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FEASIBILITY OF EXPORTING WINTER TOMATOES TO THE EEC UNDER CHANGING MARKET CONDITIONS

by

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Introduction

The question of Egypt's potential for exporting fresh winter tomatoes to the EEC can be viewed in the context of an interdependent network of supplying and consuming countries. The major supplying countries are Spain, Morocco and the Canary Islands and the major consuming countries are West Germany, France and the United Kingdom. All market participants are interconnected so that changes in supply or demand in any country affects all participants through adjustments in market prices. The entire system can be considered close to purely competitive, since market power does not exist to any significant point and tomato prices at any point in time are based primarily on quality and supply.[1]

The system can be conceptualized by a set of demand functions, one for each consuming area, and a set of supply functions, one for each producing area. Were it not for the differences in transfer costs between the various trading partners, the demand and supply functions could simply be solved simultaneously to yield equilibrium prices and shipments. Spatial considerations are significant, however, and the network of trade is affected by the location of supplies relative to markets.

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[1] Any market power which Morocco had in France before the early 1970's has now largely disappeared as Spain has expanded shipments to France and Morocco has sought markets in Germany and the UK.

The purpose of this study is to evaluate the feasibility of tomato exports from Egypt under a broad range of market conditions, giving consideration to possibly important changes in future supply-demand factors such as: (1) a devaluation of the Spanish peseta, (2) entry of Spain into the EEC, (3) development of an Egyptian tomato durable enough for ocean transport, and (4) changes in competition from Morocco, and the Canary Islands. All of these possible changes would have an important impact on Egypt's role as a supplier of winter tomatoes to the EEC. The market simulation model provides quantitative measures of how these changes would affect equilibrium market prices and Egypt's export potential.

Theoretical Model

In a purely competitive set of markets the demand functions in consuming markets interface with the supply functions in supplying areas to bring about an equilibrium set of market prices and a network of shipments which have the following characteristics:

(1) total quantities supplied are equal to total quantities demanded at the equilibrium price

(2) each producing area supplies those market(s) which return the highest price net of transfer costs

(3) the difference between the price in a consuming market and the price in its supplying region is equal to the transfer cost, where "transfer cost" is defined to include tariffs, transport and all handling charges

(4) the market prices (net of transfer cost) in all markets to which a given supplying region ships are equal and equal to the marginal supply price in the shipping region

Solution Procedure

There are several algorithms which provide the equilibrium solution to a set of demand functions, supply functions and a transfer cost matrix. The particular method used in this paper is called reactive programming.[1] Unlike other solution procedures the method of reactive programming does not maximize or minimize a specific objective function. Rather it uses an iterative procedure to arrive at an equilibrium solution based on simple market rules. The algorithm, developed in 1959, operates as follows: An initial set of supply and demand quantities is selected and a linear programming sub-routine is used to allocate supplies among markets. A market price is calculated from the demand function for each of the consuming areas. By subtracting transportation costs from these market prices, net shipping point prices are obtained for the shipments selected in the initial allocation. A new level of output for the first shipping area is selected consistent with the average net revenue received. This new quantity is then allocated among markets in such a way as to maximize returns, given the market prices and previous shipping patterns of all other shippers. This same process is repeated for the second shipping area, given the behavior of all other shipping areas. The iterative routine continues until it is not profitable for any shipping area either to change the level of output or to reallocate supplies.

Although the algorithm does not reach an "optimum" the equilibrium "solution" can be obtained to any desired degree of accuracy.

Several variations of the basic program are available. Supplies may be treated as fixed or entered in functional form, or supplies in some areas may be fixed and other entered in functional form. The

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[1] King, Richard A. and Foo-Shiung He, Reactive Programming: A Market Simulating Spatial Equilibrium Algorithm: Department of Economics, North Carolina State University, April 1972.

functional forms may be entered in linear or log-linear form. Upper limits may be placed on supplies. Marginal revenue functions may be used in place of demand functions to simulate monopolistic conditions. A problem with two or more interdependent products may be solved, or a problem with two interdependent time periods (involving storage). A mathematical statement of the structure is given in Appendix A.

Demand Functions

The demand functions by consuming country, by months were derived through statistical regression procedures using historical market data, and are given in Table 1. Estimation procedures are described more fully in Working Paper No. 36.[1]

Table 1: Demand functions for tomatoes by country, by month

December	W. Germany	P = 12.4243 - .2934Q
	France	P = 11.5262 - .2023Q
	U.K.*	P = 10.5913 - .1565Q
January	W. Germany	P = 12.9977 - .3262Q
	France	P = 10.6536 - .2400Q
	U.K.	P = 10.5881 - .1565Q
February	W. Germany	P = 13.5291 - 3727Q
	France	P = 11.8425 - .2554Q
	U.K.	P = 9.2843 - .1565Q
March	W. Germany	P = 13.7802 - .1515Q
	France	P = 13.6369 - .1512Q
	U.K.	P = 12.1684 - .1346Q

* Due to difficulties in obtaining statistically acceptable results for the U.K., the January slope coefficient was also used for December and February.

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[1] Waheed Megahid and Richard L. Simmons, "The Demand for Fresh Winter Tomatoes in West Germany, France and the United Kingdom," ADS Economics Working Paper No. 36, August 1981.

The demand functions are stated in terms of the net effect of quantity imported on price, the effects of other variables having been quantified and eliminated. Price is stated in U.S. dollars per 6 kg. carton and Q is defined as thousand metric tons of imports. Since local EEC production during this season is nil, imports can be taken to represent total demand. The demand functions have been expressed in December, 1979 prices.

Supply Functions

The supply function for Spain was based on a statistical analysis of time series data (described in Working Paper No. __).[1] For Morocco and the Canary Islands it was not possible to estimate statistical supply functions, so recourse was made to the method of passing a line through recent price-quantity equilibrium points with an assumed elasticity.

1. Spain:

A statistical supply function for tomatoes in the Alicante-Murcia area of Spain was estimated (see Working Paper No. __), as follows:

$$Y_t = -36.5552 + .2796\left(\frac{P_{t-1}}{C_{t-1}}\right) + .5332\ Y_{t-i} + 3.6503\ T_{t-1}$$

where Y_t = hectares planted in year t

P_{t-1} = average wholesale price of tomatoes exported to West Germany, lagged one year, net of transport costs, sales commission, and tariff, deflated by CPI (pesetas per 6 kg.)

C_{t-1} = index of cost of production in year t-1 divided by wholesale price index in year t-1

[1] Mohammed El Saadany and Richard L. Simmons, "Production and Supply of Winter Tomatoes in Mainland Spain," ADS Economics Working Paper No. __, October 1981.

T_{t-1} = average temperature in November, December and January in Murcia, year t-1

R^2 = .63

The long run price elasticity of supply indicated by this function is +.55.

This supply relationship must be translated from hectares planted to quantity of tomatoes produced, in order to match up with the demand functions. This was done by determining the equation of a supply function passing through the recent price-quantity equilibrium points with an elasticity of +.55.

The Price-Quantity equilibrium points are given in Table 2.

Table 2: Shipments from supplying countries, and net prices, by months, average of 1979 and 1980

Month	Exports from:			Net Prices in:		
	Spain	Morocco	Canaries	Spain	Morocco	Canaries
	(thousand tons)			($ U.S. per carton)		
December	22.6	16.6	19.1	4.52	3.65	3.12
January	16.8	14.0	27.0	4.77	3.52	3.37
February	13.7	15.0	31.4	5.23	3.99	3.83
March	12.7	18.0	30.0	6.92	6.26	5.52

Sources:

Column (1): Ministerio de Agricultura, Informe-Resumen de la Campana de Exportacion 1978-79, Madrid

Ministry of Agriculture, Food and Fisheries, Department of Trade, Overseas Trade Statistics of the United Kingdom, London. Monthly issue.

Zentral Markt-und Preisberichtstelle für Erzeugnisse der Land-Forst-und Ernährungswirtschaft GmbH, ZMP Bilanz: Gemuse. Various issues.

Column (2): ZMP, Bilanz

Column (3): OCE, Casablanca

Column (4): ZMP, Bilanz

Column (5): Same as Column (1)

Column (6): ZMP, Bilanz

Tariff and commission charges (both in ad valorem terms) and transport costs were subtracted from the average wholesale price to get a price f.o.b. the packing plant. These f.o.b. prices were used with the quantities shipped (Table 2) to derive the supply functions.

The price used for this calculation was the German wholesale price (average of 1979 and 1980) in U.S. dollars minus tariff and sales commission. Since the tariff and sales commission are measured in ad valorem terms the supply function is then altered by adding the effects of these two factors as illustrated in Figure 1. The sales commission is 5 percent and the tariff is 11 percent in December and March and 4.4 percent in January and February.

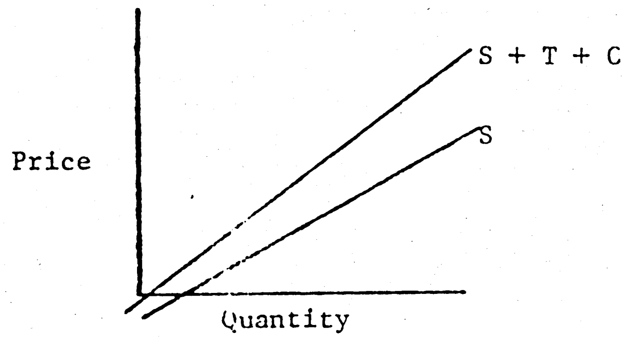

Figure 1: Supply function with and without ad valorem tariff and sales commission.

Morocco

Supply functions for each month were estimated for Morocco by passing a line through the price equilibrium points in Table 2 using an assumed elasticity of +1.0. The supply functions were then multiplied by 1.072 to account for ad valorem tariff[1] and sales commission charges. The resulting supply functions are given in Table 3.

[1] Morocco has an exemption of 80 percent of the 11 percent tariff during the whole season. The 1.072 factor includes 2.2 percent tariff plus 5 percent sales commission.

Table 3: Supply functions, by months, including tariffs and sales commission.

Spain		
	December	$P = -3.1474 + .4181Q$
	January	$P = -3.5354 + .5647Q$
	February	$P = -3.8805 + .7595Q$
	March	$P = -4.8157 + 1.1397Q$
Morocco		
	December	$P = 0 + .2357Q$
	January	$P = 0 + .2695Q$
	February	$P = 0 + .2850Q$
	March	$P = 0 + .3728Q$
Canaries		
	December	$P = -2.2080 + .3762Q$
	January	$P = -3.05$[illegible] $+ .2731Q$
	February	$P = -3.4714 + .2669Q$
	March	$P = -4.6920 + .4232Q$

Canary Islands

It was not possible to estimate statistical supply functions for the Canary Islands. Severe limitations on irrigation water supplies would probably invalidate such an estimation (see Working Paper No. 20).[1] It is likely that tomatoe exports will decline in the future regardless

[1] Richard L. Simmons, "Production of Winter Tomatoes in the Canary Islands, ADS Economics Working Paper No. 20, May 1981.

of price. However, the initial assumption in this study was that the elasticity of supply was +0.5 and supply functions were constructed to pass through the equilibrium price-quantity points of Table 2. Ad valorem tariff and sales commission values identical to those used for Spain were then added to obtain the supply functions in Table 3.

Egypt

The detailed analysis of the supply of export tomatoes in Egypt has not yet been completed, so the level of exports was fixed at 10,000 tons per month. With such a procedure the model cannot indicate the optimal level of Egyptian exports under various market conditions, but it can indicate the net price (f.o.b. packing plant) received by Egyptian exporters under various conditions.

TRANSFER COSTS

Estimates of transfer costs between supply and demand points were obtained by averaging quotations given in personal interviews with producers and trades people, and those reported in other publications and trade magazines. Transfer costs were assumed to be independent of volume shipped and constant over the four month period.

Egypt to EEC

In 1980 it cost $550 (U.S.) to fly a metric ton of tomatoes to London and slightly less to Frankfurt ($535). Since there are 166 boxes of 6 kgs. each in a metric ton this means a cost of $3.31 per box to London and $3.22 to Frankfurt. Egypt must also pay an 11 percent ad valorem tariff and a 5 percent sales commission. Based on average 1980 prices in Germany the tariff cost $.74 per box in December,

$.72 in January, $.78 in February and $1.05 in March. Commission charges (5 percent ad valorem) would be $.34, $.33, $.35, and $.48, respectively. Since we do not have a supply function for Egyptian tomatoes on which to add ad valorem charges, the tariff and sales commission are added as a fixed amount at the 1980 average price.

Shipment by ocean transport would be much more economical if Egypt were to adopt a consumer acceptable variety with good shipping qualities and, in addition, to develop the transportation and refrigeration facilities necessary to avoid excessive quality deterioration. Ocean shipping rates are highly variable depending on type of ship and schedule, but rates from Alexandria were quoted at $130 per ton, on the average, to London or Rotterdam in 1980, $100 to Venice and $105 to Marseille. Shipments to Venice instead of Rotterdam, with subsequent movement to West Germany by truck, would be faster and possibly improve quality, but would cost about the same as shipment to Rotterdam. Truck costs from Venice to Frankfurt were quoted at $.37 per carton in 1980. For lack of better transport cost information the transfer cost via ship is set at $1.50 per carton to France and West Germany and $1.75 to U.K.

Spain to EEC

Truck costs from Alicante, Spain to England were quoted in 1980 as $1.50 per carton. Truck costs to France were $.82 per carton and truck costs to West Germany were $1.20 per carton.

Morocco to EEC

Shipping costs from Casablanca to Marseille are estimated at $2.20 per carton and $2.40 to Rotterdam. Additional trucking costs from Rotterdam to West Germany and from Marseille to the interior of France are estimated at $.40 and $.30 respectively. Shipping costs to England are the same as to West Germany.

Canary Islands to EEC

Shipping costs from the Canaries to the EEC are roughly the same as from Morocco. Transfer costs are summarized in Table 4.

Table 4: Transfer Costs for Tomatoes ($ U.S. per 6 kg. carton)

Supplier		Destination W. Germany	France	U.K.
Spain		1.20	.82	1.50
Morocco		2.60	2.50	2.60
Canary Islands		2.60	2.50	2.60
Egypt*	Dec.	4.30	4.30	4.39
	Jan.	4.27	4.27	4.36
	Feb.	4.35	4.35	4.44
	Mar.	4.75	4.75	4.84

*Costs for Egypt include tariff and sales commission.

SOLUTIONS

The four months included in this study were treated as independent of each other in a time sense, so independent solutions were obtained for each month. An initial run was made to simulate 1979 conditions as a tentative check on the validity and accuracy of the model. (Egypt was not included as a supplier in the initial run, since Egyptian exports have been relatively insignificant.)

The results of the initial simulation run are compared with the existing pattern of shipments in Table 5. Data on actual shipments are not quite complete, since the country origin of France's imports were not available in detail. However, the data are complete enough to show that the correspondence between the simulation results and the actual situation is acceptable.

Simulation results show Spain shipping more to France in January and December than actual shipments, with Morocco shipping less to France and more to W. Germany. This corresponds to the trend in recent years. It seems that Spain's location close to France results in a locational advantage for Spain. This advantage was suppressed for many years because of traditional political ties between France and Morocco. Another factor causing a discrepancy between actual and simulated shipments for December and January is that, during these months, Spain produces mostly round tomatoes whereas France consumes primarily the beef-type tomatoes produced in Morocco. This distinction will tend to disappear in the near future as Spain increases production of beef tomatoes earlier in the season.

Table 5 : Comparison of Model 1 results with actual shipments

December

Consuming Country / Suppliers	W. Germany		France		U.K.		Total	
	Actual	Model 1	Actual	Model 1	Actual	Model 1	Actual	Model 1
Spain	5.3	0	12.1	22.3	5.2	0	22.6	22.3
Morocco	7.4	17.4	9.2	0	0	2.6	16.6	20.0
Canaries *	2.8	0	.8	0	10.4	18.4	14.0	18.4
Total	15.8		20.9		15.9		53.2	60.7

January

Consuming Country / Suppliers	W. Germany		France		U.K.		Total	
	Actual	Model 1	Actual	Model 1	Actual	Model 1	Actual	Model 1
Spain	2.6		10.6	16.6	3.6		16.8	16.6
Morocco	5.3	15.8	8.7		0		14.0	15.8
Canaries *	5.0	3.0	2.1		12.9	23.8	20.0	26.8
Total	13.7		20.7		16.9		50.8	59.2

Table 5: (continued)

February

Consuming Country / Suppliers	W. Germany		France		U.K.		Total	
	Actual	Model 1	Actual	Model 1	Actual	Model 1	Actual	Model 1
Spain	1.5		10.7	12.7	1.5		13.7	12.7
Morocco	4.1	6.5	10.9	7.8	0		15.0	14.3
Canaries*	6.7	11.8	2.7		14.4	16.5	23.2	28.3
Total	12.3		22.4		15.9		52.0	55.3

March

Consuming Country / Suppliers	W. Germany		France		U.K.		Total	
	Actual	Model 1	Actual	Model 1	Actual	Model 1	Actual	Model 1
Spain	.2		12.2	12.4	.3		12.7	12.4
Morocco	4.4	9.3	13.6	11.1	0		18.0	20.4
Canaries*	7.3	14.4		0	16.6	14.7	23.9	29.1
Total	12.8		25.2		16.9		54.6	61.9

*The Canaries shipped 9.6 thousand tons in December, 9.0 in January, 14.4 in February and 14.3 in March to the Netherlands. Most of this was re-shipped to the U.K. and other countries. Data are not available to allocate these shipments as to final destination, but it is believed that most went to the U.K.

Simulation results show the Canary Islands shipping primarily to the U.K., with lesser amounts to West Germany. This corresponds to the actual shipment pattern.

After establishing the validity of the model using the results of the initial run the following scenarios were evaluated:

(1) Shipments of 10,000 tons from Egypt each month

(2) Elimination of the EEC tariff for Spain, in addition to (1) above

(3) Devaluation of 25 percent of the Spanish peseta in addition to (1) above

(4) Reduction of 25 percent in supplies from the Canary Islands in addition to (3) above

(5) Reduction in shipping costs for Egypt from airfare to ocean shipping rates, in addition to (4) above

Each solution requires less than one second of computing time on the IBM 370/165. Most solutions involve four supplying countries and three consuming countries.

Simulation results for the various scenarios are given in Tables 6-9. Numbers in the tables without parentheses represent shipments. Numbers in parentheses represent net decreases in shipping prices which would occur if shipments were made on noneconomic routes. Scenario (1), called "Egypt's entry," is characterized by Egypt exporting 10,000 metic tons per month to the EEC. West Germany turns out to be the best market for Egypt. The U.K. would return $.10 per carton less due to higher shipping costs, and France would return $.10 per carton less because Spain's proximity to France causes France's price to be somewhat lower than in West Germany.

Table 6: Solutions for December

Shipping Country	Scenarios (1) Base Solution	(2) Egypt Entry	(3) Spain Member	(4) Devaluation	(5) Canary 75%
Spain					
W. Germany	(-.08)*	(-.28)	(-.28)	1.6	5.3
France	22.3	21.7	24.1	28.8	26.6
U.K.	(-.38)	(-.58)	(-.58)	(-.30)	(-.30)
Morocco					
W. Germany	17.4	9.1	9.8	10.0	4.7
France	(-.20)	2.0	0.7	(-.28)	(-.28)
U.K.	2.6	6.9	6.6	4.8	11.9
Canaries					
W. Germany	(-.01)	(-.01)	(-.01)	(-.01)	(-.01)
France	(-.20)	(-.01)	(-.01)	(-.28)	(-.28)
U.K.	18.4	17.1	18.9	24.0	14.0
Egypt					
W. Germany	--	10.0	10.0	10.0	10.0
France	--	(-.10)	(-.10)	(-.38)	(-.38)
U.K.	--	(-.09)	(-.09)	(-.09)	(-.09)
Market price					
W. Germany	7.31	6.83	6.61	6.09	6.53
France	7.01	6.73	6.51	5.71	6.15
U.K.	7.31	6.83	6.61	6.09	6.53
Supply price					
Spain	6.19	5.91	5.69	4.89	5.33
Morocco	4.71	4.23	4.01	3.49	3.93
Canaries	4.71	4.23	4.01	3.49	3.93
Egypt air	--	2.48	2.26	1.74	2.18
Egypt ship	--	5.33	4.19	3.39	3.83

* Numbers in parantheses are decreases in net shipping prices which would occur by shipping to noneconomic destinations.

Notes:

(1): Simulates 1980 conditions
(2): 10,000 metric tons from Egypt
(3): (2) above plus elimination of tariffs for Spain and Canary Islands
(4): (2) above plus devaluation of 25 percent in Spanish peseta
(5): (4) above plus decrease of 25 percent in Canary shipments

Table 7: Solutions for January

Supplier	(1) Base Solution	(2) Egypt Entry	(3) Spain Member	(4) Devaluation	(5) Canary 75%
	Scenarios				
Spain					
W. Germany	(-.18)	(-.28)	(-.28)	(-.28)	3.2
France	16.6	16.0	16.7	21.5	19.4
U.K.	(-.48)	(-.58)	(-.58)	(-.58)	(-.30)
Morocco					
W. Germany	15.8	10.2	10.6	11.2	7.07
France	(-.10)	2.2	1.9	(-.01)	(-.28)
U.K.	(-.01)	(-.01)	(-.01)	(-.01)	(-.01)
Canaries					
W. Germany	3.0	(-.01)	(-.01)	1.5	(-.01)
France	(-.10)	(-.01)	(-.01)	(-.01)	(-.28)
U.K.	23.8	25.1	26.3	31.8	20.0
Egypt					
W. Germany	--	10.0	10.0	10.0	10.0
France	--	(-.10)	(-.10)	(-.10)	(-.38)
U.K.	--	(-.09)	(-.09)	(-.09)	(-.09)
Market price					
W. Germany	6.86	6.40	6.29	5.61	6.37
France	6.67	6.30	6.19	5.50	5.99
U.K.	6.86	6.40	6.29	5.61	6.37
Supply price					
Spain	5.85	5.48	5.37	4.68	5.17
Morocco	4.26	3.80	3.69	3.01	3.77
Canaries	4.26	3.80	3.69	3.01	3.77
Egypt air	--	2.05	1.94	1.26	2.02
Egypt ship		3.98	3.87	3.18	3.67

Notes:

(1): Simulates 1980 conditions
(2): 10,000 metric tons from Egypt
(3): (2) above plus elimination of tariffs for Spain and Canary Islands
(4): (2) above plus devaluation of 25 percent in Spanish peseta
(5): (4) above plus decrease of 25 percent in Canary shipments

Table 8: Solutions for February

	Scenarios				
	(1)	(2)	(3)	(4)	(5)
Supplier	Base Solution	Egypt Entry	Spain Member	Devaluation	Canary 75%
Spain					
W. Germany	(-.28)	(-.28)	(-.28)	(-.28)	(-.28)
France	12.7	12.1	12.6	16.4	17.8
U.K.	(-.58)	(-.58)	(-.58)	(-.58)	(-.58)
Morocco					
W. Germany	6.5	2.5	2.1	0.7	8.2
France	7.8	10.3	10.2	9.1	4.6
U.K.	(-.01)	(-.01)	(-.01)	(-.01)	(-.01)
Canaries					
W. Germany	11.8	7.1	7.7	11.0	1.4
France	(-.01)	(-.01)	(-.01)	(-.01)	(-.01)
U.K.	16.5	19.5	20.2	24.7	19.6
Egypt					
W. Germany	--	10.0	10.0	10.0	10.0
France	--	(-.10)	(-.10)	(-.10)	(-.10)
U.K.	--	(-.09)	(-.09)	(-.09)	(-.09)
Market price					
W. Germany	6.69	6.23	6.12	5.42	6.22
France	6.59	6.13	6.02	5.32	6.12
U.K.	6.69	6.23	6.12	5.42	6.22
Supply price					
Spain	5.78	5.31	5.20	4.50	5.30
Morocco	4.09	3.63	3.52	2.82	3.62
Canaries	4.09	3.63	3.52	2.82	3.62
Egypt air	--	1.98	1.77	1.07	1.87
Egypt ship		3.81	3.70	3.00	3.80

Notes:

(1): Simulates 1980 conditions
(2): 10,000 metric tons from Egypt
(3): (2) above plus elimination of tariffs for Spain and Canary Islands
(4): (2) above plus devaluation of 25 percent in Spanish peseta
(5): (4) above plus decrease of 25 percent in Canary shipments

Table 9: Solutions for March

Supplier	Scenarios (1) Base Solution	(2) Egypt Entry	(3) Spain Member	(4) Devaluation	(5) Canary 75%
Spain					
W. Germany	(-.28)	(-.28)	(-.28)	(-.28)	(-.28)
France	12.4	12.0	13.5	16.7	17.5
U.K.	(-.58)	(-.58)	(-.58)	(-.58)	(-.58)
Morocco					
W. Germany	9.3	5.5	5.0	3.9	11.2
France	11.1	13.9	13.8	13.7	8.2
U.K.	(-.01)	(-.01)	(-.01)	(-.01)	(-.01)
Canaries					
W. Germany	14.4	10.7	12.6	16.7	4.8
France	(-.01)	(-.01)	(-.01)	(-.01)	(-.01)
U.K.	14.7	17.5	19.1	22.4	17.2
Egypt					
W. Germany	0	10.0	10.0	10.0	10.0
France	0	(-.10)	(-.10)	(-.10)	(-.10)
U.K.	0	(-.09)	(-.09)	(-.09)	(-.09)
Market price					
W. Germany	10.19	9.82	9.60	9.15	9.85
France	10.09	9.72	9.50	9.05	9.75
U.K.	10.19	9.82	9.60	9.15	9.85
Supply price					
Spain	9.27	8.90	8.68	8.23	8.93
Morocco	7.59	7.22	7.00	6.55	7.25
Canaries	7.59	7.22	7.00	6.55	7.25
Egypt air	--	5.47	5.25	4.80	5.50
Egypt ship		7.40	7.18	6.73	7.43

Notes:

(1): Simulates 1980 conditions
(2): 10,000 metric tons from Egypt
(3): (2) above plus elimination of tariffs for Spain and Canary Islands
(4): (2) above plus devaluation of 25 percent in Spainsh peseta
(5): (4) above plus decrease of 25 percent in Canary shipments

The market prices in the three receiving countries would decrease by $.28-.48 per carton by virtue of the increased supplies coming from Egypt. The lesser amount occurs in March, the month in which the demand function has the least slope.

Egypt's entry reduces shipments from the other supplying countries. Morocco is most severely affected, being displaced in substantial measure from the West German market to the French and U.K. markets, with a loss of $.48 per carton in net supply price.

Scenario (2), called "Spains membership," reduces prices by an additional $.11-.22 per carton because Spain (and the Canaries) would no longer be subject to the EEC tariff. A higher net supply price for Spain and the Canaries would stimulate additional supplies from those areas and cause the fall in market prices. Price decreases would be $.11 in January and February, months in which Spain is already 60 percent exempt from the tariff, and $.22 in December and March.

Scenario (3), characterized by a devaluation of 25 percent in the Spanish peseta would have the most significant result. Market prices fall by $.70-1.00 per carton based on the devaluation alone. This reduces Morocco's and Egypt's net price to a very low level in December, January and February. Egypt's net supply price drops to $1.74 in December, $1.26 in January, $1.07 in February and $4.80 in March.

Egypt's net supply price after paying transport, sales commission and tariff should cover the costs of the carton (approximately $1.00), packing costs of $.70 per carton[1] and production costs (perhaps $.75 per carton),

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[1] Packing costs in Morocco were about $0.70 per carton in April, 1980. This is probably close to the cost which would have been incurred in Egypt, had packing facilities been operating.

for a total of \$2.45 per carton. It appears that if Egypt relies on air shipment a profit cannot be made except in March.

The drastic impact of a possible devaluation of 25 percent in the Spanish peseta is mitigated in part by a possible water shortage in the Canary Islands--simulated by a reduction of 25 percent in supplies from the Canaries in Scenario (4). If the predicted water shortage reduces Canary's supplies by 25 percent the market prices increase by \$.70-.80 per carton and the effects of the devaluation are largely offset. Egypt's net supply price with air shipment becomes \$2.18 in December, \$2.02 in January, \$1.87 in February and \$5.50 in March. This is still, however, insufficient to cover costs in December, January and February.

If Egypt can successfully ship by ocean freight at \$1.50 per carton to W. Germany net supply prices can be increased to \$5.05 in December, \$4.87 in January, \$4.72 in February and \$8.35 in March. The feasibility of Egyptian exports thus seems to depend largely on the development of appropriate facilities for ocean shipping. Air shipment, which has always been marginally profitable, will no longer be feasible under the projected price decreases caused by increased market supplies that would result from Egypt's expansion, Spain's possible membership in the EEC, or a Spanish devaluation.

CONCLUSIONS

The market simulations indicate that despite possible decreases in market prices for tomatoes arising from (1) expansion of Egypt's exports to the EEC, (2) Spains future membership in the EEC, and (3) a possible devaluation in the Spanish peseta of 25 percent, exports from Egypt of

10,000 metric tons of tomatoes per month from December through March would be feasible if Egypt can develop facilities for successful ocean shipping. Air shipments are costly and, unless Egypt obtains substantial quality premiums, (not likely) market prices would not cover costs of air shipment except in March.

The foregoing analysis assumes that political conditions in the EEC do not change as a result of Spain's possible membership. If Spain becomes a member, the "reference price" for tomatoes may be increased and made applicable during the entire season instead of only April through December 20. This would decrease Egypt's prospects for exports since sales below the reference price requires payment of a penalty.

Comments on the Model

A model such as this can bring together a considerable amount of data and information in providing quantitative conclusions to important questions about specific projected market changes in the future, either singly or in combination. However, any model has important limitations which must be recognized. The behavioral functions such as consumer demand and producer supply are estimated from historical data and are projectable conditionally upon continuation of conditions not included in the model--such as states of technology, price changes of other commodities related in demand or supply, etc.

Also, to attain maximum usefulness the model should be continuously updated as new data become available. Finally, the use of a model depends in part on knowledge of the workings of the market and the ability of the user to simulate possible market changes.

The work presented in this paper is just a beginning--an illustration of the types of questions which can be addressed.

Appendix A. Mathematical Structure of Reactive Programming Model

The term "transportation problem" is used to refer to a special type of linear programming problem in which fixed supplies in each of M regions are to be allocated to meet fixed demands in N markets so as to minimize total transfer costs. Shipments from i to j are identified as Q_{ij} and total transfer costs as $\sum_{ij}\sum T_{ij}\, Q_{ij}$. Shipments from each region may not exceed the quantity supplied ($\sum_j Q_{ij} \leq S_i$) and receipts at each market must be at least equal to the quantity demanded ($\sum_i Q_{ij} \geq D_j$). No negative shipments are allowed ($Q_{ij} \geq 0$).

The dual of this problem is stated in terms of shipping point prices u_i, and market prices, v_j. The objective is to maximize the difference between the value of market receipts and the cost of quantities supplied $R = \sum_j D_j v_j \quad \sum_i S_i u_i$, subject to the restrictions that $v_j - u_i \leq T_{ij}$ and the above constraints on S_i and D_j hold.

Reactive programming is an extension of this model that allows substitution of supply functions for the fixed supplies and replaces the fixed demands with demand functions. There is a price-dependent demand function in each market in which the price of the commodity in region j is a function of the total quantity received.

$$P_j = F_j \left(\sum_i Q_{ij}\right), \; i = 1, \ldots, N$$

where

$$\sum_i Q_{ij} = D_j.$$

The unit cost of production in the <u>ith</u> producing region is C_i.

$$C_i = G_i \left(\sum_j Q_{ij}\right), \; j = 1, \ldots, M$$

where $\sum_j Q_{ij} = S_i$. The net price for quantities shipped from region i to market j is $R_{ij} = P_j - C_i - T_{ij}$. The weighted average net price for all shipments from i is $\bar{R}_i = \sum_j R_{ij} Q_{ij} / \sum_j Q_{ij}$. Deviation of the net price for a given route, R_{ij}, from the weighted average price for all shipments from that region, $\bar{R}_i$, is D_{ij}, where $D_{ij} = R_{ij} - \bar{R}_i$.

The reactive programming problem consists of solving the following M x N equations:

$$R_{ij} = F_j \left(\sum_i Q_{ij}\right) - T_{ij}, \; I = 1, \ldots, M, \; j = 1, \ldots, N$$

subject to the following restrictions:

i) Negative shipments are not permitted.

$$Q_{ij} \geq 0$$

ii) a) Net prices for all routes used by region i must be non-negative and equal to each other.

$$Q_{ij} \neq 0 \Rightarrow R_{ij} = \bar{R}_i \geq 0$$

b) Net prices for all routes not used by region i must be no larger than the net price for active routes.

$$Q_{ij} = 0 \Rightarrow R_{ij} \leq \bar{R}_i \geq 0$$

iii) Deviations from weighted average net prices are non-positive.

$$D_{ij} = R_{ij} - \bar{R}_i \leq 0$$

a) Equality holds for active routes (see ii(a) above).

b) Either condition may hold for otehr routes (see ii(b).

iv) Shipments from region i may not exceed supply.

a) $\overline{R}_i > 0 \Rightarrow \sum_j Q_{ij} = S_i$

b) $\overline{R}_i = 0 \Rightarrow \sum_j Q_{ij} \leq S_i$

Supply is fully allocated if the weighted average net price is positive but this is not necessary if net price is zero.

When supply is a function of price, the quantity allocated, S_i, may not be larger than the quantity supplied, Z_i (i.e., $S_i \leq Z_i$). If the equality holds, then restrictions in (ii) above are applicable. If the inequality holds, then only the equalities in (ii) hold.