibrium of international trade.<sup>2</sup> Because two varietal groups of oranges were distinguished and one of the study's objectives was to evaluate the welfare implications of the possible EEC policies, it was also necessary to construct the analytical tools that would provide some measures of the changes in the welfare of the trading parties, following the adoption of the various EEC policies. It is believed that, in addition to the specific findings, there is some interest in the method of analysis since it is applicable to trade problems in general and, in particular, to problems involving variable import levies and similar policy measures.

The welfare and trade effects of the EEC tariff policy were studied exten-

sively by Dean and Collins (6 and 7). However, because (until 1965) "the reference prices established . . . have been well below levels at which fresh oranges have been imported into the EEC," (7, page 24) the operation and effects of the reference price mechanism were disregarded in Dean and Collins' study. Since 1965, levels of orange reference prices have been raised, and the system has become a matter of great concern to exporting countries. Though still ineffective, it is not unlikely that a policy instrument first designed to prevent temporary disturbances of the market may develop into a principal protective device. In this study we shall, therefore, attempt to determine the levels at which reference prices become effective and to evaluate their consequences.

## The European Market for Fresh Winter Oranges

The international market for oranges and tangerines was described by Dean and Collins (6 and 7). The main features of the European market for winter oranges—those marketed during November through May—are presented in table 1.

Except for Lebanon, Turkey, and Egypt, Mediterranean countries deliver a negligible fraction of their total orange exports to non-European markets. Furthermore, winter oranges are imported to Europe almost exclusively from Mediterranean producers. The European-Mediterranean market thus constitutes an almost closed system with rather weak links with the rest of the world.

The crucial importance of the EEC trade policy derives from the fact that

imports to its member countries constituted in 1963-64 approximately 65 per cent of total imports of fresh oranges to European countries.

Eastern Europe, including Yugoslavia, was a relatively small market in 1963-64. However, it is a fast-growing market and may soon become one of the major outlets for Mediterranean exporters. Imports to East European countries are, however, mostly determined by governmental policies and not by the interplay of free-market forces.

The shipment pattern is a function of supply and demand conditions, relative transportation costs, and tariff policies. Thus, the North African countries rely heavily on the French market because the French government, in the past, has accorded them substantial tariff preferences. However, past trade policies have been changing rapidly in recent years, and major shifts in the pattern

<sup>2</sup> The solution procedure employed in the present analysis is a multiproduct variant of Tramel and Seale's "reactive programming" technique (34).

of shipments are to be expected. Both demand and supply of winter oranges are predicted to grow rapidly (13), and

the equilibrium of trade will be subjected to major displacements.

## The EEC Tariff and Reference Price Policy

### General outlines

The EEC tariff policy with regard to oranges has been characterized by the establishment of a Common External Tariff and the gradual abolition of tariffs and other trade barriers among the member countries.

This policy aims at protecting the Community producers from external competition and encouraging trade within the EEC. After the harmonization process is completed, no import duties will be levied on orange exports originating within the Community, while exports from "third" countries will be subject to high and uniform tariff rates.

Compared to their 1963-64 levels, tariff rates on imports of fresh oranges to West Germany and Benelux countries will increase by some 30 per cent, while corresponding rates in France will be lowered by about 35 per cent. The new Common External Tariff rate will be around 20 per cent (4).

The principal beneficiaries of these changes are Italy, a member of the EEC, and Greece, whose association with the Community entitles her to duty-free exports of citrus fruit up to a certain quota.<sup>3</sup>

<sup>3</sup>The system of reference prices and countervailing charges for fruits and vegetables was initiated in 1962 by Regulation 23 of the Council of the European Economic Community (8). Regulation 100 provided, later in 1962, a procedure for determining reference and entry prices (9).

<sup>3</sup> In 1962 this quota amounted to 22,000 metric tons. Over the succeeding five years, the quota was to be increased by 20 per cent annually. See 4, pp. 208 and 209.

However, in view of the accumulated experience, Regulation 23 was amended in 1965 by Regulation 65/65/EEC (10). The revised Article 11(2) states:

"2. In order to avoid disturbances due to offers from Third countries at abnormal prices, reference prices applicable to the whole Community shall be fixed annually.

"The reference price shall be equal to the arithmetic mean, . . . , of the producer price in each Member State. These producer prices shall correspond to the average of the prices recorded during the three years prior to the date of fixing the reference price for an indigenous product with specified commercial characteristics, on the representative market or markets situated in the production zones, where prices are the lowest. . . . The reference price shall be fixed for the period of one year. However, in order to take into account seasonal differences of price, each year may be divided into several periods, within which prices remain relatively stable.

\* \* \*

"The price on entry of that product shall be fixed on the basis of the lowest price recorded on the representative import markets . . . , less Custom duty arising from application of Article 23 of the Treaty and less other import dues as well as transport charges from those markets to the Community frontier transit points.

"In the case of the price on entry



... being lower than the reference price, imports of this product from Third countries shall be subject to countervailing duty. However, if imports are made at prices which on entry are lower than the reference price, only from certain countries the countervailing duty shall be limited to imports from those countries.

“The amount of the countervailing duty shall be equal to the difference between the reference price and the price on entry. The amount of this duty shall be the same for all Member States and shall be added to the Customs duties in force.”

Regulation 100 (1962) was replaced in 1965 by Regulation 99/65/EEC, which established computational and reporting procedures (11).

Until the 1965-66 season, reference prices for oranges were determined at very low levels and were, therefore, ineffective. For the 1965-66 season, the levels of reference prices for oranges were raised substantially. These changes were designed largely at the insistence of Italy as compensation for its concessions on other EEC policy matters in the agricultural sector.

The 1965-66 season's reference price regulation has established three varietal groups and a method of computing the countervailing charges designed to assure qualitative comparability between the Italian varieties and those of non-EEC countries (12). Thus, entry prices are obtained by multiplying quoted wholesale or auction prices (net of import duties) by certain “correction coefficients” given in the EEC regulation for specific varietal groups. Countervailing charges are then equated to the difference between entry and reference prices.

## The impact of the reference price mechanism—a simplified graphic analysis

Before undertaking a detailed mathematical and quantitative analysis, let us investigate the economic functioning of the reference price mechanism by a simplified graphic analysis. This will help clarify the operation of the system and provide insight into its *modus operandi*.

To this end, consider an international market consisting of two importing countries, A and B, and a fixed world supply of oranges. Assume that both countries impose an *ad valorem* tariff but only country A employs a reference price mechanism. Assume, further, that there are no transportation costs, and competition prevails in all markets. This situation is depicted graphically in figure 1.  $D_A D_A$  and  $D_B D_B$  are the demand functions at the wholesale level of country A and country B, respectively. (Note that the quantity demanded by country B is measured from  $O_B$  to the left.) The curves  $D'_A D'_A$  and  $D'_B D'_B$  are the demand function's net of import duties, and the total fixed supply is represented by the interval  $O_A O_B$ .

Under free trade, the world equilibrium is represented by the point  $E_1$ . However, once import duties are introduced, the equilibrium point shifts to  $E_2$ .

Suppose now that, in addition to import duties, country A puts into effect a “reference price” mechanism with reference prices set at  $P_R$ . To find the new equilibrium point, we construct a new demand function  $D'_A D_F$  which represents demand behavior in country A net of both import duties and countervailing charges. This is done by connecting all points, under the horizontal line through  $P_R$ , whose vertical distance to  $DD'_A$  (from below) is equal to the vertical distance between  $DD'_A$  and the horizontal

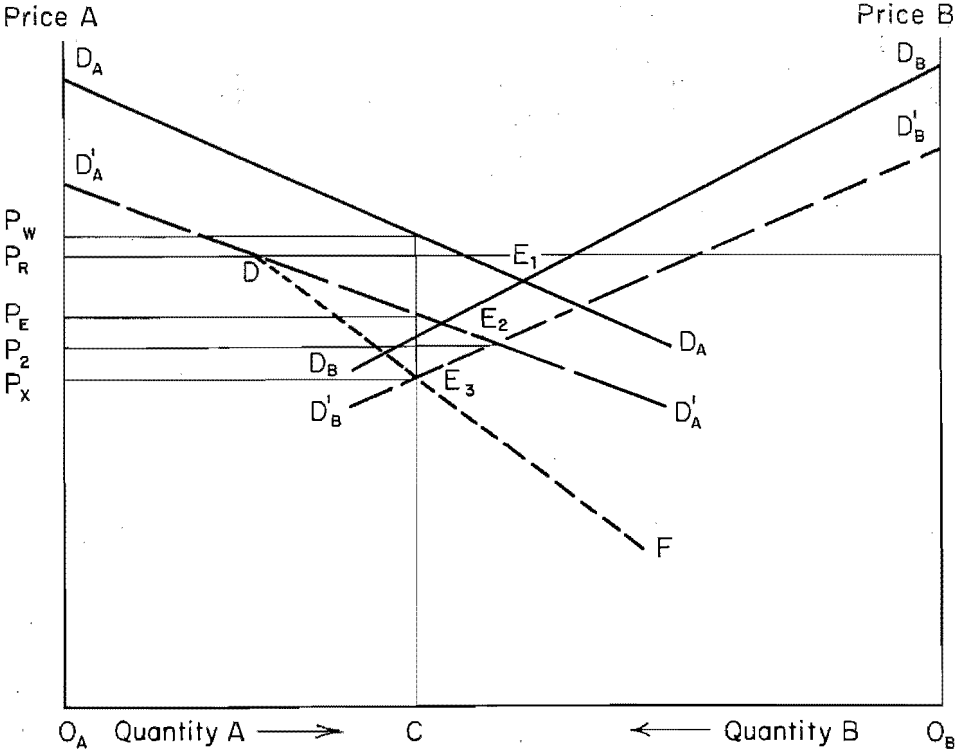


Fig. 1. A simplified graphic analysis of the reference price mechanism.

line through  $P_R$ . The equilibrium point for trade with tariff and a reference price mechanism is then represented by the intersection of  $D'_A D F$  and  $D'_B D'_B$  at point  $E_3$ . In equilibrium, the quantities imported to country A and country B are represented by  $O_A C$  and  $O_B C$ , respectively. Wholesalers in country A pay the price  $P_W$  whereas exporters get the price  $P_X$ . The difference is made up of an *ad valorem* tariff,  $P_W - P_E$ , and a countervailing charge,  $P_E - P_X$ , which is equal,

by the construction of  $D'_A D F$ , to  $P_R - P_E$ .  $P_E$  thus represents the entry price. As long as the reference price,  $P_R$ , is below the price,  $P_2$ —the equilibrium entry price in country A under tariffs alone—the reference price is ineffective.<sup>4</sup> Also, an increase in reference prices above  $P_2$  leads to diversion of trade from country A to country B, increased prices within country A, and lower prices to exporters and to consumers in country B.

### The Model

The model developed in the present analysis is essentially a static model of interregional competition with transportation costs, tariffs, and the peculiar mechanism of reference prices and countervailing charges.

The assumption of competition ap-

pears to be, at least approximately, valid because there are numerous buyers and sellers in all markets.

In constructing the model, seven consuming regions, four producing regions,

<sup>4</sup> This actually was the situation in the early years of the program.

and two varietal groups have been distinguished.<sup>5</sup> The model reflects short-run relationships, because production in each producing region was regarded as fixed. The following consuming and producing regions were distinguished:

<i>Producing regions</i>	<i>Consuming regions</i>
1. Italy and Greece	1. Italy and Greece
2. Spain and Portugal	2. Spain and Portugal
3. Northwest Africa	3. Switzerland and Austria
4. Near East	4. Scandinavia
	5. United Kingdom
	6. West Germany and Benelux
	7. France

East European countries, including Yugoslavia, were excluded from the analysis because their imports are determined directly by governments and not by the interplay of market forces. Shipments to these countries were, therefore, naively projected and then subtracted from the producing regions' outputs. A similar approach was applied to the rest of the world, which constitutes an insignificant share of total Mediterranean exports.

Domestic consumption in Northwest Africa and the Near East is supplied mostly by oranges not suitable for export. Exports from these regions were, therefore, assumed to be price inelastic.

<sup>5</sup> The first varietal group in the present analysis corresponds to Group 2, as defined by the EEC, and includes such varieties as Washington navels, Valencias, Shamouti, and others; the second varietal group corresponds to Group 3 of the EEC and includes varieties such as Biondo Comune, Grano de Oro, Hamlin, Blood Oval, etc. Group 1 of the EEC includes the Italian varieties Moro and Torocco alone. In the present analysis, these varieties were associated with the first group. For more details, see Appendix B, p. 32. Also, see footnote 12, p. 16. Hereafter, all references to variety groups are in terms of the group nomenclature of the present study.

## Formal statement of the model

Let

$Q_{ik}^S$  = quantity of fresh oranges of the  $k$ th varietal group supplied by  $i$ th producing region

$Q_{jk}^D$  = quantity of fresh oranges of the  $k$ th varietal group demanded by the  $j$ th consuming region

$q_{ijk}$  = shipment of oranges of the  $k$ th varietal group from the  $i$ th producing region to the  $j$ th consuming region

$P_{jk}$  = auction or wholesale price of oranges of the  $k$ th varietal group in the  $j$ th consuming region

$V_{ik}$  = f.o.b. price of oranges of the  $k$ th varietal group in the  $i$ th producing region

$R_{ijk}$  = countervailing charges levied on oranges of the  $k$ th varietal group imported from the  $i$ th producing region to the  $j$ th consuming region

$A_{ik}$ ,

$\alpha_{kk'j}$  = parameters of the demand relations

$T_{ij}$  = tariff plus internal tax rate imposed in the  $j$ th consuming region on imports from the  $i$ th producing region

$C_{ij}$  = per unit transportation cost from the  $i$ th producing region to the  $j$ th consuming region

$P_{Rk}$  = the reference price for the  $k$ th orange group

and

$K_k$  = the correction coefficient applied to the "quoted" price to obtain the entry price of varietal group  $k$ .

**The structural relations.**—In the following we set forth the structural relations:

(a) Demand relations in consuming regions:<sup>6</sup>

$$Q_{jk}^D = A_{jk} P_{j1}^{\alpha_{k1}} P_{j2}^{\alpha_{k2}} \quad (1)$$

$$j = 1, 2, \dots, 7$$

$$k = 1, 2.$$

(b) Shipments balance equations:  
i. Supply

$$Q_{ik}^S = \sum_{j=1}^7 q_{ijk} \quad (2)$$

$$i = 1, 2, 3, 4$$

$$k = 1, 2.$$

ii. Demand

$$Q_{jk}^D = \sum_{i=1}^4 q_{ijk} \quad (3)$$

$$j = 1, 2, \dots, 7$$

$$k = 1, 2.$$

(c) Nonnegative shipments:

$$q_{ijk} \geq 0$$

$$i = 1, 2, 3, 4$$

$$j = 1, 2, \dots, 7 \quad (4)$$

$$k = 1, 2.$$

(d) F.o.b. prices in producing countries:

$$V_{ik} \geq P_{jk} (1 - T_{ij}) - C_{ij} - R_{ijk} \quad (5)$$

$$i = 1, 2, 3, 4$$

$$j = 1, 2, \dots, 7$$

$$k = 1, 2.$$

Whenever  $q_{ijk} > 0$ , the strict equality in equation 5 holds and, conversely, if the strict inequality in equation 5 holds,  $q_{ijk} = 0$ .

(e) The reference price mechanism:

$$R_{ijk} = \begin{cases} \max \left\{ 0, P_{Rk} - K_k \frac{1}{2} \sum_{j=6}^7 P_{jk} (1 - T_{ij}) \right\} \\ \quad \text{if } i = 2, 3, 4 \\ \quad \quad \quad j = 6, 7 \\ \quad \quad \quad k = 1, 2 \\ 0 \text{ otherwise.} \end{cases} \quad (6)$$

That is, the countervailing charges are calculated as the differences between the average entry prices

$\left( \frac{1}{2} \sum_{j=6}^7 P_{jk} [1 - T_{ij}] \right)$  and the reference prices  $P_{Rk}$ .

## Values of the Structural Parameters and Exogenous Variables

### The demand relations

The structure of demand for fresh oranges has been the subject of several studies. Earlier studies were surveyed in

<sup>6</sup> The particular functional form of the demand functions (equation 1) was selected for computational convenience. The constant elasticity assumption implied by this form was actually retained only at a restricted neighbor-

hood of the project equilibrium. See footnote 12, page 16. The effect of income is included in the constant  $A_{jk}$ . This effect is made explicit in equation 12.

Levhari (23) and the more recent estimates of demand elasticities are cited by Wolf (44), and Dean and Collins (6 and 7). Most estimates of the price elastic-

ties of demand for the aggregate of all fresh oranges at the wholesale level are at the range of  $-0.6$  to  $-1.0$ . Following Dean and Collins, a uniform price elasticity of  $-0.8$  was adopted in the present study for all consuming countries. A sensitivity analysis for other values of the price elasticities within the above-mentioned range was carried out by Dean and Collins. Equilibrium prices were found to be insensitive to these parametric changes.

Without adequate information on prices and quantities by varietal groups in the various consuming regions, it was impossible to estimate the direct and cross-price elasticities of demand as defined in the present study. However, some propositions of the classical theory of consumer behavior and certain estimates obtained by Levhari allowed us to construct the desired estimates.

First, consider a change of 1 per cent in the price of all oranges; then, by definition, we have:

$$\epsilon_{A_0, j} = (\alpha_{11j} + \alpha_{12j}) \frac{Q_{j1}^D}{Q_{j1}^D + Q_{j2}^D} + (\alpha_{21j} + \alpha_{22j}) \frac{Q_{j2}^D}{Q_{j1}^D + Q_{j2}^D} \quad (7)$$

where  $\epsilon_{A_0, j}$  is the price elasticity of aggregate demand. In order to have  $\epsilon_{A_0, j} = -0.8$  for all  $j$ , as was assumed, we must have

$$\begin{aligned} \alpha_{11j} + \alpha_{12j} &= \alpha_{21j} + \alpha_{22j} \\ &= -0.8 \text{ for all } j. \end{aligned} \quad (8)$$

Second, from the theory of consumer behavior, we have for the individual consumer (the  $r$ th consumer, say) the following Slutsky relation:<sup>7</sup>

$$\alpha_{kk'j}^r = S_{kk'j}^r \frac{P_{jk'}}{Q_{jkr}^D} - \left( \frac{Q_{jk'r}^D P_{jk'}}{M_j^r} \right) \eta_{kj}^r \quad (9)$$

$$k, k' = 1, 2$$

$$j = 1, 2, \dots, 7$$

where

$S_{kk'j}^r$  = the substitution term

$M_j^r$  = the consumer's total expenditures

and

$\eta_{kj}^r$  = the income elasticity of demand for oranges of the  $k$ th varietal group.

Now, Levhari's study provides estimates of the cross-elasticity of demand for Jaffa oranges (Group 1) with respect to the prices of all other oranges of about 4.3 in the United Kingdom and 3.0 in Holland (23). Checking orders of magnitudes, we have  $\eta_{kj}^r \approx 1.0^8$  and

$$\frac{Q_{jk'r}^D P_{jk'}}{M_j^r} < .005.$$

Hence, the income effect term in equation 9 is negligible, and the cross-price derivatives of the demand functions are approximately symmetric (that is,  $S_{kk'}^r \approx S_{r'kk}$ ). Since the symmetry property is preserved under aggregation over individuals, the market demand behavior is also characterized by symmetric cross-price derivatives. Hence, by definition of  $\alpha_{kk'j}$ , we have the additional relation:

$$\alpha_{12j} Q_{j1}^D P_{j1} = \alpha_{21j} Q_{j2}^D P_{j2} \quad (10)$$

<sup>7</sup> Slutsky's relations are ordinarily stated in terms of price derivatives. See, for instance, Hicks (17), pp. 305-14. The translation to elasticities is straightforward.

<sup>8</sup> Appendix table B-3.

TABLE 2  
SALES RATIOS ( $r_j$ )\* AND PRICE FLEXIBILITIES OF DEMAND ( $\delta_{kk'j}$ )† FOR WINTER ORANGES  
1963-64 AND 1970 PROJECTED

Countries	Actual 1963-64 conditions					1970 projected conditions				
	$r_j$	$\delta_{11}$	$\delta_{12}$	$\delta_{21}$	$\delta_{22}$	$r_j$	$\delta_{11}$	$\delta_{12}$	$\delta_{21}$	$\delta_{22}$
Italy and Greece.....	.812	-.704	-.537	-.602	-.580	.611	-.792	-.458	-.752	-.498
Spain and Portugal.....	.572	-.810	-.440	-.769	-.481	.358	-.931	-.318	-.889	-.361
Austria and Switzerland.....	.558	-.817	-.433	-.776	-.474	.348	-.938	-.312	-.896	-.354
Scandinavia.....	.263	-1.006	-.244	-.962	-.288	.158	-1.087	-.163	-1.039	-.211
United Kingdom.....	.196	-1.053	-.197	-1.008	-.242	.059	-1.183	-.067	-1.130	-.120
West Germany and Benelux.....	.410	-.909	-.341	-.867	-.383	.384	-.915	-.335	-.873	-.377
France.....	.427	-.891	-.359	-.849	-.400	1.412	-.545	-.705	-.499	-.751

$$* r_j = \frac{Q^{D_{j2}} P_{j2}}{Q^{D_{j1}} P_{j1}}$$

$$\dagger \delta_{kk'j} = \frac{\partial Q^{D_{jk'}}}{\partial P_{jk'}} \cdot \frac{Q^{D_{jk'}}}{P_{jk'}}$$

On the basis of Levhari's findings, the cross-elasticity of demand in the United Kingdom during the base year was set at  $\alpha_{12, U.K.} = 3.5$ . Using equations 8 and 10, it was then possible to estimate all elasticities and cross-elasticities of demand in the United Kingdom in the base year. To obtain equivalent elasticities for other consuming regions and other sets of conditions, where the ratios  $r_j = Q_{j2}^D P_{j2} / Q_{j1}^D P_{j1}$  are different, we imposed the requirement that, in addition to satisfying equations 8 and 10, the cross elasticities should resemble those estimated for the United Kingdom in 1963-64. This was accomplished by adopting for each consuming region values of cross-elasticities minimizing the sum of squared deviations

$$s_j = (\alpha_{12, j} - \alpha_{12, U.K.})^2 + (\alpha_{21, j} - \alpha_{21, U.K.})^2$$

subject to equation 10. The following solution for  $\alpha_{21, j}$  is obtained:

$$\alpha_{21, j} = \frac{r_j \alpha_{12, U.K.} + \alpha_{21, U.K.}}{1 + r_j^2} \quad (11)$$

Admittedly, the estimation procedure used is somewhat arbitrary. In particular, one may question the assumption concerning the resemblance of cross-price elasticities in various countries. However, the estimation procedure does preserve some basic characteristics of theoretical demand behavior. It utilizes somewhat more information and allows one to analyze the effects of the reference price mechanism at the required level of disaggregation.

Demand flexibilities, rather than elasticities, were used in the iterative computations. They were obtained by inverting the matrix of elasticities. Values

of the flexibilities for actual 1963-64 and the 1970 projected conditions are presented in table 2. Note that the smaller the sale ratio ( $r_j$ ), the greater (in absolute terms) the direct price flexibility of demand for Group 1 oranges and the smaller the direct price flexibility of demand for Group 2 oranges. That is, when the quantity of Group 1 is large ( $r_j$  is small), a change of 1 per cent in the quantity of Group 1 oranges represents a larger absolute change in quantity; and larger relative price changes are thereby generated.

For the base year, the values of the parameters  $A_{jk}$  were obtained by solving equation 1 for the given quantities, prices, and price elasticities. Consumption and prices of fresh oranges for 1963-64 are presented in table 3 (see also Appendix B).

Since the main analysis of the EEC policy was in terms of 1970 conditions, extrapolation of the demand functions was achieved using the formula:

$$A_{jk, 1970} = A_{jk, 1963-64} [(1 + \theta_j) (1 + \eta_{kj} \xi_j)]^{6.5^9} \quad (12)$$

where  $\theta_j$  is annual rate of population growth in region  $j$  and  $\xi_j$  is annual rate of increase in per capita income in region  $j$ . The income elasticities of demand were assumed equal for both varietal groups. They vary between countries and are, on the whole, in the neighborhood of 1.0 (Appendix table B-3).

### 1970 supplies

Projected 1970 supplies by producing countries were obtained by interpolation from 1975 projections of the Food

<sup>9</sup> The exponent 6.5 is equal to the number of years between the 1963-64 season and the 1970 calendar year. The estimation of the  $A_{jk}$  and the extrapolation method are identical with the one used by Dean and Collins (7), pp. 7-10.

**TABLE 3**  
**EXPORTS, IMPORTS, PRICES, COUNTERVAILING CHARGES, AND TRADE FLOWS OF WINTER ORANGES**  
**FOR ACTUAL 1963-64 CONDITIONS AND FOR 1970 PROJECTED CONDITIONS UNDER**  
**THREE ALTERNATIVE TARIFF AND REFERENCE-PRICE SITUATIONS\***

Exporting countries	Economic situation	Consuming regions							Exporting countries, totals	
		Italy and Greece	Spain and Portugal	Austria and Switzerland	Scandinavia	United Kingdom	West Germany and Benelux	France	Total supply or export	F.o.b. prices
		1,000 metric tons							1,000 metric tons	dollars per metric ton
Italy and Greece	1963-64 actual†	379.3† 437.7	—†	30.7 30.3	10.8 10.2	.5 .5	28.1 27.9	—	449.4 508.0	149.15 104.98
	1970 projected	471.8 404.5	—	—	—	—	127.7 272.0	—	599.5 676.5	179.82 128.11
	1970 high reference prices	425.5 433.6	—	—	—	—	174.0 242.9	—	599.5 676.5	189.05 133.76
	1970 free trade	536.8 423.4	—	—	—	—	62.7 253.0	—	599.5 676.4	159.00 113.66
Spain and Portugal	1963-64 actual†	—	305.3 248.7	38.0 31.6	50.1 40.9	69.4 56.6	322.9 203.1	149.3 121.7	935.0 762.0	130.05 91.31
	1970 projected	—	501.2 250.3	136.0 62.0	—	—	166.3 —	302.9 589.3	1,106.4 901.6	119.08 85.35
	1970 high reference prices	—	603.0 164.6	158.7 43.2	—	—	100.8 43.5	243.9 650.3	1,100.4 901.6	114.54 84.21
	1970 free trade	—	379.4 242.1	110.7 83.5	—	—	268.4 9.2	347.9 566.8	1,106.4 901.6	156.00 110.66
North Africa	1963-64 actual†	—	—	—	5.9 1.1	18.3 6.7	126.2 30.8	227.9 92.1	378.2 130.7	157.50 115.00
	1970 projected	—	—	—	22.5 21.4	32.3 8.1	326.6 118.1	—	381.4 147.6	117.08 82.60
	1970 high reference prices	—	—	—	77.6 5.7	23.7 2.2	280.1 159.7	—	381.4 147.6	112.54 82.23
	1970 free trade	—	—	—	3.5 28.8	12.1 13.2	365.8 105.5	—	381.4 147.5	154.00 108.88
Near East	1963-64 actual†	—	—	15.5 1.5	83.0	146.0	112.8 1.2	6.0	363.3 2.7	124.00 79.52
	1970 projected	—	—	—	218.3 27.8	307.5 17.9	144.8 1.7	—	670.6 47.4	106.08 71.00
	1970 high reference prices	—	—	—	188.0 25.0	334.9 14.0	147.7 8.4	—	670.6 47.4	101.54 71.23
	1970 free trade	—	—	—	198.9 29.8	289.0 17.6	182.7	—	670.6 47.4	143.00 97.67
Total imports (1,000 metric tons)	1963-64 actual†	379.3 437.7	305.3 248.7	84.2 62.8	149.8 52.2	234.2 63.8	590.0 323.0	383.2 213.8	—	—
	1970 projected	471.8 404.5	501.2 250.3	136.0 62.10	240.8 49.2	339.8 26.0	765.4 391.8	302.9 589.3	—	—
	1970 high reference prices	425.5 433.6	603.0 164.6	158.7 43.2	265.6 30.7	358.6 16.2	702.6 434.5	243.9 650.3	—	—
	1970 free trade	536.8 423.4	379.4 242.1	110.7 83.5	202.4 58.6	301.1 30.8	879.6 307.7	347.9 566.8	—	—
Wholesale prices at entry‡ (dollars per metric ton)	1963-64 actual†	149.15 104.98	130.06 91.31	184.08 137.83	180.23 135.98	181.20 130.16	192.20 144.00	186.50 142.83	—	—
	1970 projected	179.82 128.11	119.08 85.35	162.89 124.49	160.17 123.62	160.42 122.55	206.82 155.10	177.30 128.68	—	—
	1970 high reference prices	189.05 133.76	114.54 84.21	157.73 123.20	155.37 123.33	155.44 122.15	216.05 160.75	186.14 133.14	—	—
	1970 free trade	150.00 113.66	156.00 110.66	180.00 134.66	188.00 142.08	183.00 137.68	186.00 140.67	169.00 123.66	—	—
Countervailing charges (dollars per metric ton)	1963-64 actual†	—	—	—	—	—	—	—	—	—
	1970 projected	—	—	—	—	—	12.24 6.89	12.24 6.39	—	—
	1970 high reference prices	—	—	—	—	—	23.97 11.16	23.97 11.16	—	—
	1970 free trade	—	—	—	—	—	—	—	—	—

\* 1970 projected = 1970 conditions with a change to the EEC common tariffs (alternative A for North Africa), tariffs in non-EEC countries at the 1963-64 levels, and reference prices set at \$171 and \$86 per metric ton (1965-66 levels).  
1970 high reference prices = same as in 1970 projected, but reference prices set at \$200 and \$100 per metric ton.  
1970 free trade = 1970 conditions but with tariffs and reference prices in all countries at zero levels.  
† Derived on the assumption that the varietal composition of all flows originating in a given country is the same.  
‡ The upper figure in each pair of entries refers to varietal Group 1. The lower figure refers to varietal Group 2.  
§ Dashes indicate no trade flow between countries.  
|| Inclusive of import duties and countervailing charges.



TABLE 4  
LEAST-COST TRANSPORTATION COSTS OF ORANGES FROM  
PRODUCING TO CONSUMING REGIONS

Exporting regions	Importing regions				
	Switzerland and Austria (central point)	Scandinavia (Copenhagen)	United Kingdom (London)	West Germany and Benelux (Hamburg)	France (Marseilles)
	<i>dollars per metric ton</i>				
Italy and Greece (Italy).....	22* (0 + 0 + 22)	39 (29 + 10 + 0)	34 (24 + 10 + 0)	27 (0 + 0 + 27)†	19 (0 + 0 + 19)
Spain and Portugal.....	24 (0 + 0 + 24)	36 (26 + 10 + 0)	31 (21 + 10 + 0)	30 (0 + 0 + 30)†	13 (0 + 0 + 13)‡
Northwest Africa.....	40 (15 + 10 + 15)	34 (24 + 10 + 0)	29 (19 + 10 + 0)	32 (23 + 10 + 0)	29 (19 + 10 + 0)
Near East (Israel).....	40 (20 + 10 + 10)	45 (35 + 10 + 0)	40 (30 + 10 + 0)	43 (33 + 10 + 0)	40 (30 + 10 + 0)

\* The top number in each cell is the transportation cost. The lower figures in parentheses provide a breakdown of total costs into sea freight plus unloading from ship plus rail freight, respectively.

† For shipments originating in Spain and Italy, the reference point was shifted from Hamburg toward the sources.

‡ For shipments originating in Spain, the reference point was shifted to the Spanish border.

SOURCE: 7, p. 22.

and Agriculture Organization of the United Nations (FAO), taking into account recent trends in production; 1970 supplies to East European countries and to the rest of the world were projected likewise and subtracted from overall supplies (13). The varietal composition in 1970 was assumed to resemble that of 1963-64.

### Transportation costs

Transportation costs from producing to consuming regions are presented in table 4. The figures in the table are based on estimates obtained by Dean and Collins (7), but some of the original estimates have been modified to account for changes in geographical reference points.

### Tariff and internal tax rates

Combined tariff and internal tax rates in 1963-64 and 1970 projected are presented in table 5.<sup>10</sup> All values represent *ad valorem* rates. In a few cases the actual duties and taxes are in absolute terms.

<sup>10</sup> Only internal taxes imposed at the wholesale level were included.

The rates were then computed using base-year prices. In the non-EEC countries, 1970 rates are assumed to be at their 1963-64 levels. Table 5 reflects the expected rise in EEC tariff rates and the preferred position of Italy and Greece. Because the future of the tariff preferences accorded to North African exporters is uncertain, the analysis was carried out under two alternative assumptions: (1) All preferences will be abolished and (2) imports from North Africa will enjoy somewhat lower tariffs which will be uniform (8 per cent) in all of the Community markets.

### Reference prices

Regulation 156/65/EEC specified the following system of reference prices for 1965 (12):

Varietal group	Reference price ( $P_{Rk}$ )	Correction coefficient ( $K_k$ )
	<i>(dollars per metric ton)</i>	
$k = 1$	$P_{R1} = 171$	$K_1 = 1.10$
$k = 2$	$P_{R2} = 86$	$K_2 = .76$

TABLE 5  
COMBINED TARIFF AND INTERNAL TAX RATES ON WINTER ORANGES  
IN 1963-64 AND 1970

Exporting region	Importing region				
	Switzerland and Austria	Scandinavia	United Kingdom	West Germany and Benelux	France
	<i>per cent</i>				
Italy and Greece					
1963-64.....	12.16	5.68	8.94	10.50	16.97
1970.....	12.16	5.68	8.94	4.19	0
Spain and Portugal					
1963-64.....	12.16	5.68	8.94	17.13	20.97
1970.....	12.16	5.68	8.94	22.01	18.60
Northwest Africa					
1963-64.....	12.16	5.68	8.94	17.13	0
1970: Alternative 1.....	12.16	5.68	8.94	22.01	18.60
Alternative 2.....	12.16	5.68	8.94	12.10	8.00
Near East					
1963-64.....	12.16	5.68	8.94	17.13	26.97
1970.....	12.16	5.68	8.94	22.01	18.60

## Sources:

1963-64: Figures based on information available in 4, Appendix V.

1970: Figures derived from 7, Appendix A.

The analysis was carried out on the assumption that the 1965 reference prices will continue in 1970. However, since the EEC policy is instrumental in raising prices paid to the Italian producers, reference prices, which are based

on a moving-average price, are also expected to rise. The effects of higher reference prices were, therefore, investigated also. To this end, reference prices were set at  $P_{R1} = \$200$  per metric ton and  $P_{R2} = \$100$  per metric ton.

## The Solution Procedure

The endogenous variables of the system are the quantities demanded in each consuming region ( $Q_{jk}^D$ ), the interregional shipments ( $q_{ijk}$ ), wholesale or auction prices ( $P_{jk}$ ), f.o.b. prices ( $V_{ik}$ ), and the countervailing charges ( $R_{ijk}$ ).

The equilibrium values of the endogenous variables may be obtained by solving equations 1 through 6. Because some of the conditions are, in effect, strict equalities while others are inequalities and because the set of relations which are equalities can be determined only by solving the equilibrium conditions, the problem of finding a suitable solution procedure assumes primary importance.

Accepted solution procedures have, so far, relied, in various degrees, on the application of some kind of programming technique. However, the algorithms turn

out either to be difficult to use because the system is complex, or inappropriate because of some general *a priori* considerations. A natural solution to the problem may, therefore, be provided by the market mechanism which, in some senses, may be viewed as a computational device. This approach was actually adopted in the present analysis.<sup>11</sup>

The equilibrium values of these variables were obtained by an iterative procedure which is essentially a simulation of the shipment adjustment process taking place in a competitive international market. Accordingly, starting with an arbitrary shipment program satisfying the balance equation 2 and the non-negativity constraints in equation 4,

<sup>11</sup> To our knowledge, the use of this approach was first suggested by Tramel and Seale (35).

f.o.b. prices were computed, using equations 1, 3, 5, and 6. The shipping program of each producer was then adjusted by shifting quantities from markets yielding low f.o.b. prices to more remunerative markets. The change in shipments was made proportional to the f.o.b. price differentials, subject to the nonnegative shipment constraints. The process continues until equation 5 is satisfied at some required degree of accuracy. Provided the demand relations satisfy some mild stability conditions,

convergence of the adjustment process may be assured by selecting appropriate adjustment factors. The accuracy required in the present analysis was 1 cent as the maximum f.o.b. price differential among markets to which there were non-zero shipments. The solution procedure described above represents a deviation from some programming procedures hitherto used in solving competitive trade equilibria. It, therefore, deserves a more detailed discussion (see Appendix A).

## Equilibrium Values of Prices and Quantities in 1970 Under Three Alternative Trade Policies

### The tested policies

The following trade policies were considered:

**1970 projected.**—Tariffs are at the levels cited in table 5 (with Alternative 1 for North Africa), and reference prices are at their 1965 levels (\$171 per metric ton for Group 1, \$86 per metric ton for Group 2).

The effects of tariff preferences for North African producers (Alternative 2) were explored separately.

**1970 high reference prices.**—Tariffs are at the levels cited in table 5, but reference prices are raised to \$200 per metric ton for Group 1, and \$100 per metric ton for Group 2.

**1970 free trade.**—Tariff rates and reference prices are set at zero levels for all importing regions.

The first alternative provides information concerning the equilibrium values of prices and quantities under the 1970 projected supply and demand conditions and trade policies most likely to prevail. However, existing political pressures, coupled with rising producer prices in Italy, may lead to increased reference

prices. The effect of such changes is examined in the second alternative. The third alternative is designed to provide a norm of comparison, particularly with reference to welfare implications. It may also provide some indications on the likely changes due to possible relaxations of trade restrictions (for instance, in consequence of agreements achieved in the Kennedy Round negotiations).

The equilibrium values assumed by the various endogenous variables under the three alternative policies and their actual values in 1963–64 are presented in table 3.<sup>12</sup>

### Main findings

**Prices.**—Future developments in supply and demand conditions in conjunc-

<sup>12</sup> Since the shift from the base-year conditions to the 1970 projected conditions involved changes in sales ratios and, consequently, in demand elasticities, the following procedure was adopted: The 1970 projected equilibrium was first obtained from the 1963–64 values, using 1963–64 elasticities. A set of new elasticities relevant to 1970 conditions was then derived; and the 1970 projected equilibrium was recomputed, using the averages of 1963–64 and 1970 elasticities. The other two alternatives were derived from the 1970 projected equilibrium solution, using the 1970 elasticities presented in table 2.

tion with projected changes in the EEC trade policy are expected to have depressing effects on exporters' f.o.b. prices, except for EEC producers who will benefit substantially from the projected changes. F.o.b. prices to non-EEC producers will fall by some 5-30 per cent, while f.o.b. prices in Italy and Greece will rise by some 13-20 per cent.

The contribution of the reference price mechanism to these changes constitutes about one-third of the change as can be judged from the values of the countervailing charges. The effect on wholesale or auction prices is mixed. In all non-EEC consuming regions and in France, prices will fall by 6-15 per cent; in West Germany, Benelux, Italy, and Greece, prices are expected to rise by 4-20 per cent.

The tested increase in reference prices will further lower f.o.b. prices in non-EEC exporting countries by approximately 3-7 per cent and raise f.o.b. prices to EEC producers by some 7 per cent. At these levels, the countervailing charges amount to about 20 per cent of wholesale prices in EEC markets, and reference prices become a major protective mechanism.

The increase in reference prices will also lead to a rise in wholesale or auction prices in all EEC consuming regions. Consequently, trade flows will be diverted to non-EEC consuming regions, thus bringing about a further price decline in these markets.

Trade liberalization tends to reverse these trends. Wholesale prices in non-EEC countries (that actually gain from the high degree of protection in the EEC) will increase under free trade, while an opposite price change is expected to take place in the EEC consuming regions.

As a result of free trade, non-EEC producers will enjoy a substantial in-

crease in their f.o.b. prices at the expense of EEC producers who will face much lower prices.

**Trade flows.**—Supplies of all orange groups in 1970 will rise much above their base-year levels. Most of this increase will be absorbed by a simultaneous growth in demand.

Two profound changes in the pattern of trade flows are expected to take place. First, the termination of trade preferences accorded to North African exporters in the French market will lead to a major diversion of trade. North African oranges will be completely shifted away from the French market, which will be taken over by Spanish oranges exclusively. Since North Africa produced in 1963-64 mostly Group 1 oranges, French consumption also consisted mainly of Group 1 oranges. With Spanish exports dominating the French market in 1970, the composition of French orange consumption will be reversed in favor of Group 2 oranges. Imports of Group 2 oranges to other markets will, consequently, suffer a relative decline. Second, Italian and Greek exporters will concentrate on the West German and Benelux markets, refraining from shipping oranges to any other market. This tendency is bound to lower the sizable present exports from Greece to East European countries.

An increase in reference prices will enhance these trends and will encourage diversion of orange exports, particularly Group 1 oranges, to non-EEC markets. However, a shift to free trade is not expected to modify the predicted changes in the destination of North African, Italian, and Greek exports.

The equilibrium solutions obtained under the various alternative assumptions are sensitive to disturbances. In many cases the f.o.b. prices obtainable from rival markets are very close. For example, the pattern of shipments from

the Near East and North Africa could be modified without violating the equilibrium conditions because the differentials of transportation costs from the two regions to various destinations are alike.<sup>13</sup>

Similarly, in the 1970 projected equilibrium, the f.o.b. prices that Spanish exporters could realize by allocating some Group 1 oranges to Scandinavia and the United Kingdom are lower by only \$4.00 per metric ton than comparable prices actually received in France and West Germany. Such narrow price

differentials are hardly discernible by exporters, and deviations from the predicted equilibrium pattern of trade are likely to occur.

Indeed, given the imperfect price information, the presence of product differentiation, and the importance of established trade channels characterizing real markets, one expects actual shipment programs to be more diversified than those predicted by our model. Dean and Collins (7) report similar observations. However, only mild price effects are associated with such deviations.

## Welfare Implications

In analyzing the welfare consequences of the EEC trade policy, three components of the problem are distinguished: (1) producers' income, (2) consumers' surplus, and (3) government revenue.

Because outputs are regarded constant, variation in producers' income represents the corresponding variation in producers' welfare measured in monetary terms. However, in treating consumers' welfare, some measure of consumers' surplus must be adopted. In the present analysis, the aggregate compensating variations are used to measure changes in consumers' welfare.<sup>14</sup> The compensating variation is a particularly convenient measure because it allows a direct application of the "compensating principle" of welfare economics. The meaning and derivation of this measure deserve a short explanation.

<sup>13</sup> For this reason, the number of nonzero shipments exceeds 20, the number implied by the solution to a transportation cost minimization problem inherent in the equilibrium conditions (see Appendix A). It is possible to rearrange the shipments program without violating the equilibrium conditions so that the number of nonzero shipments will be 20.

<sup>14</sup> For a detailed discussion of the concept, see 42, pp. 395-423, and 27, pp. 83-114.

The individual income function,  $M^r(P_1, \dots, P_n; U_r)$ , is defined to be the smallest income required to furnish the  $r$ th consumer with a utility level (real income),  $U_r$ , in the price configuration  $P_1, \dots, P_n$ . Accordingly, the individual compensating variation ( $CV_r$ ), associated with the price configuration  $P_1^1, \dots, P_n^1$  relative to  $P_1^0, \dots, P_n^0$ , represents the change in minimal income required to compensate the consumer for the change in prices from  $P_1^0, \dots, P_n^0$  to  $P_1^1, \dots, P_n^1$ ; that is,

$$CV_r = M^r(P_1^1, \dots, P_n^1; U_r^0) - M^r(P_1^0, \dots, P_n^0; U_r^0) \quad (13)$$

and, assuming independent utilities among individuals, we have for the aggregate:

$$CV = \sum_r [M^r(P_1^1, \dots, P_n^1; U_r^0) - M^r(P_1^0, \dots, P_n^0; U_r^0)]. \quad (14)$$

Now, it has been shown that

$$\frac{\partial M^r}{\partial P_i} = Q_i^{cr}(P_1, \dots, P_n; U_r) \tag{15}$$

$$i = 1, 2, \dots, n$$

where  $Q_i^{cr}$  is the compensated demand function of the  $r$ th individual for the  $i$ th commodity (21, p. 272). Similarly, the corresponding partial derivative of the aggregate income function,  $M = \sum_r M^r$ , is the market-compensated demand function.

$$Q_{jk}^D = Q_{jk}^{CD} = \beta_{jk} + \gamma_{jk1}P_{1j} + \gamma_{jk2}P_{2j}$$

$$j = 1, 2, \dots, 7; k = 1, 2; \text{ with} \tag{16}$$

$$\gamma_{j12} = \gamma_{j21} \tag{15}$$

We now conceive our system as consisting of three commodities: Group 1 oranges, Group 2 oranges, and a composite commodity comprising all other commodities with its price being identi-

The demand functions for oranges are dominated by the substitution effects and may be closely approximated by compensated demand functions. The approximation was actually accomplished by imposing symmetric cross-price derivatives in the estimation procedure. However, the symmetry conditions hold only at the 1970 projected equilibrium point, whereas equation 15 implies symmetry everywhere. This requirement can be satisfied by linearizing our demand functions about the 1970 projected equilibrium point. Equation 1 then becomes:

cally equal to one—that is, the composite commodity serves as a numeraire.

The aggregate income function of the  $j$ th consuming region is then quadratic:

$$M_j(P_{1j}, P_{2j}) = \delta_{0j} + \beta_{j1}P_{1j} + \beta_{j2}P_{2j}$$

$$+ \frac{1}{2}[\gamma_{j11}P_{1j}^2 + (\gamma_{j12} + \gamma_{j21})P_{1j}P_{2j} + \gamma_{j22}P_{2j}^2] \tag{17}$$

as can be verified by differentiation  $M_j$  with respect to  $P_{kj}$ .<sup>15</sup>  $\delta_{0j}$  can be determined from overall consumer expenditures. In the present analysis, however, the value of  $\delta_{0j}$  is immaterial as we are interested solely in changes in  $M_j$  and not in its absolute value.

Evidently, the validity of our analysis is restricted to the neighborhood of the 1970 projected equilibrium in which equation 16 is a good approximation. The measures presented in table 6 fur-

nish welfare comparisons between the 1970 projected equilibrium and the other two 1970 equilibria discussed in the preceding section. The 1970 projected equilibrium was thus selected as a base, and the entries in table 6 represent deviations from the 1970 projected welfare measures.

the line integral

$$\int \sum_{k=1}^2 Q_{jk}^D(P_{1j}, P_{2j}) dP_{kj} .$$

<sup>15</sup> The coefficients  $\beta_{jk}$  and  $\gamma_{jkk}$ , were obtained from the 1970 elasticities and equilibrium prices and quantities by expanding the demand equations in a Taylor expansion about the equilibrium values neglecting the nonlinear terms.

This is the  $n$  commodities generalization ( $n = 3$ ) of the "consumer surplus" measured by the "area under the (compensated) demand curve." However, if  $Q_{jk}^D$  is the constant-money-income demand function, the above line integral would not yield the income function.

<sup>16</sup> The income function, equation 17, is in fact

TABLE 6  
WELFARE COMPARISONS OF HIGH REFERENCE PRICES AND FREE TRADE  
RELATIVE TO 1970 PROJECTED CONDITIONS  
WINTER ORANGES, 1970\*

Country	High reference prices†				Free trade			
	Consumers' surplus	Government revenue	Producers' income	Net gain or loss	Consumers' surplus	Government revenue	Producers' income	Net gain or loss
	<i>1,000 dollars</i>							
Italy and Greece ..	- 6,494	0	9,352	2,858	16,302	0	-22,255	- 5,863
Spain and Portugal	2,700		-0,049	-3,349	-21,757	0	69,604	41,907
Switzerland and								
Austria .....	821	58	0	879	- 2,805	- 3,633	0	- 6,438
Scandinavia .....	1,233	24	0	1,257	- 7,097	- 2,535	0	- 9,632
United Kingdom .....	1,736	0	0	1,736	- 7,601	- 5,159	0	-12,760
West Germany and								
Benelux .....	- 9,083	5,030	0	-4,053	22,475	-41,675	0	-19,200
France .....	- 5,144	6,087	0	943	5,582	-31,571	0	-25,989
North Africa .....	0	0	-1,785	-1,785	0	0	17,930	17,930
Near East .....	0	0	-3,058	-3,058	0	0	25,995	25,995
Total, all countries.....	-14,231	11,199	-1,540	-4,572	5,189	-84,573	85,334	5,950

\* Entries represent deviations from the 1970 projected equilibrium.

† For Group 1 oranges, \$200 per metric ton; for Group 2 oranges, \$100 per metric ton.

Source: Calculated from basic data.

Perhaps the most striking finding of the analysis is the relative insensitivity of the "overall welfare measure" to considerable variation in trade policies. Thus, if one is willing to adopt the compensation principle, then the gainers from free trade are left with a net gain of a mere \$5.950 million after having compensated the losers. In view of the overall size of the market (hundreds of millions of dollars), this is a negligible amount.

However, the distributional effects are more substantial. Thus, an increase in reference prices by some 16 per cent will raise returns to Italian and Greek producers by \$9.4 million and lower returns to the other exporters by about \$11 million. The associated losses by EEC consumers are valued at \$20.7 million, while the increase in government revenues in the EEC countries is \$11.1 million.

All EEC countries together actually realize a net loss because of higher refer-

ence prices, but the loss is negligible (\$252,000). The principal function of the increase in reference prices is, therefore, to redistribute income from EEC consumers to EEC governments and producers. The cost of this transfer is borne by the non-EEC producers who, consequently, stand to lose about \$10.9 million, while non-EEC consumers will benefit from increased reference prices.

The distributional effects associated with a move toward free trade are considerable. The resulting net increase in producers' income is \$85.3 million, while the loss in governments' revenues amounts to \$84.6 million (of which \$16 million are derived from countervailing charges). Because the net loss to the Community, due to trade liberalization, adds up to \$51 million, EEC countries have a strong incentive to retain their protective policy in the orange market. The same conclusions, in essence, were arrived at by Dean and Collins (6 and 7).

## The Effects of Preferential Trade Arrangements Between the EEC and North African Exporters

The preceding analysis was performed under the assumption that the preferred position of North African exporters in the French market will be discontinued. However, such eventuality is by no means certain. In fact, there are indications that present trade preferences may be modified but not cancelled. It appears that in the future North African exporters are likely to enjoy tariff concessions in all of the Community markets, though these concessions may be smaller than formerly accorded to them by France.

This possibility was investigated by finding the 1970 equilibrium values, given that imports from North Africa to the Community will be liable to uniform tariff charges of 8 per cent (Alternative 2 of table 5). To these charges were added the internal sales taxes. Reference prices were assumed to retain their 1965 levels.

As might have been expected, the entire North African export was then diverted to the Community (to West Germany and Benelux countries), and North Africa f.o.b. prices were raised to

\$149.85 per metric ton for Group 1 oranges and \$104.11 per metric ton for Group 2 oranges.

These shifts in the pattern of trade were accompanied by compensating trade diversions on the part of other exporters, mostly the Near East.

Changes in prices, other than North African f.o.b. prices, were insignificant because the international price structure is determined by the pattern of trade of Spain and Portugal and the Near East whose shipment programs are connected and together cover all markets excluding Italy. This holds true independently of the nature of the EEC-North African trade relations.

In the short run, therefore, trade preferences to North African countries will have no adverse effects on the competitive position of other exporters. In the longer run, however, the supply response of North African producers to the favorable price condition is bound to impair the competitive position of other exporters.

### Concluding Remarks

The present study is in effect an extension and updating of Dean and Collins' work (6 and 7). In particular, it aims at analyzing the possible effects of the reference-prices and countervailing-charges mechanism, which may evolve into a principal protective device of the EEC agricultural trade policy.

The incorporation of reference prices required a disaggregation of winter oranges into varietal groups and increased considerably the complexity of the system. Consequently, it was neces-

sary to develop appropriate solution procedures and to generalize the concept of consumer surplus to the many-commodities situation. These needs were met by devising a "market simulating" algorithm and by adopting the changes in aggregate income functions as welfare measures.

Though adding to the complexity of the model and increasing the number of parameters which have to be estimated, the disaggregation provided a more realistic description of the European market



for fresh oranges and shed additional light on the shipping patterns.

The projected developments of prices and quantities in the European market tend to substantiate Dean and Collins' findings. In general, consumer and producer prices in the EEC markets are expected to rise, while consumer prices in other importing countries and f.o.b. prices in exporting countries (excluding Italy and Greece) will tend to decline.

The role of the reference-price mechanism in these developments will be significant but not dominant, provided reference prices are retained at their 1965-66 levels. However, an increase of 16 per cent in reference prices will have adverse effects on producers' income outside the EEC. At these levels, a system of reference prices and countervailing charges constitutes a very effective protective device.

The distributional effects of the EEC protective policy are considerable, with government revenues and producers' gains exceeding consumer losses. The

distributional effects of high reference prices are significant, but the net gain to the Community at large is negligible and is achieved at substantial costs to non-EEC producers.

The findings of the present study are derived from a short-run model. In the longer run, the equilibrium values depend critically on the rate at which Italian and Greek producers are capable of expanding orange production relative to the anticipated growth in demand.

All the forecasts derived from the present analysis are conditional on the assumed policy measures, which are subject to constant change. Thus, trade preference previously accorded to North African countries may be modified but not abolished; the United Kingdom may join the EEC; or tariffs may be lowered in some countries in consequence of Kennedy Round negotiations. However, any analysis of the likelihood of such events is beyond the scope of the present study.

## APPENDIX A

### The Solution of Spatial Competitive Equilibria

#### The conceptual problem

Equations 1 through 6 define the conditions of a spatial equilibrium of trade involving transportation costs, tariffs (*ad valorem*), and the peculiar protective device of the reference price and countervailing charges. As such, they constitute a somewhat special example of a spatial trade model. The model may be further generalized by (a) treating supply as a function of prices, (b) allowing costless disposal of goods if they become "free," (c) letting the number of commodities ( $m$ ) exceed two, and (d) allowing both production and consumption to take place in every region. If we disregard, for the moment, tariffs and countervailing charges, the following more general and somewhat simpler model emerges:

$$Q_{jk}^D = Q_{jk}^D(P_{j1}, \dots, P_{jm})$$

$$j = 1, \dots, n \quad (1A)$$

$$k = 1, \dots, m$$

$$Q_{ik}^S = Q_{ik}^S(P_{i1}, \dots, P_{im})$$

$$i = 1, 2, \dots, n \quad (2A)$$

$$k = 1, 2, \dots, m$$

$$Q_{jk}^D \leq \sum_i q_{ijk}$$

$$j = 1, 2, \dots, n \quad (3A)$$

$$k = 1, 2, \dots, m$$

$$Q_{ik}^S \geq \sum_j q_{ijk}$$

$$i = 1, 2, \dots, n \quad (4A)$$

$$k = 1, 2, \dots, m$$

$$q_{ijk} \geq 0$$

$$i, j = 1, 2, \dots, n \quad (5A)$$

$$k = 1, 2, \dots, m$$

$$P_{jk} - C_{ij}^k - P_{ik} \leq 0$$

$$i, j = 1, 2, \dots, n \quad (6A.1)$$

$$k = 1, 2, \dots, m$$

$$\sum_i \sum_j \sum_k (P_{jk} - C_{ij}^k - P_{ik}) q_{ijk} = 0. \quad (6A.2)$$

By virtue of equation 6A.2,  $q_{ijk} > 0$  implies the strict equality in equation 6A.1; and conversely, the strict inequality in equation 6A.1 implies that  $q_{ijk} = 0$ . Equations 1A through 6A define the set of equilibrium conditions, determining the equilibrium values of all prices, quantities demanded and supplied, and the shipment program.

Having defined equilibrium conditions, one is interested in two general classes of problems: (1) For a set of known demand and supply equations and transportation costs, how can the equilibrium conditions be solved? And (2) what are the general properties of the equilibrium solution? For instance, in what direction will the equilibrium be displaced in consequence of certain parametric changes?

It was shown by Samuelson (30) in 1952 that, for the case of one commodity ( $m = 1$ ), there exists a formal equivalence between some maximum problem

and the competitive equilibrium. In particular, let  $P_j^D(Q_j^D)$  and  $P_i^S(Q_i^S)$  be the price demand and supply functions, respectively, and define the following "net social payoff" (NSP) function:

$$\begin{aligned} NSP = & \sum_{j=1}^n \int_0^{Q_j^D} P_j^D(X_j) dx_j \\ & - \sum_{i=1}^n \int_0^{Q_i^S} P_i^S(X_i) dx_i \\ & - \sum_i \sum_j q_{ij} C_{ij}. \end{aligned}$$

Then it can be shown, using the Kuhn-Tucker theorem, that the necessary conditions for maximum NSP, subject to equations 3A, 4A, and 5A, are formally equivalent to the equilibrium conditions.<sup>17</sup> A corollary of this equivalence is that, given the quantities supplied and demanded in equilibrium, the competitive shipment program will minimize the transportation costs. Furthermore, the corollary holds in the multiproduct case as well, even in cases where no corresponding maximum problem can be established. This follows from the fact that the equilibrium prices,  $P_{it}$ , can always be construed as the dual solution to the problem of minimizing transportation costs, in which case equations 3A, 4A, 5A, and 6A are formally equivalent to the Kuhn-Tucker conditions.

In addition to the light it sheds on the properties of the equilibrium shipment program, this formal equivalence was the basis of solution procedures employed by several researchers, including Judge and Wallace (20), King and

Schrader (22), Bawden, Carter, and Dean (2), and Dean and Collins (7). The solution procedure used is iterative. It starts with an initial set of prices which are adjusted until total "world supply" equals total "world demand." Given the quantities supplied and demanded at these prices in each country, an optimal shipment program is determined by linear programming. Prices are revised, the new set of prices retaining the price differentials implied by the cost minimization solution. Using a price-differential-preserving adjustment procedure, the new prices are again adjusted until world supply equals world demand. The procedure continues until no more price revisions are required.

This approach is perfectly general. However, the computational problem may become cumbersome when multiproduct nonlinear supply and demand equations are involved. Moreover, once complex trade policies have been introduced, it may become difficult to find appropriate algorithms.

In 1964 it was proposed by Takayama and Judge (32) that the equivalence between spatial equilibria and extremum problems, established by Samuelson (30) for a single commodity, could be extended to the many-commodity case. Such an approach is particularly advantageous in empirical analyses, since trade equilibria are thereby rendered soluble by means of existing concave programming routines. Moreover, it was later indicated by Bawden (1) and Takayama (31) that a variety of trade policies could be incorporated and analyzed within the framework of the Takayama-Judge model.

However, as will be demonstrated subsequently in the multiproduct case, the Takayama-Judge formulation severely restricts the demand equations.<sup>18</sup>

To prove this assertion, let us first

<sup>17</sup> An equivalence between the spatial price equilibrium and the dual of Samuelson's maximization problem was demonstrated by Smith (29) in 1963.

<sup>18</sup> These restrictions apply to the supply functions as well. However, in this case they are justifiable by *a priori* theoretical considerations.

reproduce a somewhat more general version of the Takayama-Judge formulation. To this end let  $P_{jk}^D(Q_{j1}^D, \dots, Q_{jm}^D)$  and  $P_{ik}^S(Q_{i1}^S, \dots, Q_{im}^S)$  denote the price demand and supply functions. These functions are obtained by solving equa-

tions 1A and 2A, respectively, for prices in terms of quantities. The equivalence with a maximum problem is then established by forming the following sum of line integrals:<sup>19</sup>

$$\begin{aligned} \Phi(Q_{11}^D, \dots, Q_{nm}^D, Q_{11}^S, \dots, Q_{nm}^S) &= \sum_{j=1}^n \int_{(0 \dots 0)}^{(Q_{j1}^D \dots Q_{jm}^D)} \sum_{k=1}^m P_{jk}^D dQ_{jk}^D \\ &- \sum_{i=1}^n \int_{(0 \dots 0)}^{(Q_{i1}^S \dots Q_{im}^S)} \sum_{k=1}^m P_{ik}^S dQ_{ik}^S. \end{aligned}$$

The maximum problem is then:

Maximize

$$NSP = \Phi - \sum q_{ijk} C_{ij}^k$$

subject to equations 3A, 4A, and 5A. The related Kuhn-Tucker conditions are then equivalent to the equilibrium conditions.

However,  $\Phi$  exists if, and only if,  $P_{jk}^D$  and  $P_{ik}^S$  satisfy certain integrability conditions. In particular, since

$$\frac{\partial \Phi}{\partial Q_{jk}^D} = P_{jk}^D$$

and

$$\frac{\partial \Phi}{\partial Q_{ik}^S} = P_{ik}^S,$$

we must have

$$\frac{\partial P_{jk}^D}{\partial Q_{jh}^D} = \frac{\partial P_{jh}^D}{\partial Q_{jk}^D} \quad (7A.1)$$

and

$$\frac{\partial P_{ik}^S}{\partial Q_{ih}^S} = \frac{\partial P_{ih}^S}{\partial Q_{ik}^S} \quad (7A.2)$$

$$i, j = 1, 2, \dots, n$$

$$h, k = 1, 2, \dots, m.$$

Equations 7A.1 and 7A.2 must hold over the entire domain of the behavioral functions. Since symmetry of cross-derivatives is preserved under inversion, it must hold for equations 1A and 2A as well.

What are the implied restrictions on the demand functions? Recall first that  $Q_{jk}^D$  is a market, and not an individual, demand function; and though it is possible that aggregation of individual demand functions with asymmetric cross derivatives will yield a market demand function satisfying the symmetry requirement, it is highly unlikely. We must, therefore, conclude that symmetric cross derivatives in the market demand function follow from individual demand functions endowed with the symmetry property.

<sup>19</sup> To avoid excessive notations,  $Q_{jk}^D$  and  $Q_{ik}^S$  denote both variables of integration and integration limits. No confusion need arise due to this ambiguous use of notations. Readers interested in the concept of line integral can consult 28.

Rewriting equation 9 in terms of derivatives, we get:

$$\frac{\partial Q_{jkr}^D}{\partial P_{jh}} = S_{khj}^r - Q_{jhr}^D \frac{\partial Q_{jkr}^D}{\partial M_j^r} \quad (9')$$

Excluding some unrealistic assumptions concerning the structure of preferences, the only symmetric element in the derivative is the substitution term,  $S_{khj}^r$ .<sup>20</sup> Hence, the symmetry condition is satisfied, at least approximately, only if the analyzed commodities are closely related in demand (that is, a strong substitution effect) and have a relatively low income derivative ( $\partial Q_{jkr}^D / \partial M_j^r$ ) with expenditures on these commodities amounting to a minor portion of overall consumer expenditures (that is, a weak income effect).<sup>21</sup> Although many analyses may in fact involve just such commodities (as is the case in the present study), the class of analyzable commodities is, nonetheless, severely restricted.

From the practical econometric point of view, there is the additional disadvantage of narrowing the class of functional forms which may effectively represent demand behavior. Thus, the often-used log-linear forms—for example, equation 1—are unsuitable since symmetry must hold over the entire domain in which the functions are defined.

The difficulties with Takayama's programming approach to the solution of competitive equilibria were recognized by Yaron, Plessner, and Heady in 1965 (45). These authors have proposed an

<sup>20</sup> If we assume homogeneous utility indices, then the income elasticity of demand is unitary for all commodities. The reader may verify that the price derivative (equation 9') is then symmetric. The realism of this assumption is rather doubtful.

<sup>21</sup> Generally speaking, the demand structure for these commodities is such that the uncompensated demand function can be approximated adequately by the compensated demand functions.

ingenious modification in the programming formulation that would permit the application of nonlinear programming techniques in solving competitive equilibria. The proposed formulation involves the maximization of net producers' returns, exclusive of cash and imputed (shadow) costs, subject to resource constraints and to the condition that demand prices do not exceed the marginal costs (inclusive of imputed cost). It is not clear, however, how adaptable the proposed approach is to situations involving complex trade arrangements.

Indeed, one wonders if the attempt to establish a correspondence with an extremum problem is worth all these troubles. There must be other, less restrictive solution algorithms.

Tramel and Seale proposed in 1963 an alternative algorithm which they named "reactive programming" (Tramel, 34). The suggested solution procedure may be viewed as a market-simulating procedure in the sense that the shipments adjustment process employed in the calculations may correspond to the actual processes in a competitive spatial market. Tramel and Seale (35), while dealing mostly with the single-product case, indicated the possibility of extending their technique to the multiproduct situation. Their approach was criticized by Takayama and Judge (32) on the grounds that the computational efficiency of reactive programming may be inferior and that, furthermore, its convergence is not assured. In his answer to this criticism, Tramel (34) provided only a partial answer to the convergence problem.<sup>22</sup>

The solution procedure adopted in the

<sup>22</sup> Tramel's argument concerning the convergence properties of reactive programming relies exclusively on the convergence of the "Hildreth process" which was developed only for cases where the equivalence with an extremum problem is valid (18).

present study is essentially a market-simulating algorithm. The only restrictions placed on the behavioral relations have to do with the stability of the assumed market adjustment processes. Given the stability of these processes, market simulation will yield the equilibrium solution at any specified level of accuracy since, by definition, market stability implies convergence of a market-simulating computational procedure. Moreover, stability conditions provide information on the comparative statics of the system analogous to that provided by the second-order conditions of the equivalent maximum problem. But

how restrictive is the stability assumption? For a full answer to this question, one must know all possible sufficiency conditions for the stability of the postulated adjustment process. The task of determining all these conditions is not undertaken in the present study. We shall derive, however, one set of rather mild sufficiency conditions for *local* stability. But before doing so, it will be shown that the symmetry conditions in effect insure *global* stability of the adjustment process. To prove this assertion, we first express the postulated adjustment process as a set of differential equations.<sup>23</sup>

$$\frac{dq_{ijk}}{dt} = \begin{cases} \Pi_{ij}^k = P_{jk}^D - C_{ij}^k - P_{ik}^S \text{ if } \Pi_{ij}^k > 0, \\ \text{or if } \Pi_{ij}^k < 0 \text{ and } q_{ijk} > 0 \\ 0 \text{ otherwise.} \end{cases} \quad (8A)$$

Then,  $\lambda(t) = -NSP$  may serve as a *modified Lyapunov function*; that is, to prove the global stability of equation 8A, we have to show that

$$\lambda(t) = -\Phi \left[ \sum_i q_{i11}(t), \dots, \sum_i q_{inm}(t), \sum_j q_{1j1}(t), \dots, \sum_j q_{njm}(t) \right] + \sum_i \sum_j \sum_k C_{ij}^k q_{ijk}(t)$$

is strictly decreasing in  $t$  except at the equilibrium point (41). Taking the time derivative of  $\lambda(t)$ , we get:

$$\begin{aligned} \frac{d\lambda(t)}{dt} &= - \sum_i \sum_j \sum_k \frac{\partial(NSP)}{\partial q_{ijk}} \frac{dq_{ijk}}{dt} \\ &= - \sum_i \sum_j \sum_k (P_{jk}^D - C_{ij}^k - P_{ik}^S) \frac{dq_{ijk}}{dt} \\ &= - \sum_{ijk \in I} (P_{jk}^D - C_{ij}^k - P_{ik}^S)^2 \leq 0 \end{aligned} \quad (9A)$$

where  $I$  is  $\{ijk : \Pi_{ij}^k > 0 \text{ or } \Pi_{ij}^k < 0 \text{ and } q_{ijk} > 0\}$ .

The strict inequality in equation 9A holds at any nonequilibrium point,

<sup>23</sup> The actual market simulation used in the present study is, essentially, a discretized form of equation 8A, slightly modified in accordance with the particular problem on hand.

while the strict equality holds in equilibrium points since then  $\Pi_{ij} \leq 0$ , and if  $\Pi_{ij}^k < 0$ ,  $q_{ijk} = 0$ . The symmetry of cross-derivatives, therefore, implies the global stability of equation 8A. However, it is not a necessary condition, and there may be other sets of sufficient conditions.

Consider, for example, the case of linear demand and supply functions; and suppose the sets of equations 1A and 2A are both invertible so that we can express the demand prices,  $P_{jk}^D$ , and supply prices,  $P_{ik}^S$ , as functions of quantities.<sup>24</sup>

Consider now the price adjustment process (equation 8A). Evidently, equations 6A.1 and 6A.2 define a stationary point of the process (equation 8A). Denote the equilibrium shipment program by  $\{q_{ijk}^0\}$ , and the current shipment program by  $\{q_{ijk}\}$ . The system is stable if the current nonequilibrium program converges to the equilibrium program. To

investigate convergence, define the Euclidian distance function

$$D(q, q^0) = \frac{1}{2} \sum_{i, j, k} (q_{ijk} - q_{ijk}^0)^2.$$

Convergence is assured if the time derivative  $dD/dt$  is strictly negative whenever  $\{q_{ijk}\}$  is not an equilibrium program.<sup>25</sup>

Now, by equation 8A

$$\begin{aligned} \frac{dD}{dt} &= \sum_{i, j, k} (q_{ijk} - q_{ijk}^0) \frac{dq_{ijk}}{dt} \\ &\leq \sum_{i, j, k} (q_{ijk} - q_{ijk}^0) \Pi_{ij}^k \end{aligned} \quad (10A)$$

since either  $dq_{ijk}/dt = \Pi_{ij}^k$  or  $\Pi_{ij}^k < 0$  and  $q_{ijk} = 0$ ; but in the latter case,  $dq_{ijk}/dt = 0$ , and then,

$$(q_{ijk} - q_{ijk}^0) \Pi_{ij}^k = -q_{ijk}^0 \Pi_{ij}^k \geq (q_{ijk} - q_{ijk}^0) \frac{dq_{ijk}}{dt} = 0 \text{ as } q_{ijk}^0 \geq 0.$$

Under the assumption of linear behavioral relations, we may write

$$\begin{aligned} \Pi_{ij}^k &= \Pi_{ij}^{k0} + \sum_h a_{jkh} (Q_{jh}^D - Q_{jh}^{D0}) \\ &\quad - \sum_h b_{ikh} (Q_{ih}^S - Q_{ih}^{S0}) \end{aligned} \quad (11A)$$

where

$$\begin{aligned} \Pi_{ij}^{k0} &= \text{equilibrium value of } \Pi_{ij}^k \\ Q_{jh}^{D0} \text{ and } Q_{ih}^{S0} &= \text{equilibrium quantities} \end{aligned}$$

$$\begin{aligned} \frac{dD}{dt} &\leq \sum_{i, j, k} (q_{ijk} - q_{ijk}^0) \Pi_{ij}^{k0} \\ &\quad + \sum_{j, k, h} (Q_{jh}^D - Q_{jh}^{D0}) a_{jkh} (Q_{jk}^D - Q_{jk}^{D0}) \\ &\quad + \sum_{i, k, h} (Q_{ih}^S - Q_{ih}^{S0}) b_{ikh} (Q_{ik}^S - Q_{ik}^{S0}). \end{aligned} \quad (12A)$$

<sup>24</sup> If the demand and supply functions are nonlinear, the following analysis can be used to establish sufficient conditions for local stability. This is done by linearizing the behavioral relations about the equilibrium point.

<sup>25</sup> This analytic method has been frequently employed in studying stability problems (21).

The first sum on the right of equation 12A is nonpositive since, by equations 5A and 6A.1,  $\sum_{ijk} q_{ijk} \Pi_{ij}^{k0} \leq 0$ ; and by equation 6A.2,  $\sum_{ijk} q_{ijk}^0 \Pi_{ij}^{k0} = 0$ . We therefore conclude that, if the matrix  $A_j = [a_{jkh}]$  is negative quasi definite for all  $j$  and the matrix  $B_i = [b_{ikh}]$  is positive quasi definite for all  $i$ ,  $dD/dt < 0$  whenever the shipment program is not an equilibrium program.<sup>26</sup> That is, stability does not require that  $A_j$  and  $B_i$  be symmetric. The quasi-definiteness is, in fact, a much milder condition than symmetry.<sup>27</sup> Hence, the stability requirement is weaker than the symmetry requirement.

The simulation approach provides rather flexible algorithms in the sense that a wide variety of trade policies may be incorporated in the analysis.

### Outlines of the market-simulating solution algorithm employed in the study

A flow chart of the solution procedure is presented in Appendix figure A-1. The procedure involves four main phases. In the first phase, data pertaining to the demand behavior is used to form the price demand functions for the analyzed year (year of projection). In the second phase, total initial (arbitrary) shipments to each importing region are entered into the demand function to yield wholesale prices which, in turn, are used to calculate f.o.b. prices obtainable by each exporting region in every market. In the third phase, the resulting f.o.b. prices obtainable in each market are compared,

<sup>26</sup> A matrix  $C$  is said to be negative quasi definite if  $C + C'$  is negative definite. A positive quasi-definite matrix is similarly defined.

<sup>27</sup> Since we have assumed invertibility of the supply and demand function, the matrices  $A_j$  and  $B_i$  are definite whether symmetric or not. Second-order conditions for a Takayama-type objective function also require that the  $A_j$  be negative and the  $B_i$  be positive (both definite as indicated).

and the maximum f.o.b. price differentials over consuming and exporting regions are determined for each varietal group. In the fourth phase, the highest price differentials of the two varieties are examined. If the differential of variety  $K$  is larger than  $\epsilon$  ( $\epsilon = 1$  cent), the exporter facing this differential transfers quantity  $\Delta x_K$  from the market with low prices to the market with high prices.

The quantity to be transferred is a certain proportion of the price differential where the proportionality factor,  $F$ , varies with the shipment program (see equation 13A). Experience showed that transfers calculated in this manner assured convergence. After transferring the quantities between the markets, the computational process is repeated, this time beginning with the second phase.

This iterative procedure continues until the highest price differential for each variety is less than the required level of accuracy,  $\epsilon$ .

The input data in the flow chart are:

$QB(J,K)$ —total imports of variety  $K$  to region  $J$  at the base year.

$PB(J,K)$ —wholesale price of variety  $K$  in region  $J$  at the base year.

$XM(J)$ —estimated shifter of the demand function of region  $J$  from the base year to the year of projection.

$A(J,K,L)$ —matrices of elasticities and cross-elasticities for the two varieties in region  $J$ .

$T(I,J)$ —rate of tariff levied in consuming region  $J$  on imports from the  $I$ th exporter.

$RP(K)$ —reference price of variety  $K$ .

$H(I,J)$ —transportation cost from region  $I$  to region  $J$ .



$X(I, J, K)$ —initial shipments of variety  $K$  from region  $I$  to region  $J$ .

$\epsilon(K)$ —level of accuracy for  $K$ th variety.

$$I = 1, 2, 3, 4$$

$$J = 1, 2, \dots, 7$$

$$L, K = 1, 2.$$

Circled statements describe the nature of operations performed in the subsequent phase. Other notations are defined in the flow chart. The proportionality factor,  $F(K)$ , used in adjusting the shipment program is computed as follows:

$$F(K) = -\epsilon_{Ag} \left[ \frac{V(JMAX, K)}{Q(JMIN, K)} + \frac{V(JMIN, K)}{Q(JMAX, K)} \right]^{-1} \quad (13A)$$

where  $\epsilon_{Ag}$  = the price elasticity of demand for the aggregate of all oranges (see page 9) and the other variables are defined in Appendix figure A-1.

The program yields as output: the equilibrium shipment program, whole-

sale prices in each importing region, f.o.b. prices of each exporter by consuming region, import duties and countervailing charges levied, and transportation costs.

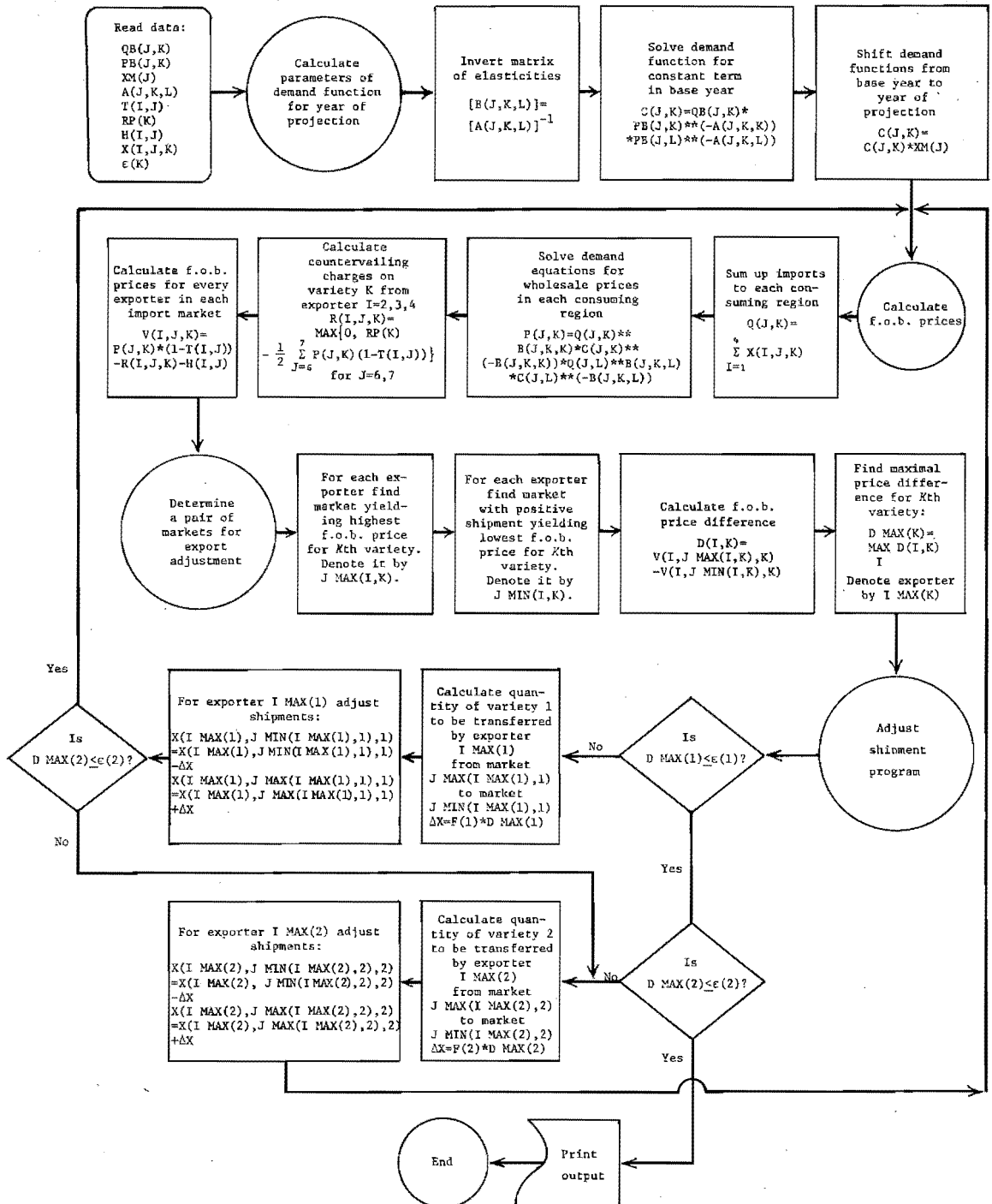


Fig. A-1. Flow chart of the solution algorithm.

## APPENDIX B

### Sources of Data and Estimation Procedures

#### Production, consumption, and trade: 1963-64

Production of oranges and tangerines and exports of fresh oranges by countries of origin, regions of destination, and varietal groups are presented in Appendix table B-1.

The production data were obtained from FAO (15). Sources of information on exports are listed in table 1 of this monograph. Consumption of fresh oranges in importing countries was obtained as sums of imports to the consuming country. Consumption in North Africa and the Near East was estimated as follows: Information available from Wintrant (43, table 1) was used to determine the percentage of oranges in the aggregate of "oranges and tangerines." Applying this percentage to the 1963-64 production figures gave total production of oranges by countries. Information available from Wintrant (43, table 2) provided the ratio of fresh to processed exports. The ratios were applied to the fresh export figures, and total orange exports (in fresh equivalents) were thus obtained. Total domestic consumption of oranges (fresh and processed) was then obtained as the difference between the corresponding production and export figures. Consumption of fresh oranges in Spain and Italy was obtained from data of the Organization of Economic Co-operation and Development (OECD) (25 and 26). Due to lack of appropriate information, consumption in Portugal consists of both fresh and processed oranges. Consumption of fresh oranges in Greece was calculated on the assumption that its share in total orange consumption resembled that of the Greek exports.

Information on the varietal composition of North African, Spanish, and Israeli exports was available in *Marchés Européens des Fruits et Légumes* (24). Data on the varietal composition of Italian orange production were taken from OECD data (25). Similar information on orange varieties for other producers is scanty. The percentages presented in Appendix table B-1 for Greece, Turkey, and Cyprus are based on clues available from the U. S. Foreign Agricultural Service (38, 39) and the Commonwealth Economic Committee (5), while, for other Near Eastern countries, the figures represent subjective authors' estimates based on some personal familiarity with citriculture in the Near East. Group 1 of the present study consists of varieties included in Group I (Moro and Torocco) of the EEC classification (12) and varieties included in Group II of the EEC classification. Group 2 of the present study corresponds to Group III of the EEC and includes the Surinam varieties, Biondo Comune (Blanca Comune, Comune), Grano de Oro (Imperial, Sucrena), Baladi, Pera, Hamlin, Mace-tera, Pineapple, Blood Oval (Doble-fina, Double Fine), Portugaise Sanguine, Sanguina Redona (Entrefina) and Sanguine Ordinaire, with the exception of Navel Sanguina (Double Fine Améliorée, Washington Sanguina, Sanguina Grande) and Maltese Sanguine. Varieties not referred to above belong to EEC Group II (our Group 1).

#### Production, consumption, and exports: 1970 projections

Projected production of oranges and tangerines and exports of fresh oranges

APPENDIX TABLE B-1  
 PRODUCTION OF ORANGES AND TANGERINES AND EXPORTS OF  
 FRESH ORANGES BY VARIETAL GROUPS, 1963-64

Producing country	Production of oranges and tangerines	Total supply of oranges	Domestic consumption of oranges*	Exports of fresh oranges			Composition of exports to Europe by varietal groups	
				West Europe	East Europe	Non-European	Group 1	Group 2
				<i>1,000 metric tons</i>			<i>per cent</i>	
Northwest Africa .....	1,025	912	327	509	68	8	74.72	25.28
Algeria .....	343	308	159	137	12	—†	50.95	49.04
Morocco .....	608	537	125	349	55	3	82.21	17.79
Tunisia .....	74	67	43	23	1	—	100.00	—
Spain and Portugal .....	2,079	1,735	554	1,143	37	1	55.10	44.90
Spain .....	1,976	1,640	459	1,148	37	1	55.10	44.90
Portugal .....	103	95	95	—	—	—	—	—
Italy and Greece .....	1,291	190	817	139	51	—	46.10	53.84
Italy .....	1,086	144	710	133	11	—	51.32	48.68
Greece .....	225	46	107	6	40	—	30.00	70.00
Near East .....	1,606	1,388	863	366	50	109	89.14	10.86
Israel .....	668	493	127	335	13	18	100.00	—
Cyprus .....	61	58	8	27	16	7	100.00	—
Lebanon .....	155	147	54	—	14	79	50.00	50.00
United Arab Republic .....	376	361	356	1	1	3	50.00	50.00
Turkey .....	346	329	318	3	6	2	27.27	72.73

\* In Spain, Portugal, Italy, and Greece, figures represent domestic consumption of fresh oranges only. In other countries they include both fresh and processed oranges.

† Dashes indicate zero or negligible quantities.

Sources: 5, 38, 39, 24, 25, 26, 43, 36, 37, and 15.

in 1970 are presented in Appendix table B-2.

The 1970 projected production of oranges and tangerines was derived as follows: An initial estimate was obtained by graphical interpolation from the FAO 1961-1963 base year figures and their 1975 projection (13). This estimate is represented in Appendix figures B-1 and B-2 by the ordinate of the intersection point of the line connecting the base year with 1975 production and the vertical line through 1970. The initial estimate was then adjusted in accordance with the actual evolution of outputs in the period 1962-63 through 1966-67 (Appendix figures B-1 and B-2).

Information on actual production of oranges and tangerines (15, 16) and projections for 1975 (13) were available from FAO publications. Projected 1970 exports of oranges and tangerines from North African and Near Eastern countries (excluding Israel) were obtained as

the difference between projected production and projected consumption. The latter figures were derived by interpolation from the average of high and low FAO consumption projections (13). The resulting export figures include export of fresh and processed oranges and tangerines. The fresh orange component in the aggregate was projected on the assumption that its share in 1970 output will be the same as in 1963-64. The 1970 projected export from Israel was given directly in the five-year plan of its Center for Agricultural Planning and Development (3).

Domestic consumption in Spain, Portugal, Italy, and Greece is assumed, in this study, to be price elastic. Consequently, it is an endogenous variable in the model. Total supply of fresh oranges for both domestic consumption and export is, thus, the relevant exogenous variable. Projections of 1970 production of fresh oranges (net of processed quan-

APPENDIX TABLE B-2  
 PRODUCTION OF ORANGES AND TANGERINES  
 AND EXPORTS OF FRESH ORANGES  
 PROJECTIONS FOR 1970

Producing country	Projected production of oranges and tangerines	Projected fresh orange exports to Europe		
		Total	West Europe	East Europe
<i>1,000 metric tons</i>				
Northwest Africa.....	1,230	679	529	150
Algeria.....	440			
Morocco.....	600			
Tunisia.....	100			
Spain and Portugal.....	2,360	2,089	2,008*	81
Spain.....	2,200			
Portugal.....	160			
Italy and Greece.....	1,680	1,368	1,276*	112
Italy.....	1,300			
Greece.....	380			
Near East.....	1,940	825	718	107
Israel.....	900			
Cyprus.....	75			
Lebanon.....	175			
United Arab Republic.....	420			
Turkey.....	370			

\* Includes domestic consumption.  
 Sources: 13, 15, 3, 16, 25, 26, and 43.

tities) for Spain (26) and Italy (25) were available from publications of the OECD. Total 1970 supply of fresh oranges in Greece was calculated on the assumption that it would constitute the same proportion of production of oranges and tangerines as in 1963-64. Portugal was assumed to follow the same pattern as Spain.

Exports to the East European countries were subtracted from total supplies. The total import of fresh oranges from Mediterranean countries to East European countries in 1970 was calculated as a naive projection of the current trends. The relevant import figures, showing a high rate of growth, were taken from Wintrant (43). The projected distribution of exports to East Europe by countries of origin was calculated on the basis of the 1963-64 distribution. However, exports from Greece to East Europe were adjusted downward on the assumption that, because of its association with the EEC, Greece will

divert an increasing share of its exports to EEC markets.

The varietal composition of 1970 supplies was assumed to resemble that of 1963-64.

### 1963-64 prices

Given the price and income elasticities of demand in each country, the demand functions are determined in the present study on the basis of the price-quantity combinations observed in 1963-64. To this end it was necessary to obtain price estimates for each country by varietal groups. However, detailed and comparable price reports, by varieties, were available only for Hamburg (auction prices) and London (wholesale prices). Biweekly price quotations for Hamburg were available in "Weekly Citrus Fruit Information" (40). Group 1 was represented by the Shamouti variety and Group 2, by Hamlin and various Spanish varieties. The season average prices were obtained from the average

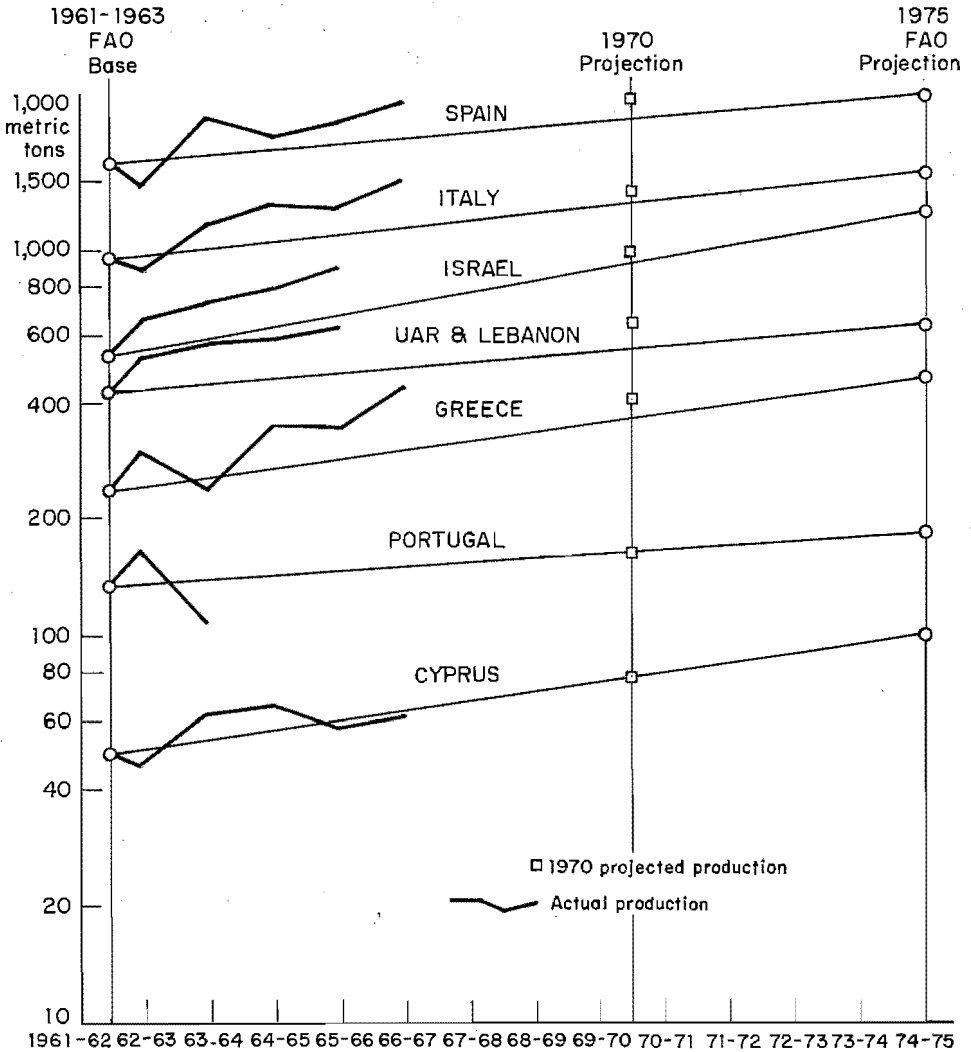


Fig. B-1. Actual and projected production of oranges and tangerines. Sources of actual production: 1961-63—13, 15; 1964-67—13, 15, 16.

monthly prices as weighted averages, using monthly shipments from Spain and Israel to Germany, available in *Fruit Intelligence*, as weights (5, February-May, 1963). Monthly wholesale prices in London were quoted in the same publication. Group 1 was again represented by the Shamouti variety and Group 2, by Spain's Blancas. Seasonal average prices were obtained as weighted averages, using monthly arrivals of oranges

from Israel and Spain as weights (5, February 1965). The 1963-64 season's prices in other consuming regions were calculated on the assumption that a competitive equilibrium prevailed in the international market. F.o.b. prices in Spain and Israel were computed from Hamburg and London prices by netting out import duties and transportation costs. Import prices in other consuming regions were consequently obtained from

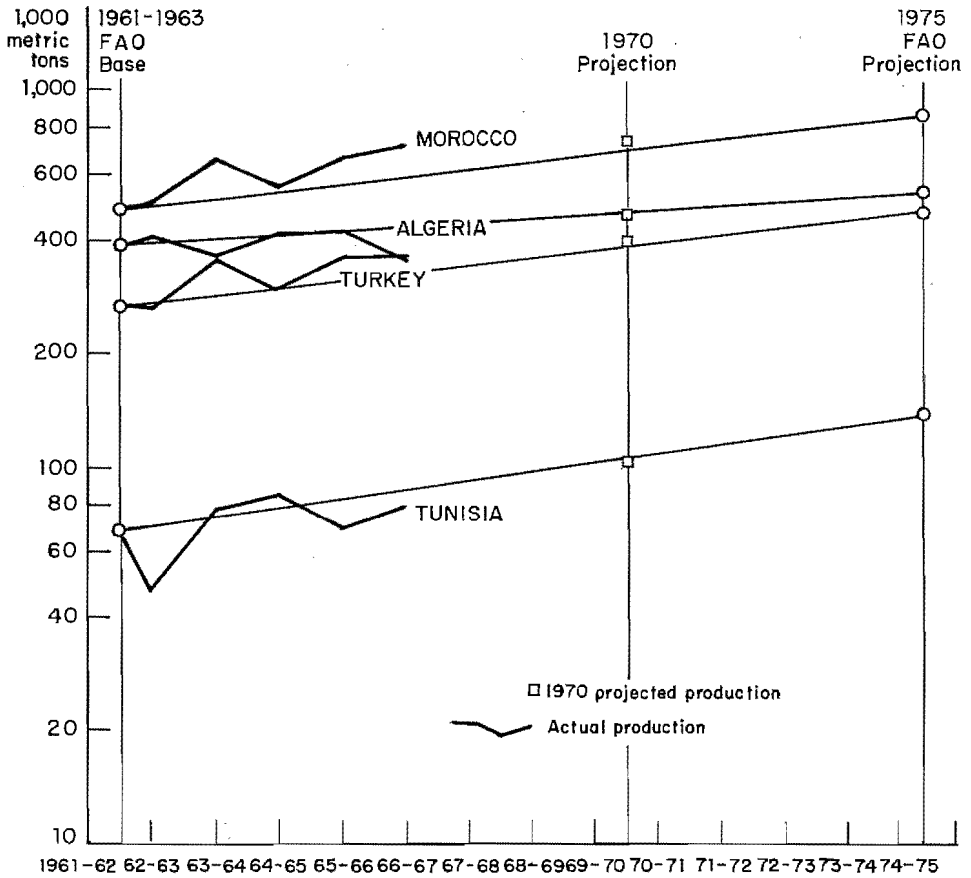


Fig. B-2. Actual and projected production of oranges and tangerines. Sources of actual production: 1961-63—13, 15; 1964-67—13, 15, 16.

the f.o.b. prices by adding the corresponding transportation costs and import duties. Since estimates based on different "routes" were somewhat different, the final price estimates were derived as weighted averages, using the appropriate 1963-64 exports as weights.

The estimated prices are presented in table 3.

### Time shifts in the demand functions

As population and per capita income in consuming regions grow, the demand function is shifted upward. The shifts are incorporated into the model by pos-

tulating the following functional relationship between the constant term in the demand equation 1 and population and per capita income:

$$A_{jkt} = \Pi_{jt} I_{jt}^{\eta_{kj}} \bar{A}_{jk} \tag{1B}$$

where

- $\Pi_{jt}$  = population size
- $I_{jt}$  = per capita income in the  $j$ th consuming region in year  $t$

and

$$\bar{A}_{jk} = \text{a constant.}$$

APPENDIX TABLE B-3  
 RATES OF GROWTH OF POPULATION, PER CAPITA INCOME (GDP),  
 INCOME ELASTICITIES OF DEMAND, AND SHIFT FACTORS,  
 1963-64 TO 1970

Consuming country	Annual rate of growth		Income elasticity of demand	Shift factor 1963-64 to 1970
	Population	Per capita GDP		
	<i>per cent per year</i>			
Italy and Greece.....				
Italy.....	.6	3.7	.9	1.284
Greece.....	.7	4.3	.7	
Spain and Portugal.....				1.323
Spain.....	.9	4.1	.9	
Portugal.....	.4	4.1	.7	
Austria and Switzerland.....				1.263
Austria.....	.1	3.7	1.0	
Switzerland.....	1.0	2.5	1.0	
Scandinavia.....				1.297
Denmark.....	.6	3.7	1.0	
Finland.....	.9	3.5	1.0	
Iceland.....	1.4	3.5	1.0	
Norway.....	.9	3.2	1.0	
Sweden.....	.6	3.2	1.0	
United Kingdom.....	.4	2.8	.6	1.143
West Germany and Benelux.....				1.309
West Germany.....	.5	3.7	1.1	
Netherland.....	1.0	3.0	.9	
Belgium-Luxembourg.....	.5	3.1	.8	
France.....	.7	3.6	.8	1.258

SOURCES: 7 and 14.

Given the value  $A_{jk0}$  in the base year ( $t = 0$ ), we have:

$$A_{jkt} = A_{jk0} \times [(1 + \theta_j)(1 + \eta_{kj}\xi_j)]^t \quad (2B)$$

where  $\theta_j$  is annual rate of population growth in region  $j$  and  $\xi_j$  is annual rate of increase in per capita income in region  $j$ .

Let  $M_{jt} = A_{jkt}/A_{jk0}$  be the shift factor for the  $j$ th country; then, for a region consisting of several countries, the combined shift factor is obtained as a weighted average of the individual countries, using 1963-64 consumption of fresh oranges as weights.

Rates of growth of population and per capita income, income elasticities of demand, and the calculated shift factors

for consuming regions are given in Appendix table B-3.

Annual rates of growth in population and per capita income are those given by the FAO for the 1965-1975 period (14). The rates of growth in per capita income given in Appendix table B-3 are simple averages of the high and low projections (14).

Income elasticities of demand were adapted from Dean and Collins (7).

Shift factors were first calculated for individual countries. The exponent 6.5 was used since there are 6.5 years in the projection period (1963-64 season to calendar year 1970). Shift factors for consuming regions were then obtained as weighted averages, using 1963-64 consumption of oranges in individual countries as weights.



## 1963-64 tariffs and internal tax rates

Unless otherwise indicated, all information concerning tariff and internal tax rates have been taken from the Commonwealth Economic Committee (4, Appendix V). Whenever an importing region consists of more than one country, the region's rates were obtained as weighted averages, using 1963-64 imports to individual countries as weights.

### Austria

Import duty:

40s. per 100 kg. = \$15.38 per metric ton (assuming price of \$170 per metric ton = 9.05 per cent).

Turnover equalization tax (of duty-paid value): 5.25 per cent.

### Switzerland

Import duty:

8 frs. per 100 kg. = \$18.52 per metric ton (assuming price of \$170 per metric ton = 10.89 per cent).

### Austria and Switzerland (weighted averages)

Tariff: 10.08 per cent.

Internal tax: 2.31 per cent.

Combined tax rate:  $T = 1 - (1 - 1.1008)(1 - .0231) = .1216 = 12.16$  per cent.

### Scandinavia

Country and period	Import duty	Internal tax	Import duty plus internal tax rate
	<i>per cent</i>		<i>per cent</i>
Denmark.....	5	*	5.0
Sweden.....		4 kr. per ton = $\frac{\$ .77}{\text{metric ton}}$	.4
Norway.....			
Finland.....			
July 1-December 31.....	40		32.9
Other periods.....	30		5.68
Weighted average.....			

\* Blanks indicate not applicable.

† Internal tax rate in Sweden was computed assuming a price of \$170 per metric ton.

### The United Kingdom

Import duty:

December 1 through March 31, 10  
per cent.

April 1 through November 30, 3s. 6d.  
per hundredweight.

Given the average price prevailing in 1963-64 (\$170.3 per metric ton), the fixed duty imposed in the latter period amounts to 5.6 per cent. The season average weighted by period imports is, thus, **8.94 per cent.**

## West Germany and Benelux Countries

## Import duty:

Country and period	Days in period	Duties on imports from non-EEC countries		Duties on Italian imports	
		Periodical	Weighted average*	Periodical	Weighted average*
		<i>per cent</i>			
<i>West Germany</i>					
April 1-October 15.....	31	11.5		6.0	
October 16-March 31.....	151	13.0	12.74	6.0	6.0
<i>Belgium</i>					
April 1-October 15.....	31	15.0		7.8	
October 16-March 31.....	151	15.1	15.08	7.8	7.8
<i>Netherlands</i>					
April 1-October 15.....	31	15.0		7.8	
October 16-March 31.....	151	15.1	15.08	7.8	7.8

\* Weighted averages for individual countries obtained by using "days in periods" as weights. Weighted region average: on imports from non-EEC countries, 13.51 per cent; on Italian imports, 6.59 per cent.

Internal tax (paid on duty-paid value):

West Germany, "turnover and equalization tax"—2.5 per cent.

Belgium, "transmission tax"—12.0 per cent.

Netherlands, "turnover tax"—5.0 per cent.

Weighted average for the consuming region on all imported oranges—4.19 per cent.

Combined tax rate on imports from non-EEC countries—17.13 per cent.

Combined tax rate on Italian imports—10.50 per cent.

## France

## Tariff:

Period	Tariff rate on non-EEC countries	Tariff rate on Italian imports
	<i>per cent</i>	
October 1-October 15.....	29.0	*
October 16-March 14.....	30.5	19.25
March 15-June 14.....	22.0	13.75
Weighted season average.....	26.97	16.97

\* Not applicable.

In 1963-64, North African countries enjoyed preferential tariff rates.

### 1970 projected tariff and internal tax rates

Tariff duties and internal tax rates for 1970 are presented in table 5.

For non-EEC consuming regions, it was assumed that the 1963-64 tax structure would prevail in 1970.

Projected tariff rates for EEC consum-

ing regions were available from Dean and Collins (7, Appendix A). The 1963-64 internal tax rates were added to the projected tariffs to form the combined tax rates ( $T_{ij}$ ).

### Transportation costs

Least-cost transportation costs were adapted from Dean and Collins' data (7, Appendix A) with few modifications. These are presented and explained in table 4.

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