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ESTIMATED EFFECTS OF RELATIVE PRICES ON TRADE SHARES

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# ESTIMATED EFFECTS OF RELATIVE PRICES ON TRADE SHARES\*

by

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## I. Introduction

This paper grew out of my work on a multicountry econometric model (Fair (1981a, 1981b)). The trade matrix in this model is  $64 \times 64$ , and the trade shares have heretofore been taken to be exogenous. Estimated effects of relative prices on these trade shares are presented in this paper, and the sensitivity of the properties of the model to the endogenous treatment of trade shares is examined. The estimates are based on quarterly data from 1971I through 1979IV (36 quarters) for 64 countries.

## II. The Data and the Trade-Share Equation

The relevant variables are presented in Table 1. The raw data were taken from two tapes of the International Monetary Fund: the International Financial Statistics (IFS) tape and the Direction of Trade (DOT) tape. The way in which each variable was constructed is explained in brackets in Table 1. Some variables were taken directly from the tapes, and some were constructed from other variables. When "IFS" precedes a number in the table, this refers to the variable on the IFS tape with the particular number. The date of the tapes was October 1980.

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TABLE 1. The Variables for Country  $i$  in Alphabetic Order

$e_{i75}$  = average exchange rate in 1975, lc per \$. [= IFSRF for 1975.]  
 $e_{it}$  = exchange rate, average for the quarter, lc per \$. [= IFSRF.]  
 $M\$_{it}$  = merchandise imports (fob) in \$. [= IFS71V/ $e_{it}$  .]  
 $M75\$_{it}$  = merchandise imports (fob) in 75\$ from Type A countries.  
 [=  $\sum_{j \in A} XX75\$_{jit}$  .]  
 $PX_{it}$  = export price index, 1975 = 1.0. [= IFS74/100.]  
 $PX\$_{it}$  = export price index, \$/75\$. [= ( $e_{i75} PX_{it}$ )/ $e_{it}$  .]  
 $PY_{it}$  = GNP or GDP deflator, 1975 = 1.0. [= (IFS94A or IFS99B)/(IFS99AP or IFS99BP or IFS99AR or IFS99BR) .]  
 $PY\$_{it}$  = GNP or GDP deflator, \$/75\$. [= ( $e_{i75} PY_{it}$ )/ $e_{it-1}$  .]  
 $X\$_{it}$  = merchandise exports (fob) in \$. [= IFS70/ $e_{it}$  .]  
 $XX\$_{ijt}$  = merchandise exports (fob) from  $i$  to  $j$  in \$. [DOT tape.]  
 [ $XX\$_{i65t} = X\$_{it} - \sum_{j \neq 65} XX\$_{ijt}$  and  $XX\$_{65it} = M\$_{it} - \sum_{j \neq 65} XX\$_{jit}$  .]  
 [ $XX\$_{ijt} = 0$  if  $i = j$  .]  
 $XX75\$_{ijt}$  = merchandise exports (fob) from  $i$  to  $j$  in 75\$. [=  $XX\$_{ijt}/PX\$_{it}$   
 if  $i$  is a Type A country; = 0 otherwise.]  
 $\alpha_{jit}$  = share of  $i$ 's total merchandise imports from Type A countries  
 imported from  $j$  in 75\$. [=  $XX75\$_{jit}/M75\$_{it}$  .]

Notes: 1) lc = local currency.

2) \$ = U.S. dollar.

3)  $\sum_{j \in A} \alpha_{jit} = 1$  .

4) There is no country 48. In earlier versions this was Taiwan, but Taiwan has now been eliminated from the IMF tapes.

5) A Type A country is a country for which data on  $PX\$_{it}$  exist. There are 47 Type A countries out of the total of 64.

The variable to be explained is  $\alpha_{jit}$ , the share of country  $i$ 's total merchandise imports from Type A countries imported from country  $j$  (in units of 75\$). Type A countries are countries for which data on exchange rates and export prices exist. These data, as can be seen in Table 1, are needed to construct  $\alpha_{jit}$ . There are 47 Type A countries out of the total of 64. The  $\alpha_{jit}$  obey the property that  $\sum_{j \in A} \alpha_{jit} = 1$ , where the summation is over Type A countries.

The equation that was estimated for a given country  $i$  is:

$$(1) \quad \frac{\Delta \alpha_{jit}}{\alpha_{jit-1}} = \beta_i \left[ \frac{\Delta \text{PX}\$_{jt}}{\text{PX}\$_{jt-1}} - \sum_{k \in A} \alpha_{kit-1} \frac{\Delta \text{PX}\$_{kt}}{\text{PX}\$_{kt-1}} \right] + u_{jit}, \quad j \in A, \quad t = 1, \dots, T$$

The total possible number of observations is (47 Type A countries)  $\times$  (36 quarters) = 1692. There are 64 equations, one for each country  $i$ .

Given that  $\sum_{j \in A} \alpha_{jit} = 1$ , equation (1) has the property that  $\sum_{j \in A} \hat{\Delta} \alpha_{jit} = 0$ ,

where  $\hat{\Delta} \alpha_{jit}$  is the predicted value of  $\Delta \alpha_{jit}$  from equation (1) using some estimate of  $\beta_i$  and setting  $u_{jit}$  to zero for all  $j$  and  $t$ .

This is as desired to preserve the property that  $\sum_{j \in A} \hat{\alpha}_{jit} = 1$ . Equation

(1) is restrictive in that the coefficient  $\beta_i$  is the same across all values of  $j$  (i.e., there is only one coefficient to estimate over all 1692 observations). If, say,  $\alpha_{8it-1} = \alpha_{9it-1}$ , then the percentage change in the share of country 8 corresponding to a given percentage change in country 8's export price is assumed to be the same as the percentage change in the share of country 9 corresponding to the same percentage change in country 9's export price.

Equation (1) is similar to the share equation estimated by Samuelson (1973).<sup>1</sup> The differences are as follows. (1) Samuelson uses  $\alpha_{jit}$  in

<sup>1</sup>Other possible equations and approaches are discussed in Taplin (1973).

place of  $\alpha_{jit-1}$  and  $PX_{jt}$  in place of  $PX_{jt-1}$  in the denominators. The use of the lagged values here is in keeping with the usual interpretation of percentage changes. (2) Samuelson adds two other variables to the equation: the relative change in capacity output and the relative change in demand pressure. These variables are designed to measure "relative non-price competitiveness" (p. 10). The problem with the capacity output variable is that while capacity output and exports tend to be positively correlated, the relationship between the two variables is not necessarily a structural one. Similarly, demand pressure and exports may be negatively correlated, but this is not necessarily a structural relationship. The assumption here is that any effects of capacity output and demand pressure on exports are reflected in the effects of these two variables on export prices. (3) Samuelson uses seasonal dummy variables, something which has not been done here.

Samuelson (p. 11) argues that equation (1) (without the capacity output and demand pressure variables) is a first-order approximation to the CES demand system of Armington (1969). This is not, however, correct. In the present case of one good per country, Armington's CES system is as follows. Consider the demand of a country for its own and other countries' goods. It's utility function is assumed to be:

$$(2) \quad U = U(Z) ,$$

where

$$(3) \quad Z = [b_1 X_1^{-\rho} + b_2 X_2^{-\rho} + \dots + b_K X_K^{-\rho}]^{-1/\rho} .$$

$K$  is the number of countries and  $X_k$  is the amount consumed of country  $k$ 's good. Armington shows that maximizing (2) with respect to

$X_1, \dots, X_K$  subject to (3) and the budget constraint  $D = \sum_{k=1}^K P_k X_k$ ,

where  $D$  is nominal income of the country and  $P_k$  is the price of good  $k$ , leads to

$$(4) \quad X_j = b_j^\sigma Z \left( \frac{P_j}{P} \right)^{-\sigma}, \quad j = 1, \dots, K,$$

where  $\sigma = 1/(1+\rho)$  and  $P$  is a function only of  $P_k$  ( $k = 1, \dots, K$ ),  $b_k$  ( $k = 1, \dots, K$ ), and  $\sigma$ .

Now, multiplying equation (1) by  $\alpha_{jit-1}$ , ignoring the error term, and using the fact from Table 1 that  $\alpha_{jit} = \text{XX75\$}_{jit} / \text{M75\$A}_{it}$  yields:

$$(1)' \quad \text{XX75\$}_{jit} = \alpha_{jit-1} \text{M75\$A}_{it} + \beta_i \alpha_{jit-1} \text{M75\$A}_{it} \left[ \frac{\Delta \text{PX\$}_{jt}}{\text{PX\$}_{jt-1}} - \sum_{k \in A} \alpha_{kit-1} \frac{\Delta \text{PX\$}_{kt}}{\text{PX\$}_{kt-1}} \right],$$

$j \in A, \quad t = 1, \dots, T.$

Equation (1)' is the same as the equation derived by Samuelson (p. 11) except for the use of the lagged values rather than the current values of  $\alpha$  and  $\text{PX\$}$ . Samuelson argues that this equation is a first order approximation to equation (4). This is not the case because  $Z$ , unlike  $\text{M75\$A}_{it}$ , is not merely the weighted sum of imports: it is also a function of  $\rho$  (and thus of  $\sigma$ ). Likewise,  $P$  is a function of  $\rho$ . Although in a loose sense equation (1)' is an approximation to (4), it seems better merely to argue directly that equation (1) may not be too bad an approximation to the true structure, rather than to appeal to the CES demand system.

### III. The Econometric Techniques

Equation (1) is an example in which there is a fairly large number of observations both across individuals (countries) and across time. It will be useful for purposes of this section to drop the  $i$  subscript and rewrite (1) as

$$(5) \quad y_{jt} = \beta x_{jt} + u_{jt}, \quad j = 1, \dots, N, \quad t = 1, \dots, T.$$

$N$  is the number of Type A countries. The error term is assumed to be autocorrelated across time and heteroskedastic across countries. In particular, it is assumed that

$$(6) \quad u_{jt} = \rho_j u_{jt-1} + \epsilon_{jt},$$

$$(7) \quad E u_{jt}^2 = \sigma_j^2,$$

$$(8) \quad E u_{jt} u_{kt} = 0 \quad (j \neq k).$$

(6) and (7) imply that

$$(9) \quad E \epsilon_{jt}^2 = \sigma_{\epsilon j}^2 = \sigma_j^2 (1 - \rho_j^2).$$

The model (5)-(8) (with an arbitrary number of explanatory variables) is analyzed by Kmenta (1971, pp. 508-512). The model can be written

$$(10) \quad y = X\beta + u,$$

where  $y = (y_{11}, \dots, y_{1T}, \dots, y_{N1}, \dots, y_{NT})'$ ,  $X = (x_{11}, \dots, x_{1T}, \dots, x_{N1}, \dots, x_{NT})'$ , and  $u = (u_{11}, \dots, u_{1T}, \dots, u_{N1}, \dots, u_{NT})'$ . The covariance matrix of  $u$ , denoted  $\Omega$ , is

$$(11) \quad E u u' = \Omega = \begin{bmatrix} \sigma_1^2 P_1 & 0 & \dots & 0 \\ 0 & \sigma_2^2 P_2 & \dots & 0 \\ \vdots & \vdots & & \vdots \\ 0 & 0 & \dots & \sigma_N^2 P_N \end{bmatrix},$$

where

$$(12) \quad P_j = \begin{bmatrix} 1 & \rho_j & \rho_j^2 & \dots & \rho_j^{T-1} \\ \rho_j & 1 & \rho_j & \dots & \rho_j^{T-2} \\ \vdots & \vdots & \vdots & & \vdots \\ \rho_j^{T-1} & \rho_j^{T-2} & \rho_j^{T-3} & \dots & 1 \end{bmatrix}, \quad j = 1, \dots, N.$$

The generalized least squares (GLS) estimator of  $\beta$  is

$$(13) \quad \hat{\beta} = (X' \Omega^{-1} X)^{-1} X' \Omega^{-1} y,$$

with asymptotic covariance matrix  $(X' \Omega^{-1} X)^{-1}$ . Under the assumption of normality,  $\hat{\beta}$  is also the maximum likelihood estimator.

The GLS estimator is not feasible because  $\Omega$  is not known. It is possible, however, to estimate both  $\beta$  and  $\Omega$ . Kmenta (pp. 510-511) proposes a three step procedure for doing this. An alternative procedure was used for the results in this study, a procedure that iterates between estimates of  $\beta$  and estimates of  $\Omega$  until convergence. The procedure is:

- [1] Regress  $y_{jt}$  on  $x_{jt}$  using the  $N \cdot T$  pooled observations. Let  $\hat{\beta}$  denote the estimate of  $\beta$  from this regression.



[2] Compute:

$$\hat{u}_{jt} = y_{jt} - \hat{\beta}x_{jt}, \quad j = 1, \dots, N; \quad t = 1, \dots, T,$$

$$\hat{\rho}_j = \frac{\sum_{t=2}^T \hat{u}_{jt} \hat{u}_{jt-1}}{\sum_{t=2}^T \hat{u}_{jt-1}^2}, \quad j = 1, \dots, N,$$

$$\hat{\varepsilon}_{jt} = \hat{u}_{jt} - \hat{\rho}_j \hat{u}_{jt-1}, \quad j = 1, \dots, N; \quad t = 2, \dots, T,$$

$$\hat{\sigma}_{\varepsilon j}^2 = \sum_{t=2}^T \hat{\varepsilon}_{jt}^2, \quad j = 1, \dots, N,$$

$$y_{jt}^* = \frac{y_{jt} - \hat{\rho}_j y_{jt-1}}{\hat{\sigma}_{\varepsilon j}}, \quad x_{jt}^* = \frac{x_{jt} - \hat{\rho}_j x_{jt-1}}{\hat{\sigma}_{\varepsilon j}},$$

$$j = 1, \dots, N; \quad t = 2, \dots, T.$$

[3] Regress  $y_{jt}^*$  on  $x_{jt}^*$  using the  $N \cdot (T-1)$  pooled observations. This gives a new estimate of  $\beta$ .

[4] Repeat [2] and [3] using the new estimate of  $\beta$ . Keep repeating until successive estimates of  $\beta$  are within a prescribed tolerance level.

An estimate of the covariance matrix of  $\hat{\beta}$  is merely the covariance matrix computed on the last step from the pooled observations. Note that in going from [1] to [3] one observation is lost for each cross-sectional unit.

This procedure is a special case of the procedure discussed in Oberhofer and Kmenta (1974). They show under fairly general conditions

(conditions that are satisfied in the present application) that if the procedure converges it converges to a solution of the first order maximizing conditions of the maximum likelihood estimator. As will be seen, the procedure converged quite rapidly for the results in this study.

This procedure does not lead to consistent estimates if  $x_{jt}$  and  $\epsilon_{jt}$  are correlated. As will be discussed in Section IV,  $x_{jt}$  and  $\epsilon_{jt}$  may be correlated in the present case. If one can find variables that are correlated with  $x_{jt}$  but not with  $\epsilon_{jt}$ , then an instrumental variables (IV) version of the above procedure can be used. Let

$y^* = (y_{12}^*, \dots, y_{1T}^*, \dots, y_{N2}^*, \dots, y_{NT}^*)'$ ,  $X^* = (x_{12}^*, \dots, x_{1T}^*, \dots, x_{N2}^*, \dots, x_{NT}^*)'$ , and

$$Z^* = \begin{bmatrix} z_{12,1}^* & \dots & z_{12,M}^* \\ \vdots & & \vdots \\ z_{1T,1}^* & \dots & z_{1T,M}^* \\ \vdots & & \vdots \\ z_{N2,1}^* & & z_{N2,M}^* \\ \vdots & & \vdots \\ z_{NT,1}^* & & z_{NT,M}^* \end{bmatrix},$$

where  $z_{jt,m}^* = z_{jt,m} / \hat{\sigma}_{\epsilon_j}$ .  $z_{jt,m}$  is the  $jt$  value of variable  $m$ .

The total number of  $Z$  variables is  $M$ . They are assumed to be correlated with  $x_{jt}$  but not with  $\epsilon_{jt}$ . In the regular version of the procedure the estimate of  $\beta$  in step [3] is  $(X^*{}'X^*)^{-1}X^*{}'y^*$ . An estimate of the asymptotic covariance matrix of the estimator is  $(X^*{}'X^*)^{-1}$ .

In the IV version the estimate of  $\beta$  in step [3] is  $(\hat{X}^*{}'X^*)^{-1}\hat{X}^*{}'y^*$ , where  $\hat{X}^* = Z^*(Z^*{}'Z^*)^{-1}Z^*{}'X^*$ . An estimate of the asymptotic covariance matrix of this estimator is  $(\hat{X}^*{}'X^*)^{-1}$ . Since  $y_{jt-1}$  and  $x_{jt-1}$  are

part of  $y_{jt}^*$  and  $x_{jt}^*$ , respectively, they should be included among the Z variables if they are not correlated with  $\varepsilon_{jt}$ . In other words, they should serve as their own instruments. If they are not included, they will be treated as endogenous along with  $x_{jt}$ . Note that  $z_{jt,m}^*$ , unlike  $y_{jt}^*$  and  $x_{jt}^*$ , is not a function of  $\hat{\rho}_j$ .

#### IV. The Estimates

The results of estimating equation (1) for each of the 64 countries are presented in Table 2. There are 47 Type A countries, and the basic estimation period is 1971I-1979IV (36 quarters). If every country traded with all 47 Type A countries every quarter, the number of observations for each estimated equation would be  $35 \times 47 = 1645$ . In practice, not every country trades with every other. It is also true that for some quarters (typically the early and late quarters) data on  $PXS_{jt}$  do not exist for an otherwise Type A country. These two facts mean the number of observations for a given equation is less than 1645. The exact number for each equation is presented in Table 2.

The first set of results in Table 2 is quite remarkable.<sup>2</sup> For only three countries--Yugoslavia, Mexico, and China--is the sign of the coefficient estimate positive (and thus contrary to what is expected). Of the remaining 61 countries, 48 have t-statistics greater than or equal to 2.0 in absolute value and only 5 have t-statistics less than 1.0 in

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<sup>2</sup>The average number of iterations for the procedure (across the 64 equations) was 4.5 for a tolerance level of 0.01 percent. The largest number of iterations for a given equation was 14. The time taken to estimate the 64 equations on the IBM 370-158 at Yale was about 5.5 minutes using a program written by the author. In a few cases the initial estimate of a serial correlation coefficient was greater than one in absolute value, and in these cases the estimate was constrained to be zero. This was also done for the IV results.

TABLE 2. Estimates of Equation (1) for 64 Countries

Country	Regular Procedure Basic Sample Periods			Regular Procedure Smaller Sample Periods			IV Procedure Smaller Sample Periods	
	$\hat{\beta}_1$	t- statistic	No. of Obs.	$\hat{\beta}_1$	t- statistic	No. of Obs.	$\hat{\beta}_1$	t- statistic
1 U.S.	-0.312	(-5.01)	1551	-0.249	(-3.91)	1302	-0.033	(-0.20)
2 Canada	-0.333	(-3.14)	1460	-0.260	(-3.03)	1222	0.114	(0.51)
3 Japan	-0.303	(-7.80)	1556	-0.344	(-8.15)	1301	-0.156	(-1.63)
4 Austria	-0.290	(-3.15)	1374	-0.300	(-3.27)	1155	-0.616	(-2.55)
5 Belgium	-0.434	(-5.85)	1495	-0.443	(-6.63)	1279	-0.475	(-2.77)
6 Denmark	-0.457	(-4.04)	1414	-0.383	(-3.17)	1202	-0.394	(-1.19)
7 France	-0.258	(-6.47)	1538	-0.270	(-6.11)	1310	-0.401	(-3.64)
8 Germany	-0.231	(-5.34)	1543	-0.275	(-6.02)	1308	-0.228	(-2.10)
9 Italy	-0.300	(-8.48)	1540	-0.293	(-8.01)	1310	-0.548	(-5.77)
10 Netherlands	-0.553	(-10.18)	1518	-0.525	(-10.24)	1288	-0.498	(-2.65)
11 Norway	-0.445	(-2.75)	1404	-0.374	(-2.98)	1194	-0.400	(-1.38)
12 Sweden	-0.387	(-4.13)	1467	-0.379	(-4.12)	1243	0.137	(0.54)
13 Switzerland	-0.416	(-3.73)	1439	-0.367	(-3.03)	1191	-0.501	(-1.26)
14 U.K.	-0.309	(-6.35)	1554	-0.299	(-5.40)	1300	-0.246	(-2.03)
15 Finland	-0.371	(-3.27)	1361	-0.397	(-3.70)	1168	-0.551	(-2.38)
16 Greece	-0.555	(-5.78)	1403	-0.556	(-6.85)	1184	-0.984	(-4.72)
17 Ireland	-0.715	(-7.30)	1322	-0.729	(-6.56)	1053	-0.747	(-4.33)
18 Portugal	-0.470	(-3.24)	1321	-0.434	(-3.99)	1131	-0.272	(-1.30)
19 Romania	-0.340	(-3.16)	1236	-0.199	(-1.58)	956	-0.247	(-1.02)
20 Spain	-0.146	(-2.75)	1478	-0.158	(-2.95)	1254	-0.094	(-0.85)
21 Turkey	-0.421	(-2.90)	1299	-0.373	(-2.55)	1076	-0.627	(-2.68)
22 Yugoslavia	0.328	(2.11)	1313	0.306	(1.89)	1086	-0.289	(-0.79)
23 Australia	-0.388	(-5.54)	1498	-0.428	(-6.64)	1269	-0.347	(-2.39)
24 New Zealand	-0.385	(-3.05)	1275	-0.421	(-4.15)	1120	-0.554	(-2.33)
25 South Africa	-0.302	(-1.89)	1109	-0.238	(-1.43)	877	-0.500	(-1.17)
26 Algeria	-0.631	(-2.00)	1045	0.537	(1.26)	817	1.121	(0.84)
27 Indonesia	-0.395	(-1.99)	1137	-0.231	(-1.29)	949	0.118	(0.29)
28 Iran	-0.397	(-3.52)	1324	-0.669	(-2.30)	1017	-0.242	(-0.32)
29 Iraq	-0.185	(-0.73)	1257	-0.362	(-1.33)	1002	-1.568	(-3.02)
30 Kuwait	-0.681	(-5.87)	1265	-0.835	(-4.32)	1015	-1.379	(-3.53)
31 Libya	-0.675	(-7.91)	1085	-0.558	(-1.89)	869	1.396	(1.45)
32 Nigeria	-0.611	(-6.57)	1209	-0.613	(-2.15)	987	1.176	(1.11)
33 Saudi Arabia	-0.683	(-7.68)	1346	-0.666	(-4.32)	1029	-1.154	(-3.39)
34 United Arab Emirates	-0.689	(-5.01)	979	-0.774	(-4.07)	746	-0.916	(-2.80)
35 Venezuela	-0.448	(-2.81)	1210	-0.355	(-1.81)	1019	-1.339	(1.65)
36 Argentina	-0.855	(-5.09)	1211	-1.003	(-4.46)	970	-1.161	(-1.27)
37 Brazil	-0.358	(-5.36)	1379	-0.336	(-4.65)	1172	-0.408	(-2.80)
38 Chile	-0.303	(-1.58)	1194	-0.271	(-1.33)	1033	-0.842	(-1.62)
39 Colombia	-0.417	(-1.99)	1052	-0.252	(-1.09)	845	-0.938	(-0.93)
40 Mexico	0.001	(0.00)	1221	0.179	(0.83)	1038	0.974	(1.63)
41 Peru	-0.537	(-2.50)	1069	-0.374	(-1.45)	913	-1.449	(-1.17)
42 Egypt	-0.176	(-1.84)	1269	-0.026	(-0.25)	954	-0.201	(-1.19)
43 Israel	-0.626	(-3.42)	1195	-0.704	(-3.20)	1023	-0.507	(-0.76)
44 Jordan	-0.645	(-4.70)	1148	-0.847	(-4.47)	895	-1.138	(-3.66)
45 Lebanon	-0.724	(-12.54)	1294	-0.259	(-0.90)	983	-0.376	(-0.50)
46 Syria	-1.235	(-4.74)	1164	-1.453	(-4.76)	869	-1.955	(-2.44)
47 Bangladesh	-0.314	(-0.39)	819	-1.239	(-1.41)	635	-1.592	(-0.80)
49 Hong Kong	-0.413	(-3.91)	1345	-0.462	(-4.15)	1184	-0.638	(-2.30)
50 India	-0.408	(-3.97)	1287	-0.563	(-4.25)	1009	-0.581	(-2.63)
51 Korea	-0.339	(-3.75)	1184	-0.390	(-3.75)	1044	-0.669	(-2.98)
52 Malaysia	-0.569	(-5.44)	1172	-0.640	(-5.63)	1017	-1.050	(-2.79)
53 Pakistan	-0.550	(-5.33)	1193	-0.503	(-4.55)	986	-0.809	(-3.87)
54 Philippines	-0.477	(-5.52)	1245	-0.450	(-5.95)	1063	-0.422	(-2.72)
55 Singapore	-0.462	(-6.60)	1301	-0.341	(-4.69)	1122	-0.158	(-1.03)
56 Thailand	-0.496	(-4.49)	1235	-0.422	(-4.43)	1054	-1.346	(-3.97)
57 Bulgaria	-0.044	(-0.15)	1092	0.056	(0.18)	873	0.069	(0.09)
58 China	0.315	(0.88)	1089	0.800	(1.86)	891	1.037	(0.89)
59 Cuba	-0.522	(-0.80)	800	-0.620	(-0.87)	655	5.485	(2.25)
60 Czechoslovakia	-0.325	(-1.41)	1270	-0.195	(-0.71)	1025	0.858	(1.18)
61 E. Germany	-0.675	(-5.28)	1112	-0.774	(-2.60)	894	0.240	(0.31)
62 Hungary	-0.374	(-2.51)	1178	-0.098	(-0.46)	969	-0.442	(-0.89)
63 Poland	-0.136	(-0.60)	1270	-0.032	(-0.13)	1016	0.615	(0.87)
64 U.S.S.R.	-0.188	(-1.53)	1196	0.393	(1.58)	992	2.210	(3.03)
65 ROW	-0.165	(-1.26)	1709	-0.145	(-0.99)	1446	-0.201	(-0.41)

absolute value. These results thus seem to provide rather strong support for the hypothesis that relative prices have an important effect on trade shares.

These results are so good that they lead one to be suspicious that something else is going on. One possible problem is that  $PX\$_{jt}$  is used both in the construction of the data for  $\alpha_{jit}$  (see Table 1) and in the explanation of  $\alpha_{jit}$ . If  $PX\$_{jt}$  is measured with error, this is likely to lead to a negative correlation between  $\frac{\Delta PX\$_{jt}}{PX\$_{jt-1}} - \sum_{k \in A} \alpha_{kit-1} \frac{\Delta PX\$_{kt}}{PX\$_{kt-1}}$

and the error term in equation (1) and thus to an estimate of  $\beta_1$  that is biased downward. To test for this, equation (1) was estimated by the IV procedure. Five variables were used as Z variables: a constant term,

$$\frac{\Delta \alpha_{jit-1}}{\alpha_{jit-2}}, \frac{\Delta PX\$_{jt-1}}{PX\$_{jt-2}} - \sum_{k \in A} \alpha_{kit-1} \frac{\Delta PX\$_{kt-1}}{PX\$_{kt-2}}, \frac{\Delta PX\$_{jt-2}}{PX\$_{jt-3}} - \sum_{k \in A} \alpha_{kit-1} \frac{\Delta PX\$_{kt-2}}{PX\$_{kt-3}},$$

and  $\frac{\Delta PY\$_{jt}}{PY\$_{jt-1}} - \sum_{k \in A} \alpha_{kit-1} \frac{\Delta PY\$_{kt}}{PY\$_{kt-1}}$ . The key variable in this choice is

$PY\$_{jt}$ . This variable is defined in Table 1. It is the GNP deflator converted to dollars using the exchange rate of the previous period:

$PY\$_{jt} = (e_{j75} PY_{jt}) / e_{jt-1}$ . This variable is likely to be correlated with  $PX\$_{jt}$ , and it has not been used in the construction of the data for  $\alpha_{jit}$ .

The use of  $PY\$_{jt}$  required that a few more observations be dropped due to lack of data. The second set of results in Table 2 is the same as the first set except for the use of the shorter sample periods. The second set of results is similar to the first, although there are now six countries with a positive coefficient estimate instead of three. The third set of results is for the IV procedure.<sup>3</sup> These results do not indicate that

<sup>3</sup>The average number of iterations in this case was 5.7. The largest number of iterations for a given equation was 16. The time taken to estimate the 64 equations in this case was about 12 minutes.

the non IV estimates are biased downward. Consider the first 15 countries, which are the main countries in the model. For 7 of the 15 the IV estimates are greater than the non IV estimates, but for the other 8 they are smaller. The estimates for the other countries are also not systematically different. (The IV estimates are not as precise, as expected, and they tend to be more erratic for the smaller countries.) It thus does not appear that the non IV estimates are biased downward, and so it seems that relative prices do have an important effect on trade shares.

For each estimated equation there are  $N$  estimates of  $\rho_j$  and  $N$  estimates of  $\sigma_{\epsilon_j}$ , where  $N$  is the number of Type A countries that the given country trades with. A subset of these estimates is presented in Table 3. Estimates of  $\rho_j$  and  $\sigma_{\epsilon_j}$  for the first 15 countries for each of the first 15 equations are presented. Almost all of the estimates of  $\rho_j$  are negative, which is as expected given that the left hand side variable is in change form. The estimates of  $\sigma_{\epsilon_j}$  range from a low of 4 percent to a high of 94 percent. (Remember that the standard errors are for the percentage changes in the shares, not the absolute changes.) Most of the estimates are less than 20 percent.

#### V. The Trade Share Equations in a Multicountry Model

The sensitivity of the properties of the model in Fair (1981a) to the endogenous treatment of trade shares is examined in this section. Two main questions are considered. The first is how the fit of the model is affected by the inclusion of the trade share equations, and the second is how the multiplier properties are affected.

The model will only be briefly reviewed here. It is quarterly and contains estimated equations for 44 countries. Most of the equations

TABLE 3. Estimates of  $\rho_j$  and  $\sigma_{\epsilon_j}$  for the First 15 Countries  
for Each of the First 15 Equations

Eq.	$\hat{\rho}_j$																
	US	CA	JA	AU	BE	DE	FR	GE	IT	NE	NO	SW	ST	UK	FI		
1	US	U.S.	--	-.38	.00	-.03	-.46	-.26	-.43	-.61	-.35	-.39	-.18	-.40	-.22	-.46	-.40
2	CA	Canada	-.26	--	-.22	-.19	-.42	-.28	-.11	-.52	-.13	-.35	-.48	-.44	-.40	-.29	-.52
3	JA	Japan	-.10	-.35	--	-.17	-.31	-.18	-.34	.03	-.38	-.29	-.36	-.43	-.43	-.49	-.32
4	AU	Austria	-.36	-.47	-.09	--	-.38	-.19	-.35	-.40	-.33	-.36	-.31	-.45	-.31	-.42	-.43
5	BE	Belgium	-.49	-.38	-.12	-.37	--	-.47	-.29	-.27	-.35	-.31	-.36	-.37	-.51	-.45	-.35
6	DE	Denmark	-.36	-.31	-.10	-.36	-.57	--	-.26	-.32	-.22	-.30	-.25	-.16	-.22	-.41	-.38
7	FR	France	-.52	-.17	-.27	-.07	-.37	-.25	--	-.33	-.50	-.41	-.44	-.36	-.37	-.05	-.43
8	GE	Germany	-.22	-.33	-.04	-.34	-.55	-.14	-.27	--	-.21	-.40	-.00	-.32	-.23	-.44	-.31
9	IT	Italy	-.20	-.39	-.37	.06	-.18	-.32	-.03	-.26	--	-.28	-.19	-.38	-.23	-.26	-.27
10	NE	Netherlands	-.47	-.45	.00	-.41	-.66	-.17	-.35	-.51	-.31	--	-.38	-.48	-.24	-.08	-.45
11	NO	Norway	-.43	-.49	-.33	-.58	-.44	-.26	-.29	-.47	-.51	-.40	--	-.57	-.52	-.41	-.53
12	SW	Sweden	-.39	-.55	-.30	-.34	-.38	-.28	-.42	-.46	-.61	-.30	-.62	--	-.25	-.24	-.54
13	ST	Switzerland	-.38	-.41	-.24	-.17	-.39	-.18	-.11	-.22	-.17	-.55	-.41	-.40	--	-.13	-.38
14	UK	U.K.	-.60	-.38	-.37	-.25	-.40	-.56	-.19	-.29	-.47	-.16	-.18	-.29	-.19	--	-.37
15	FI	Finland	-.40	-.31	-.54	-.54	-.18	-.32	-.23	-.50	-.56	-.43	-.42	-.39	-.51	-.62	--

  

Eq.	$\hat{\sigma}_{\epsilon_j}$																
	US	CA	JA	AU	BE	DE	FR	GE	IT	NE	NO	SW	ST	UK	FI		
1	US	U.S.	--	.08	.09	.17	.14	.11	.10	.11	.11	.12	.23	.16	.10	.10	.30
2	CA	Canada	.04	--	.17	.29	.13	.12	.12	.11	.14	.14	.63	.19	.26	.10	.35
3	JA	Japan	.07	.17	--	.33	.18	.28	.13	.08	.26	.17	.39	.19	.13	.13	.65
4	AU	Austria	.22	.32	.16	--	.16	.09	.13	.02	.11	.07	.12	.09	.06	.08	.18
5	BE	Belgium	.10	.25	.16	.10	--	.10	.06	.04	.09	.05	.17	.09	.09	.09	.26
6	DE	Denmark	.21	.26	.37	.09	.15	--	.14	.06	.13	.11	.13	.06	.12	.08	.11
7	FR	France	.13	.14	.21	.07	.06	.09	--	.05	.09	.06	.21	.12	.06	.07	.14
8	GE	Germany	.11	.22	.11	.07	.06	.07	.06	--	.10	.05	.17	.06	.05	.08	.10
9	IT	Italy	.12	.15	.17	.09	.14	.20	.07	.05	--	.09	.54	.15	.09	.07	.24
10	NE	Netherlands	.11	.24	.22	.12	.07	.09	.10	.04	.13	--	.18	.09	.09	.09	.20
11	NO	Norway	.18	.48	.94	.16	.15	.10	.35	.10	.20	.40	--	.13	.11	.20	.38
12	SW	Sweden	.10	.22	.38	.07	.12	.05	.13	.05	.09	.13	.06	--	.05	.08	.13
13	ST	Switzerland	.19	.21	.14	.08	.10	.10	.08	.05	.11	.09	.12	.08	--	.17	.22
14	UK	U.K.	.10	.15	.21	.07	.12	.10	.11	.10	.12	.12	.29	.10	.07	--	.13
15	FI	Finland	.18	.37	.24	.09	.15	.09	.19	.07	.10	.10	.25	.08	.07	.16	--

Note:  $\sigma_{\epsilon_j}$  is in units of percent (10 percent = .10).

have been estimated by two stage least squares. The basic estimation period is 1958I-1980I. There are up to 11 estimated equations per country (excluding the U.S., for which there is a much larger model), explaining (1) imports, (2) consumption, (3) investment, (4) production, (5) GNP deflator, (6) money supply, (7) short term interest rate, (8) long term interest rate, (9) exchange rate, (10) forward rate, and (11) export price index. The part of the model that links the countries together receives as input from each country its level of imports, exchange rate, and export price index and returns as output the level of exports and the import price index. The trade shares are used in the determination of both of these variables. The model is solved by iterating between the models of the individual countries and the part of the overall model that links the countries together.

When the share equations are added to the model, the estimates of  $\rho_j$  cannot be used in the predictions of the shares. If they were used, it would not be the case that  $\sum_{j \in A} \hat{\Delta} \alpha_{j \text{it}} = 0$ . The error term  $u_{j \text{it}}$  in equation (1) must be set to zero for all  $j$  and  $t$  in order for this property to hold.

The fit of the model is examined in Table 4. The model was solved for three eight-quarter periods, both statically and dynamically, and root mean squared errors (RMSEs) were computed for each endogenous variable for each run. For the first set of results in Table 4 a weighted average of the RMSEs across all countries except the U.S. was taken for each variable. The RMSEs were weighted by the ratio of the country's real GNP (in 75\$) in the last (i.e., eighth) quarter of the prediction period to the total real GNP of all the countries. The RMSEs for the U.S. are presented in the second half of Table 4.



TABLE 4. RMSEs

STA = Static simulation  
DYN = Dynamic simulation

a = Trade shares exogenous  
b = Trade shares endogenous

	Weighted RMSEs for All Countries Except the U.S.											
	701-714				741-754				761-774			
	STA		DYN		STA		DYN		STA		DYN	
	a	b	a	b	a	b	a	b	a	b	a	b
Real GNP	1.95	2.47	4.32	4.16	2.10	3.08	3.29	6.07	1.90	2.26	3.71	4.32
GNP Deflator	0.81	0.80	2.53	2.36	1.19	1.17	2.28	2.97	0.98	0.99	2.60	2.70
Interest Rate	0.56	0.57	0.91	0.89	0.75	0.88	1.14	2.43	0.88	0.89	1.80	1.88
Exchange Rate	c	c	c	c	3.80	3.23	5.26	5.07	2.56	2.73	4.32	5.33
Import Price	0.66	2.23	1.66	3.28	2.97	2.78	4.42	4.90	2.17	2.30	3.85	4.68
Money Supply	2.99	2.93	6.60	5.85	2.85	2.92	3.87	3.67	2.55	2.57	3.83	4.14
Imports	4.70	4.82	9.43	8.43	4.79	5.03	6.44	9.85	4.30	4.41	6.56	7.08
Consumption	1.85	1.93	3.77	3.56	2.32	2.49	3.28	4.28	1.92	1.92	3.95	4.25
Investment	4.07	4.19	10.28	8.26	4.21	4.49	7.67	9.92	3.41	3.64	7.79	7.85
Interest Rate	0.27	0.27	0.49	0.48	0.43	0.55	0.74	1.28	0.41	0.40	0.90	1.02
Export Price	1.81	1.80	3.87	3.75	3.71	3.41	5.14	5.31	2.66	2.65	4.34	4.73
Exports	1.97	8.15	5.21	10.97	2.18	10.22	3.00	14.76	1.50	6.93	2.65	7.90

	RMSEs for the U.S.											
	701-714				741-754				761-774			
	STA		DYN		STA		DYN		STA		DYN	
	a	b	a	b	a	b	a	b	a	b	a	b
Real GNP	0.50	0.49	0.25	0.81	0.81	0.71	2.31	3.16	0.74	0.76	1.32	0.93
GNP Deflator	0.27	0.29	0.32	0.30	0.33	0.34	1.23	1.13	0.37	0.37	0.80	0.76
Interest Rate	0.54	0.57	0.84	1.11	0.57	0.51	0.83	1.04	0.25	0.23	0.31	0.43
Import Price	0.65	1.89	2.06	2.87	1.28	1.68	3.53	3.38	0.61	0.74	0.95	0.68
Money Supply	1.15	1.15	3.37	3.41	1.02	1.02	0.83	0.82	0.66	0.66	1.07	1.02
Imports	2.48	2.37	4.44	3.59	4.40	4.37	8.06	8.95	2.32	2.30	4.48	3.82
Interest Rate	0.28	0.29	0.37	0.43	0.28	0.26	0.33	0.35	0.12	0.12	0.31	0.39
Export Price	1.03	1.10	1.87	2.01	1.97	1.99	6.01	5.82	1.15	1.15	2.32	2.32
Exports	1.14	6.73	1.87	13.59	1.68	4.64	2.64	9.00	1.33	3.26	2.20	6.71

- Notes: 1. All errors are in percentage points.  
2. Weights are GNP in 75\$ in the last quarter of the period.  
3. First set of equations in Table 2 was used for the endogenous trade share case. The shares for the three countries with the wrong sign for  $\hat{\beta}_i$  --Yugoslavia, Mexico, and China--were taken to be exogenous.
- c = fixed exchange rate period for almost all countries.

The variable most affected by the addition of the trade share equations is (as expected) the level of exports. For the 1976I-1977IV period, for example, the RMSE increased for the dynamic simulation from 2.65 percent to 7.90 percent. The effects on the other variables were much smaller, and in some cases error cancellation was such as to lead to smaller RMSEs in the endogenous trade share case. Of the other variables, GNP was generally affected the most. This is, of course, not surprising given that exports are part of GNP.

For the results in Fair (1981b), ten experiments were performed, each experiment corresponding to a change in one or more exogenous variables. Trade shares were taken to be exogenous for these results. For present purposes these experiments were repeated with the trade share equations added. The results of two of the experiments are reported in Tables 5 and 6. For the first experiment the equation explaining the German exchange rate was dropped and the German exchange rate was taken to be exogenous. The results in Table 5 are for an increase in the exchange rate of ten percent (a depreciation). The second experiment is the same as the first except the country is the U.K. instead of Germany. The results of this experiment are presented in Table 6.

All of the countries in the model were used for the experiments. The results for 15 countries and 13 variables per country are presented in Tables 5 and 6 for the two-quarter-ahead and six-quarter-ahead predictions. Except for the numbers for the balance of payments, each number in the tables is the percentage change in the variable (in percentage points).

Without a detailed description of the model, it is not possible to explain all of the results in the two tables. This description is

TABLE 5. Percentage Change in the Variable After Two and Six Quarters Induced by a Sustained Ten Percent Increase in the German Exchange Rate (Depreciation). Initial Change in 1976I.

Country	Trade Shares Exogenous																Balance of Payments <sup>a</sup>									
	Real GNP		GNP Deflator		Short Term Interest Rate		Exchange Rate		Import Price		Money Supply		Imports		Consumption		Investment		Long Term Interest Rate		Export Price		Exports			
	2	6	2	6	2	6	2	6	2	6	2	6	2	6	2	6	2	6	2	6	2	6	2	6	2	6
U.S.	0.02	0.11	-0.12	-0.35	-0.03	-0.02	--	--	-0.93	-1.40	-0.00	-0.02	0.18	0.50	0.04	0.16	0.03	0.25	-0.01	-0.03	-0.11	-0.33	-0.07	-0.08	254.072	314.577
Canada	0.01	0.07	-0.03	-0.18	-0.04	-0.12	0.02	0.08	-0.51	-0.87	0.04	0.19	0.06	0.36	0.01	0.09	0.01	0.06	-0.02	-0.06	-0.03	-0.16	0.11	0.34	74.722	116.422
Japan	0.01	0.05	-0.02	-0.07	-0.03	-0.07	0.18	0.50	-0.19	-0.06	-0.00	0.00	0.06	0.15	0.01	0.06	0.00	0.04	--	--	0.10	0.27	0.03	0.15	17.367	24.744
Austria	0.27	-0.12	0.91	2.06	-0.00	-0.01	9.82	9.95	4.27	4.05	0.29	1.09	-0.37	-0.11	0.20	-0.03	0.23	-0.18	--	--	6.48	6.91	-0.16	-0.74	1.200	1.188
Belgium	0.90	0.47	0.68	1.63	0.71	0.40	8.04	7.82	4.49	3.65	0.14	0.66	-0.94	-1.02	0.51	0.42	0.69	0.50	0.10	0.18	4.47	4.66	-0.34	-0.96	2.648	6.112
Denmark	0.20	-0.65	0.16	0.31	0.18	-0.88	5.27	5.45	1.35	1.09	0.09	0.58	-0.37	0.33	0.12	-0.44	0.21	-0.76	0.03	-0.21	2.56	2.65	-0.12	-0.65	0.266	0.160
France	0.27	1.02	0.15	1.35	0.59	1.35	7.40	10.78	4.06	6.93	-0.06	0.20	-0.75	-1.45	0.08	0.49	0.35	1.81	0.13	0.50	3.52	5.34	-0.22	-0.71	0.014	-0.844
Germany	-0.16	-0.63	0.26	0.95	0.13	0.28	10.00	10.00	7.80	7.18	-0.05	-0.16	-0.17	-1.45	-0.11	-0.83	-0.38	-1.34	0.03	0.14	2.01	2.28	-0.31	-0.52	-4.038	-2.964
Italy	-0.10	-0.78	0.18	2.27	0.66	2.71	5.28	10.69	2.25	7.10	-0.04	-1.19	-0.13	-1.72	-0.12	-1.05	-0.18	-1.89	0.13	0.88	3.46	7.54	-0.26	-0.64	96.470	232.282
Netherlands	0.34	0.10	0.30	1.16	0.32	0.52	8.49	8.57	5.29	4.68	0.15	0.48	-0.48	-0.62	0.21	0.32	0.38	0.11	0.08	0.31	7.00	7.27	-0.34	-1.04	0.715	0.828
Norway	-0.04	-0.27	-0.09	-0.06	-0.28	-0.46	3.10	4.28	-0.01	0.35	-0.08	-0.24	0.07	0.24	0.01	-0.08	--	--	-0.04	-0.10	2.73	3.77	-0.13	-0.64	0.445	0.512
Sweden	-0.03	0.09	0.10	1.00	0.31	0.76	5.26	6.50	2.03	2.45	-0.01	0.25	-0.05	-0.53	-0.01	0.05	-0.02	0.08	0.04	0.20	1.29	1.99	-0.18	-0.38	-0.220	-0.114
Switzerland	0.20	0.94	0.15	1.00	0.28	0.41	10.65	12.43	6.51	7.38	-0.14	-0.52	-0.78	-1.41	-0.06	0.14	0.46	3.09	0.09	0.28	2.95	3.85	-0.19	-0.61	-0.234	-0.252
U.K.	-0.04	-0.41	0.05	1.13	-0.00	-0.01	5.34	13.32	3.34	10.83	0.00	0.38	-0.06	-0.94	-0.03	-0.82	-0.02	-0.30	0.00	0.08	1.68	4.68	-0.18	-0.32	-171.311	-685.638
Finland	-0.01	0.08	0.04	1.09	-0.05	-0.11	4.84	10.70	1.08	5.89	-0.04	0.83	-0.08	-0.25	-0.00	0.17	-0.01	0.10	--	--	3.99	9.12	-0.12	-0.50	200.580	184.543

Country	Trade Shares Endogenous <sup>b</sup>																Balance of Payments <sup>a</sup>									
	Real GNP		GNP Deflator		Short Term Interest Rate		Exchange Rate		Import Price		Money Supply		Imports		Consumption		Investment		Long Term Interest Rate		Export Price		Exports			
	2	6	2	6	2	6	2	6	2	6	2	6	2	6	2	6	2	6	2	6	2	6	2	6	2	6
U.S.	-0.03	0.05	-0.12	-0.36	-0.04	-0.05	0.00	0.00	-0.96	-1.42	-0.00	-0.01	0.12	0.39	0.03	0.15	-0.05	0.04	-0.02	-0.05	-0.11	-0.35	-0.57	-0.72	121.244	146.629
Canada	-0.06	-0.06	-0.04	-0.27	-0.04	-0.13	0.01	0.05	-0.54	-0.93	0.02	0.14	-0.02	0.06	-0.00	0.02	-0.05	-0.04	-0.01	-0.06	-0.03	-0.25	-0.29	-0.14	39.711	85.448
Japan	-0.07	-0.17	0.00	0.00	0.01	-0.00	0.14	0.33	-0.25	-0.25	-0.03	-0.12	0.04	0.02	-0.02	-0.08	-0.03	-0.19	--	--	0.09	0.21	-0.47	-0.53	-4.703	-0.282
Austria	0.40	-0.02	0.92	2.10	0.01	0.05	9.81	9.90	4.25	4.07	0.34	1.19	-0.16	0.04	0.28	0.03	0.33	-0.09	--	--	6.48	6.89	0.33	-0.43	1.280	1.180
Belgium	1.15	0.65	0.70	1.73	0.85	0.60	8.13	7.94	4.55	3.74	0.15	0.68	-0.60	-0.73	0.66	0.56	0.88	0.69	0.12	0.23	4.52	4.75	0.25	-0.51	3.194	6.367
Denmark	0.31	-0.50	0.16	0.36	0.18	-0.85	5.34	5.57	1.41	1.20	0.16	0.73	-0.28	0.49	0.19	-0.32	0.32	-0.54	0.03	-0.20	2.60	2.72	0.19	-0.28	0.281	0.160
France	0.48	1.63	0.15	1.36	0.75	1.82	7.38	10.77	4.02	6.92	-0.07	0.26	-0.62	-0.84	0.14	0.83	0.63	2.92	0.17	0.67	3.54	5.36	0.41	0.28	0.353	-0.604
Germany	0.72	0.20	0.37	1.63	0.58	1.28	10.00	10.00	7.79	7.13	0.21	0.07	0.91	-0.52	0.23	-0.39	1.62	0.25	0.16	0.56	2.05	2.54	1.46	1.03	-3.517	-2.246
Italy	-0.13	-0.68	0.19	2.27	0.67	2.68	5.32	10.74	2.25	7.12	-0.06	-1.14	-0.20	-1.57	-0.14	-1.01	-0.27	-1.67	0.13	0.87	3.51	7.60	-0.24	-0.27	101.246	248.632
Netherlands	0.34	0.06	0.29	1.15	0.30	0.45	8.49	8.57	5.21	4.63	0.17	0.50	-0.47	-0.66	0.21	0.33	0.39	0.07	0.07	0.30	7.00	7.27	-0.22	-1.07	0.749	0.817
Norway	-0.18	-0.32	-0.10	0.03	-0.14	-0.04	3.05	4.08	-0.07	0.16	-0.19	-0.23	-0.15	-0.12	-0.10	-0.23	0.00	0.00	-0.02	-0.01	2.68	3.57	-0.67	-0.91	0.421	0.544
Sweden	0.12	0.31	0.09	1.02	0.35	0.88	5.16	6.27	1.91	2.19	0.02	0.40	0.14	-0.24	0.05	0.19	0.11	0.25	0.05	0.23	1.25	1.93	0.39	0.29	-0.117	0.027
Switzerland	0.83	2.13	0.21	1.37	0.28	0.56	10.83	13.45	6.67	8.36	-0.13	-0.56	0.49	0.87	0.20	0.96	1.94	6.92	0.08	0.35	3.04	4.32	1.62	1.48	-0.194	-0.350
U.K.	0.08	0.25	0.05	1.20	-0.00	0.10	5.36	13.89	3.35	11.38	0.03	0.74	0.08	0.22	0.03	-0.28	0.01	0.22	0.00	0.11	1.69	4.90	0.32	1.71	-152.676	-671.156
Finland	-0.16	-0.05	0.03	1.04	-0.04	-0.11	4.80	10.57	1.04	5.76	-0.16	0.63	-0.35	-0.51	-0.09	0.03	-0.15	-0.08	--	--	3.96	9.00	-0.56	-0.70	186.903	184.915

<sup>a</sup> Change is absolute change, not percentage change, in units of local currency. The currencies are: U.S. (dollars, mil.); Canada (dollars, mil.); Japan (yen, bil.); Austria (schillings, bil.); Belgium (francs, bil.); Denmark (kroner, bil.); France (francs, bil.); Germany (D. marks, bil.); Italy (lire, bil.); Netherlands (guilders, bil.); Norway (kroner, bil.); Sweden (kroner, bil.); Switzerland (francs, bil.); U.K. (pounds, mil.); Finland (markkaa, mil.).

<sup>b</sup> First set of equations in Table 2 was used. The shares for the three countries with the wrong sign for  $\beta_1$  --Yugoslavia, Mexico, and China--were taken to be exogenous.

TABLE 6. Percentage Change in the Variable After Two and Six Quarters Induced by a Sustained Ten Percent Increase in the U.K. Exchange Rate (Depreciation). Initial Change in 1976I.

Trade Share Exogenous																											
Country	Real GNP		GNP Deflator		Short Term Interest Rate		Exchange Rate		Import Price		Money Supply		Imports		Consumption		Investment		Long Term Interest Rate		Export Price		Exports		Balance of Payments <sup>a</sup>		
	2	6	2	6	2	6	2	6	2	6	2	6	2	6	2	6	2	6	2	6	2	6	2	6	2	6	2
U.S.	0.01	0.03	-0.04	-0.08	-0.01	-0.00	--	--	-0.28	-0.27	-0.00	-0.01	0.07	0.12	0.01	0.04	0.01	0.07	-0.00	-0.01	-0.04	-0.08	0.02	-0.02	76.500	37.399	
Canada	0.00	0.00	-0.01	-0.07	-0.02	-0.03	0.00	0.01	-0.22	-0.24	0.02	0.05	0.03	0.09	0.00	0.03	0.00	0.00	-0.01	-0.02	-0.01	-0.06	0.05	0.03	28.046	19.710	
Japan	0.00	0.01	-0.00	-0.02	-0.01	-0.02	0.00	-0.02	-0.09	-0.12	0.00	-0.00	0.02	0.08	0.00	0.01	-0.00	0.01	--	--	-0.00	-0.03	0.03	0.04	5.179	3.959	
Austria	-0.02	-0.04	-0.06	-0.15	-0.00	-0.01	-0.01	-0.03	-0.27	-0.27	-0.02	-0.09	0.04	0.04	-0.01	-0.02	-0.01	-0.04	--	--	-0.02	-0.06	0.02	-0.03	0.136	0.163	
Belgium	-0.09	-0.11	-0.07	-0.20	-0.16	-0.24	-0.01	-0.05	-0.50	-0.54	-0.01	0.04	0.11	0.19	-0.02	0.12	-0.01	-0.09	-0.02	-0.06	-0.03	-0.09	0.03	-0.09	1.582	1.286	
Denmark	-0.20	-0.65	-0.10	-0.34	-0.33	-0.56	-0.04	-0.20	-0.78	-0.92	0.04	-0.34	0.29	0.30	-0.12	-0.50	-0.20	-0.93	-0.06	-0.14	-0.03	-0.14	-0.02	-0.27	0.110	0.103	
France	-0.04	-0.13	-0.03	-0.11	-0.06	-0.08	-0.01	-0.08	-0.38	-0.43	-0.01	-0.06	0.08	0.04	-0.01	-0.07	-0.05	-0.22	-0.01	-0.03	-0.02	-0.09	0.02	-0.07	0.287	0.335	
Germany	0.01	0.00	-0.01	-0.04	-0.01	-0.03	0.01	-0.00	-0.29	-0.31	0.00	0.01	0.01	0.04	0.01	0.03	0.02	-0.00	-0.00	-0.01	-0.00	-0.00	-0.02	0.04	-0.02	0.215	0.178
Italy	0.00	-0.03	-0.04	-0.14	-0.07	-0.07	-0.02	-0.07	-0.29	-0.31	0.01	0.02	0.03	0.08	0.01	0.01	-0.01	-0.10	-0.01	-0.03	-0.02	-0.10	0.03	-0.04	25.972	14.941	
Netherlands	-0.03	-0.02	-0.03	-0.10	-0.04	-0.06	-0.00	-0.02	-0.41	-0.52	-0.01	-0.04	0.03	0.06	-0.01	0.08	-0.04	-0.02	-0.01	-0.03	-0.01	-0.04	0.02	-0.08	0.122	0.148	
Norway	-0.02	-0.18	-0.16	-0.26	-0.13	-0.16	0.04	0.07	-0.55	-0.50	-0.11	-0.34	0.02	-0.05	0.01	-0.07	--	--	-0.02	-0.05	0.02	0.05	-0.03	-0.62	0.112	0.067	
Sweden	-0.01	-0.14	-0.08	-0.39	-0.25	-0.40	0.23	0.19	-0.50	-0.51	0.03	-0.15	0.04	0.11	-0.00	-0.08	-0.01	-0.12	-0.04	-0.10	-0.00	-0.14	0.04	-0.16	0.139	0.050	
Switzerland	-0.03	-0.17	-0.02	-0.12	-0.06	-0.10	0.07	-0.09	-0.65	-0.92	0.03	0.12	0.12	0.19	0.02	0.01	-0.07	-0.52	-0.02	-0.06	0.01	-0.11	0.02	-0.05	0.060	0.085	
U.K.	-0.09	-0.70	0.45	2.02	0.00	-0.03	10.00	10.00	9.97	9.97	0.10	0.83	-0.22	-1.81	-0.23	-1.68	-0.03	-0.54	0.02	0.14	3.32	4.22	0.05	0.07	-652.246	-525.555	
Finland	-0.05	-0.19	-0.10	-0.27	-0.01	-0.02	-0.03	-0.12	-0.73	-0.88	-0.06	-0.36	0.08	-0.03	-0.02	-0.12	-0.04	-0.22	--	--	-0.06	-0.18	0.00	-0.23	43.665	54.954	

  

Trade Shares Endogenous <sup>b</sup>																											
Country	Real GNP		GNP Deflator		Short Term Interest Rate		Exchange Rate		Import Price		Money Supply		Imports		Consumption		Investment		Long Term Interest Rate		Export Price		Exports		Balance of Payments <sup>a</sup>		
	2	6	2	6	2	6	2	6	2	6	2	6	2	6	2	6	2	6	2	6	2	6	2	6	2	6	2
U.S.	0.00	0.02	-0.04	-0.09	-0.01	-0.01	0.00	0.00	-0.30	-0.29	-0.00	-0.00	0.06	0.11	0.01	0.04	-0.00	0.05	-0.00	-0.01	-0.04	-0.08	-0.07	-0.09	60.629	23.397	
Canada	-0.01	-0.00	-0.02	-0.08	-0.02	-0.03	0.00	0.01	-0.23	-0.24	0.01	0.05	0.02	0.07	0.00	0.02	-0.01	-0.00	-0.01	-0.02	-0.02	-0.08	0.00	0.00	27.579	18.121	
Japan	-0.02	-0.02	0.00	-0.00	0.00	-0.00	0.06	0.08	-0.04	-0.02	-0.01	-0.02	0.01	-0.00	-0.01	-0.01	-0.01	-0.03	--	--	0.04	0.05	-0.09	-0.06	-0.737	0.970	
Austria	-0.06	-0.09	-0.07	-0.18	-0.01	-0.03	0.02	0.01	-0.27	-0.26	-0.04	-0.13	-0.02	-0.01	-0.04	-0.04	-0.04	-0.08	--	--	-0.01	-0.04	-0.10	-0.14	0.147	0.167	
Belgium	-0.16	-0.14	-0.09	-0.24	-0.21	-0.29	-0.04	-0.02	-0.57	-0.53	-0.02	0.05	0.05	0.15	-0.06	0.12	-0.12	-0.13	-0.02	-0.07	-0.05	-0.08	-0.09	-0.16	1.776	1.227	
Denmark	-0.21	-0.73	-0.10	-0.40	-0.34	-0.60	-0.13	-0.19	-0.92	-0.94	0.04	-0.40	0.30	0.33	-0.12	-0.56	-0.21	-1.04	-0.06	-0.15	-0.08	-0.15	0.02	-0.25	0.136	0.102	
France	-0.08	-0.21	-0.03	-0.11	-0.07	-0.12	0.03	-0.06	-0.36	-0.43	-0.01	-0.09	0.04	-0.06	-0.03	-0.12	-0.11	-0.39	-0.01	-0.04	-0.01	-0.09	-0.07	-0.14	0.263	0.354	
Germany	-0.06	-0.06	-0.02	-0.08	-0.04	-0.10	0.05	0.02	-0.26	-0.30	-0.01	-0.00	-0.07	-0.03	-0.02	-0.00	-0.12	-0.11	-0.01	-0.04	-0.00	-0.03	-0.09	-0.14	0.170	0.112	
Italy	-0.04	-0.10	-0.04	-0.13	-0.05	-0.06	0.02	-0.03	-0.27	-0.29	-0.01	-0.03	-0.02	-0.03	-0.01	-0.03	-0.08	-0.28	-0.01	-0.03	-0.01	-0.08	-0.10	-0.13	22.333	16.989	
Netherlands	-0.06	-0.05	-0.03	-0.12	-0.08	-0.11	0.02	0.01	-0.42	-0.51	0.00	-0.03	-0.02	0.01	-0.03	0.07	-0.07	-0.05	-0.02	-0.05	0.01	-0.02	-0.06	-0.16	0.136	0.152	
Norway	0.03	-0.12	-0.17	-0.28	-0.15	-0.20	0.05	0.09	-0.58	-0.51	-0.09	-0.31	0.08	0.09	0.03	-0.01	0.00	0.00	-0.02	-0.06	0.04	0.06	0.17	-0.33	0.133	0.081	
Sweden	-0.00	-0.12	-0.07	-0.39	-0.25	-0.42	0.27	0.24	-0.48	-0.48	0.02	-0.11	0.03	0.16	-0.01	-0.06	-0.01	-0.11	-0.04	-0.10	0.02	-0.14	0.06	-0.07	0.137	0.057	
Switzerland	-0.07	-0.27	-0.03	-0.17	-0.06	-0.12	-0.02	-0.13	-0.80	-0.98	0.03	0.14	0.04	0.08	-0.00	-0.05	-0.17	-0.85	-0.02	-0.08	-0.03	-0.15	-0.08	-0.14	0.073	0.087	
U.K.	0.62	-0.15	0.48	2.13	0.07	0.15	10.00	10.00	9.96	9.95	0.39	1.24	0.88	-0.66	0.27	-1.10	0.56	-0.15	0.03	0.21	3.33	4.29	2.11	1.77	-602.759	-481.566	
Finland	-0.06	-0.17	-0.10	-0.28	-0.01	-0.02	-0.01	-0.11	-0.75	-0.90	-0.08	-0.36	0.08	0.00	-0.03	-0.11	-0.05	-0.21	--	--	-0.04	-0.18	0.00	-0.18	48.812	58.345	

<sup>a</sup>See Table 5.

<sup>b</sup>See Table 5.

provided in Fair (1981a, 1981b). For present purposes the discussion will be limited to two effects: the effect on the balance of payments and the effect on GNP. The initial effect of a depreciation on the balance of payments is likely to be negative in the model. Depreciation raises the local currency price of imports more than it does the local currency price of exports, which, other things being equal, has a negative effect on the balance of payments. Depreciation also lowers imports and raises exports, which has a positive effect on the balance of payments. This latter effect is likely to be smaller initially than the price effect, and so the initial net effect is likely to be negative. (This is the "J curve" effect.) This is true of the results in Tables 5 and 6, where the changes in the balance of payments of Germany in Table 6 and of the U.K. in Table 7 are negative. The balance of payments falls less when the trade shares are endogenous because the changes in exports are greater. In the endogenous trade share case, the share of the depreciating country's exports in other countries' imports rises because of the fall in the relative price of the depreciating country's exports. This is the first main difference between the two cases.

Depreciation has three main effects on GNP in the model, two positive and one negative. The first effect is through the price of imports. Depreciation raises the price of imports, which has a negative effect on the demand for imports, which has a positive effect on GNP. In other words, an increase in the price of imports causes substitution from imports to domestically produced goods, which raises GNP. The second effect is through the price of exports. Depreciation lowers the foreign currency price of exports. If trade shares are endogenous, this increases the demand for the country's exports, which raises GNP. Although this effect is

lacking when trade shares are exogenous, there is still at least a slight increase in the country's exports, other things being equal. The decrease in the price of exports lowers the import price indices of countries that import from the given country, which in turn increases their demand for imports. Some of this increase in demand (even with trade shares exogenous) is an increase in demand for the given country's exports.

The third effect is through the balance of payments. If depreciation lowers the balance of payments, this decreases the country's net foreign assets, which in the model decreases the demand for imports and consumption and increases the short term interest rate. Although the decrease in imports raises GNP, the decrease in consumption and the increase in the interest rate lower GNP, and the net effect is likely to be negative.

Although the net effect of a depreciation on GNP can go either way, it is more likely to be positive when trade shares are endogenous than when they are exogenous. The positive export effect is larger in the endogenous case and the negative balance of payments effect is smaller (because the decrease in the balance of payments is smaller). This is in fact the case in Tables 5 and 6. In the German experiment with trade shares exogenous, GNP fell by 0.16 percentage points after two quarters and 0.63 percentage points after six quarters. With trade shares endogenous, GNP rose by 0.72 percentage points after two quarters and 0.20 percentage points after six quarters. In the U.K. case with trade shares exogenous, GNP fell by 0.09 and 0.70 in the two quarters, respectively. With trade shares endogenous, GNP rose by 0.62 after two quarters and fell by 0.15 after six quarters.

The differences in the results between the endogenous and exogenous trade share cases are larger in the depreciation experiments just reported

than they are when the experiment is a change in government spending or in monetary policy. Changes in fiscal and monetary policy do not change the relative price of a country's exports nearly as much as does a depreciation, and so the results are obviously less sensitive to the treatment of trade shares.

## VI. Conclusion

The results in Table 2 indicate that relative prices have an important effect on trade shares. The sensitivity of trade shares to relative prices thus appears to be an important channel through which a country's price of exports affects the demand for its exports. This channel is evident in the multicountry model discussed in Section V, where the addition of the trade share equations has noticeable effects on the properties of the model regarding the effects of a depreciation.

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