THE INFORUM-IIASA TRADE MODEL: AN INTERIM REPORT

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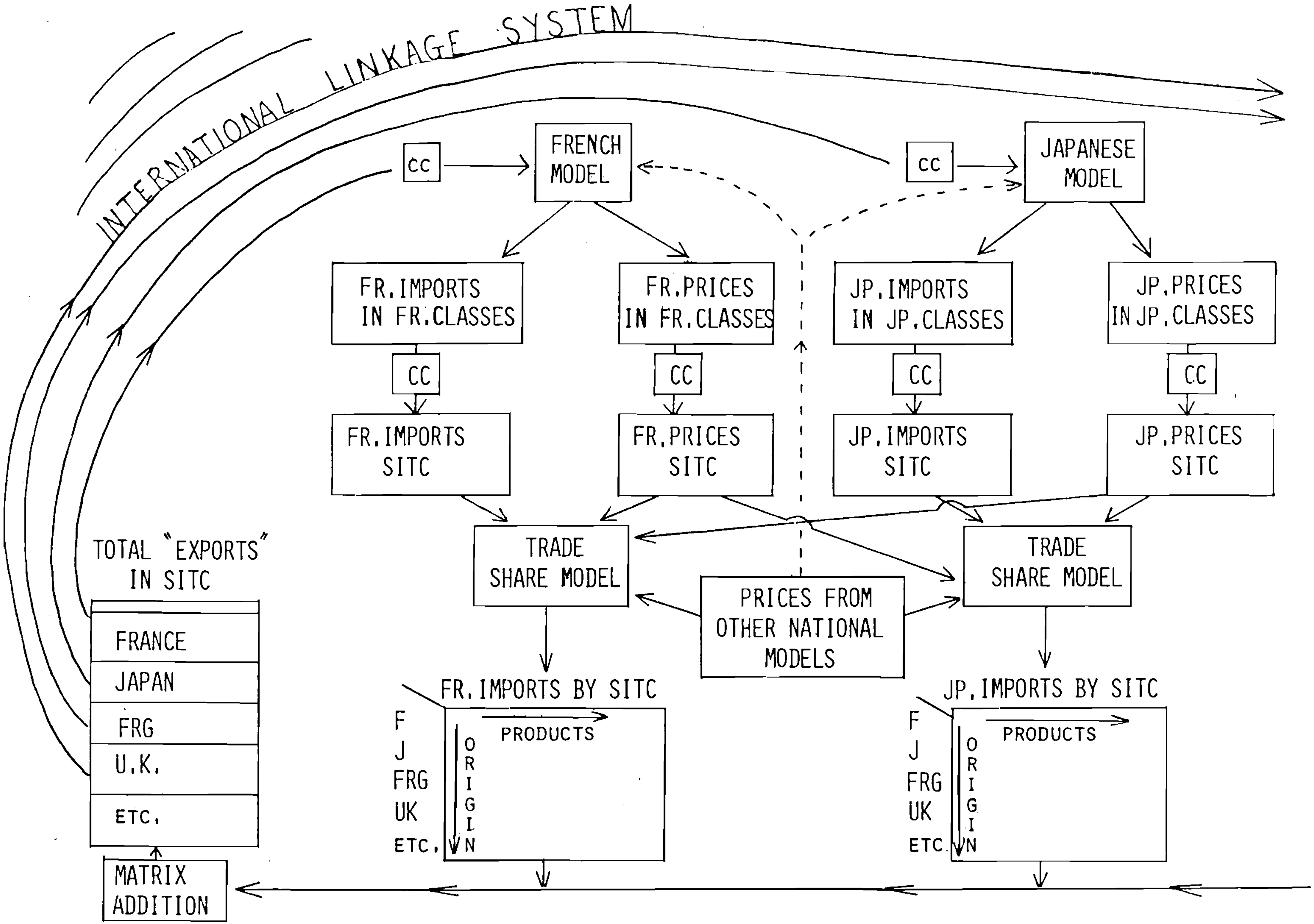
An initial version of the INFORUM-IIASA international trade model for the linkage of national input-output models was completed some years ago. For many people, the linkage model still remains the most interesting part of the system of input-output models being jointly developed by the Interindustry Forecasting Project of the University of Maryland (INFORUM), IIASA and several other cooperating institutions.

A brief overview of the system of models is presented first in Section 1. A review of the model and the results obtained from its empirical estimation and simulation is presented in Section 2. The most complete report is contained in Nyhus(75); less elaborate presentations are in Nyhus(78) and Almon,Nyhus(77). Section 3 gives some thoughts on how that model may be improved. Section 4 presents a method for the linkage problems encountered in the transference of data from the national models to the trade model.

1. AN OVERVIEW OF THE INTERNATIONAL TRADE LINKAGE SYSTEM

Figure 1 shows in block form the linkages in the system of models. We begin with the blocks labeled "French model" and "Japanese model". These two blocks are representatives of the national models. Each national model makes a forecast in its own


INTERNATIONAL LINKAGE SYSTEM
CC
FRENCH MODEL
CC
JAPANESE MODEL
FR.IMPORTS IN FR.CLASSES
FR.PRICES IN FR.CLASSES
JP.IMPORTS IN JP.CLASSES
JP.PRICES IN JP.CLASSES
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FR.IMPORTS SITC
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TOTAL "EXPORTS" IN SITC
FRANCE
JAPAN
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ETC.
TRADE SHARE MODEL
PRICES FROM OTHER NATIONAL MODELS
TRADE SHARE MODEL
FR.IMPORTS BY SITC
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currency and in its own classification scheme. Thus, the French model has 91 sectors and is based on a 1976 input-output table; the Japanese, 156 sectors with a 1970 table, the Belgian, 50 sectors based in 1970 and so on. Each of these models makes projections year by year to 1990 of personal consumption expenditures by spending category, government purchases by product and so on. In particular, forecasts of imports and domestic prices are produced in the national classification system. These values then pass through a classification conversion process described by the box "cc" to get imports and prices according to the Standard International Trade Classification (SITC) for a standard list of 119 products. The trade model then allocates the "given" imports among exporters using prices and trends to adjust base year export shares. Matrix addition of the bilateral trade flows gives total "exports" in the SITC classification by product. The trade model also gives "world prices" as seen by each importing country for each product. Once again a classification conversion scheme is used to convert exports and prices from the trade model to the national model. The exports are then used as exogenous variables in the national model. Further, world prices are used in the calculation of domestic prices as they enter through as the cost of imported materials and in the import functions where the models decide the proportion of demand to be supplied by imports and the proportion to be supplied by domestic producers.

A short example may help illustrate the basic working of the system. Suppose there is an exogenous increase in government purchases in France. The increased final demand will generate increased outputs and import demands for France. Further, French domestic prices will rise faster than before because of a tighter labor market. These influences are then transferred to the trade model. There, the increased French domestic prices will reduce France's export shares and hence its exports. Other countries' exports are increased because of substitution of their goods for French ones and also because of increased French demand for their goods. The French model is now solved once again using the new lower export demands. The lower exports will in turn lessen the tightness in the labor market and hence domestic prices will be less than on the first iteration. Other countries will see their own import demands change. The direction is, however, uncertain because two opposing factors will be acting on their import demands. The positive factor occurs because the increased exports causes the economy to be larger and hence there is a need for more imported goods. The negative factor is that these imports will cost more and so the economy may well substitute domestically produced goods for imported ones. This description is necessarily incomplete and does not reflect the full interactions but it does show the main factors at work in the system.

2.1 EXISTING TRADE MODEL

The trade model, current estimated (Nyhus,75) and simulated (Nyhus,78), is an econometric model of world trade for 119 categories of merchandise trade. The model focuses on forecasting exports by commodity for nine major developed market economies (Canada, USA, Japan, Belgium, France, Federal Republic of Germany, Italy, Netherlands and the United Kingdom) and a rest of the world region. It takes total imports and domestic prices of each country for each commodity as given and then allocates these imports to suppliers.

The basic points of reference for the analysis are trade flow matrices, M, one for each of the 119 commodities for each of the years 1962-1972. (The data has now been extended to 1975.) Each M is square and has as many rows or columns as there are countries in the model. The i^{th} row of M expresses the exports of country i to each of the other countries. The diagonal elements are all zero, except for our tenth country, a region called the "rest of the world" (or more simply "Others") where the remaining countries are aggregated together into one region to obtain intra-regional flows. Thus, the total imports of country j are given by the column sum, $M_{.j} = \sum_i M_{ij}$, and the total exports of country i by the row sum, $M_{i.} = \sum_j M_{ij}$. The matrix of market shares S_{ij} is thus obtained by dividing each column of M by its column sum. Hence, S_{ij} is the proportion of goods from country i in country j's imports.

Predicting the S matrix is the main burden of the trade model. The basic equation we shall use for doing so is:

$$(2.1.1) \qquad S_{ijt} = S_{ijo}\, P_{ijt}^{\,b_{ij}}$$

where

P_{ijt} = the effective price of the good in country i, p_{eit}, relative to the world price as seen from country j p_{wjt}. Mathematically, we could write $P_{ijt}=p_{eit}/p_{wjt}$

Note that the exponent, b_{ij} may be different for each exporter i. This is a significant generalization of previous formulation which had specified that the b's be the same for each exporter.

To insure that global exports equal global imports, the world prices as seen by country j, p_{wjt}, is defined implicitly by the simple requirement that the sum of the share of all countries in country j's imports should equal 1, thus:

$$(2.1.2) \qquad \sum_i S_{ijo} \, P_{ijt}^{\;b_{ij}} = \sum_i S_{ijo} \, (p_{eit}/p_{wjt})^{b_{ij}} = 1$$

Equation (2.1.2) is linearly homogenous in the prices. Suppose all domestic prices, p_{eit} are doubled; then a doubling of the world price, p_{wjt}, will leave the price ratio undisturbed. Another property of the definition of the world price is that the ratio of the shares of any two countries will change if a third country changes its price (provided neither country's share is zero and both do not have identical b's).

Equation (2.1.1) can also be written in terms of trade flows as:

$$(2.1.3) \qquad M_{ijt} = S_{ijo} \, M_{.jt} \, P_{ijt}^{\;b_{ij}}$$

The equality of exports and imports can easily be seen by summing (2.1.3) over exporting countries i and using the world price defined by (2.1.2):

$$\sum_i M_{ijt} = \sum_i S_{ijo} M_{.jt} P_{ijt}^{b_{ij}}$$

$$= M_{.jt} \sum_i S_{ijo} P_{ijt}^{b_{ij}}$$

$$= M_{.jt}$$

This solution to the adding-up problem by the implicity definition of p_{wjt} should be noted carefully. The whole method rests on it.

One further aspect of equation (2.1.3) should be noted. The value flow, M_{ijt}, has been deflated by the exporting country's domestic price index. So we are dealing the volume flows. Note also that total imports of country j have been expressed (in volume terms) as the sum of all volume export exports to it. Therefore, the proper deflator for imports to j does not contain the domestic price index of j (except when $M_{ii} = 0$, i.e., for intra-regional flows).

The problem now is find a set of substitution parameters (b's) and a series of world prices which are consistent with conditions (2.1.1) and (2.1.2). A simple iterative procedure was planned whereby values for the b's would be assumed and then (2.1.2) would be used to solve for the world price. Then (2.1.1) would be used to estimate the b's, and then using those b's, so ran the plan, the world prices would be recalculated, and so on. Unfortunately, this procedure did not converge, and a little reflection made it clear that it could not. Suppose that among the first b's we calculate, Canada's comes out highest on the first solution. The Canadian price will then carry a heavier weight than previously in the world price of the second interation. On that iteration, the calculated world price will conform more closely to the Canadian price and, hence, an even higher value of the b for Canada will ensue.

After the failure of the simple procedure, a more complex non-linear estimation method was adopted. The non-linearity arises because the b's enter (2.1.1) not only directly, in the exponents, but also indirectly though the definition of the world price. The way out for us was to pick initial b_i and then find the b_i which would minimize

$$(2.1.4) \qquad \Sigma_t \, \Sigma_t \, (S_{it} - S_{io} \, \Sigma \frac{\partial}{\partial b_k} \, \frac{P_{it}^{b_i}}{P_t} \, \Delta b_k)^2$$

In taking the partial derivatives required here it is essential that the dependence of p_w on the b_k, be incorporated in the derivative. The value of Δb_k is then used to modify the b_k, and the process is repeated until it converges in the sense that the world price of one iteration differs by an arbitrarily small amount from that of the previous iteration. With this procedure, convergence ceased to be a problem.

One further aspect of (2.1.1) needs to be noted. The effective price, p_{eit}, used thus far is defined as a weighted average of present and past domestic prices.

$$(2.1.5) \qquad P_{eit} = \sum_{r=0}^{5} w_r \, P_{it-\tau}$$

It is assumed that the weights, the w's, will vary from commodity to commodity; but, for a given commodity, will be the same for each importer. Data limitations are very constraining in this case. To estimate six lag weights for one country with eleven years of data is simply not a reasonable procedure; but estimate those weights for all ten countries means we have 110 observations.

For non-price effects, a simple trend term was added to (2.1.1). The resulting form,

$$(2.1.6) \qquad M_{ijt} = S_{ijo}\, M_{.jt}\, P_{ijt}^{\,b_{ij}} + g_{ij}\, t$$

estimates the b's and the world prices and then the trend parameters, the g's, are estimated for the residuals. Since each g is estimated independently, they will not automatically sum to zero. If an adjustment to the g's is needed, then those with the best fit should be adjusted proportionally less than those with poor fits. Each g was adjusted in proprotion to its standard error so that a zero sum was obtained.

2.2 SUMMARY OF RESULTS FROM EMPIRICAL ESTIMATION

2.2.1 PRICE ELASTICITIES BY COUNTRY

Table 1 presents the trade share price elasticities for each of the countries in the model. For example a 1% Canadian price decrease produces a -.09% decrease in the United States' exports through a shrinkage in the American trade shares. (Note that total imports are assumed to be unchanged by the Canadian action for the purposes of the model and so here we see only the effects generated by changes in the shares themselves.)

Table 1. Percent change in total exports caused by one percent price decrease.

	CANADA	UNITED STATES	JAPAN	BELGIUM	FRANCE	GERMANY (FRG)	ITALY	NETHERLANDS	UNITED KINGDOM	OTHERS
CANADA	2.03	-0.09	-0.35	-0.07	-0.09	-0.14	-0.05	-0.05	-0.08	-0.12
UNITED STATES	-0.15	1.44	-0.54	-0.19	-0.17	-0.24	-0.26	-0.20	-0.24	-0.17
JAPAN	-0.59	-0.36	3.62	-0.19	-0.19	-0.39	-0.32	-0.25	-0.44	-0.23
BELGIUM	-0.07	-0.07	-0.11	2.46	-0.11	-0.19	-0.16	-0.20	-0.09	-0.09
FRANCE	-0.11	-0.09	-0.17	-0.17	1.60	-0.12	-0.15	-0.24	-0.08	-0.10
GERMANY (FRG)	-0.35	-0.22	-0.64	-0.50	-0.22	2.01	-0.33	-0.42	-0.36	-0.20
ITALY	-0.05	-0.13	-0.23	-0.20	-0.12	-0.15	2.90	-0.22	-0.12	-0.17
NETHER-LANDS	-0.04	-0.08	-0.17	-0.22	-0.18	-0.19	-0.22	2.47	-0.13	-0.12
UNITED KINGDOM	-0.13	-0.14	-0.45	-0.14	-0.08	-0.20	-0.16	-0.18	2.14	-0.08
OTHERS	-0.50	-0.37	-0.92	-0.54	-0.38	-0.47	-0.81	-0.66	-0.36	1.14

2.2.2 DISTRIBUTED LAGS ON PRICES

Three general statements can be made concerning the estimated emperical lags. The first is that the lags are relatively long. Prices have substantial effects on trade even after three years. As the table below shows,

Table 2
PROPORTION OF TOTAL PRICE EFFECT

After Year	>.5	>.67	>.9
1	23	8	0
2	43	22	2
3	75	38	4
4	102	92	40

only 40 of the 119 categories had 90% or more of their total price effect even after four years. The second statement is that the lags for crude or basic materials are shorter than the lags for manufactured products. For example shorter lags were obtained for Unmilled Grains (Trade sector 4) and Crude Rubber(15)) than for Milled Grains(5) and Rubber Manufactures(38). The third statement is that the lags on consumer products are shorter than those on producer items. For example the lag on Auto Bodies(97) is longer than that for Personal Autos(95) and the same is true for Leather(14) vs. Shoes(107) .

2.2.3 FIT OF THE EQUATIONS

2.2.3.1 FITS BY IMPORTER

The error measure that was chosen emphased that the primary purpose of the model was share estimations. Accordingly the measure, EITS, Errors in the Shares, is defined by

$$(2.2.1) \qquad EITS_{jt} = \left(\sum_{i=1}^{n} |S_{ijt} - \hat{S}_{ijt}| \right) / 2$$

where

S_{ijt} is the estimated share of imports to j coming from i in year t,

S_{ijt} is the actual share and,

N is the number of countries in the model.

The division by two occurs because the constraint that the sum of all shares is unity implies that an error in one share by necessity generates an equal and opposite error elsewhere.

EITS alone, however, does not really give us a measure of how well the model performed. Assuming constant shares as an alternative model, how much does our model improve the EITS measure of fit. Figure 1 shows the distribution of the ratio of Equation EITS to constant share EITS for all countries and commodies. A glance at the figure shows that our equation removed about half, perhaps a little less, of the errors which a constant share model generated.

2.2.3.2 FITS BY EXPORTER

The fit of the object of the model--forecasts of exports--was measured by the Average Annual Percentage Errors (AAPE). They were calculated for both the model equation and for constant shares. The export weighted averages by country are shown below in Table 3.

Table 3
FITS BY EXPORTER

	Model AAPE	Constant Share AAPE	Ratio of Model to Constant Share AAPE
Canada	16.9	25.0	.675
USA	10.6	16.1	.656
Japan	19.0	55.0	.345
Belgium	22.0	40.4	.545
France	11.6	18.5	.626
Germany(FRG)	8.2	15.2	.538
Italy	16.1	24.1	.667
Netherlands	16.3	28.3	.576
United Kingdom	17.2	23.3	.737
Others	7.2	13.1	.548
Average of all	12.0	20.6	.583

The table shows that the model improves the fit for the "larger" exporters more than that for the "smaller", a logical result, given the model and the estimation procedure which minimized the squared flow errors.

3. THOUGHTS ON FUTURE EXTENSIONS TO AND IMPROVEMENTS ON THE MODEL

The exporter or supply side of the bilateral trade flow model described in section 2 has had little attention given to it beyond its price setting function. We have neglected factors such as domestic capacities to export and export pecuniary and non-pecuniary incentives.

The exclusion of relative industrial capacity has been noted as a shortcoming before (Nyhus, 75,p.95) The reason for exclusion at that time was the cost of obtaining the necessary data on industrial outputs and capacities. Now that many more of the national models have been constructed that is no longer an obstacle. The exact method of doing so has yet to be worked out. Two different methods are suggested here. The first is to work through the price system. If the price sensitiveness to industrial capacity can be estimated, then iterating between the national model for prices and the trade model as it already exists should be sufficient. That is, if a given export demand generated by the trade model results in little or no excess capacity in a particular industry, then prices rise in that industry. The resulting higher prices, produce, in the trade model, less export demand than on the previous iteration. Another formulation is to have capacities work directly on the trade shares themselves. The methods are not mutually exclusive and either or both may prove useful.

Export pecuniary incentives have been widely discussed (Wulf,78, Balassa,78). These range over a wide spectrum of policies such as a reduction of income taxes for export earnings to no import duties for imported materials used in the manufacture of exports. These policies are country specific, and, I believe, best handled in the individual country price models. For example, after domestic prices have been calculated, export subsidies, treated as a negative value-added component, can be used to alter the domestic price indices to compute export price indices to be used in the trade model.

Export non-pecuniary incentives range from less government bureaucratic red tape for export production (Wulf,78) to psychological factors necessitating an outward looking trade policy (See, for example, Fouquin & Lafay's "will to conquer markets",(75) and Balassa's "city-state objective conditions" (78).) need attention and the author welomes comments on how such factors may be included in a practical fashion. At this time these factors will be represented by a trend factor.

4. THE LINKAGE AS A PRACTICAL STEP

4.1 The Linkage Problem

We have a national model of a particular country expressed in a national classification scheme and in national currency. In particular we have its exports, imports and domestic prices expressed in this national scheme. On the other hand, its exports are expressed in U.S. dollars with a standard international trade classification scheme in the trade model. In addition, the precise conversion from one classification system to the other is done at a level of detail either not known or not available to us. How can we convert from the international scheme to the national one without "losing" or "gaining" anything in the conversion? Two approaches are given. The first uses standard regression techniques with an adding up constraint attached. The second uses a classification conversion matrix in which the row sums match our trade model values and the column sums match our national model values. Of course, such a matrix is valid for only one year. Therefore, we estimate "discrepency functions" on the errors produced by the use of the matrix for other years.

4.2.1 Approach 1 : Direct estimation

We begin by choosing those international sectors which are most closely related to each national sector. All international sectors are allocated or assigned to a national sector. We then estimate a simple model

$$(4.2.1.1) \qquad x_{it} = a + b \sum_{j \in T_i} I_{jt} R_t + c \text{ time}$$

where

X_{it} is the exports for input-output sector i in year t expressed in national currency

I_{jt} is the exports for trade sector j in year t expressed in U.S. dollars

R_t is the exchange rate in national units per dollar in year t

T_i is the set of trade sectors "belonging" to I-Ø sector i

One immediate problem with such a model is that we know apriori that, for any year, the trade represented is the same. That is

$$(4.2.1.2) \qquad \sum_i X_{it} = \sum_j I_{jt} \; .$$

The direct imposition of the above constraint on the system would mean estimating all coefficients simultaneously. (In our example that would be 3x35 or 1Ø5 coefficients.) A simpler method for this approach is shown here. We observe the sum of errors for each year, then we adjust out predicted values such that the sum of errors is zero for each year. Thus we fulfill the requirement of (4.2.1.2). The weights for distributing the error sum are the standard errors of the estimates found in the unconstrained estimation. Expressed mathematically we perform the following calculation

$$(4.2.1.3) \qquad \hat{\hat{X}}_{it} = \hat{X}_{it} + \left(\sum_i (X_{it} - \hat{X}_{it})\right) \frac{SEE_i}{\sum_k SEE_k}$$

where

X_{it} is our estimated value of X_{it} and SEE_i is the standard error of the estimate for I-O sector i.

Table 4 shows the results of this first approach for the case of the Federal Republic of Germany. For each I-O sector we show the a,b,c, coefficients and the t-values which resulted from the unconstrained estimation. The columns headed "see" is the standard error of the estimated and next column "rbarsq" is the R^2 of the unconstrained estimation. The next column "c-rbarsq" shows the effect of constraining the sum of residuals on the fit. The last column is provided as a reference for the size of the flow involved. Only two small sectors had c-rbarsq's of less than .9 . Nevertheless we can see some drawbacks to this simple approach. Why, for example, should Plastics(10) be driven by a trade model flow approximately five percent of the value of the I-O flow? Even if the fit is relatively good we can clearly see that we may have a problem in forecasting using such an equation. This difficulty leads us directly to the next approach.

4.2.2 Approach 2: Indirect estimation

This approach involves find a matrix C such that

$$(4.2.2.1) \qquad \sum_j C_{ijo} = X_{jo}$$

$$(4.2.2.2) \quad \sum_i C_{ijo} = I_{jo}$$

We then perform the following calculations

$$(4.2.2.3) \quad D_{it} = X_{it} - \sum_j \left(C_{ijo}/I_{jo} \right) I_{jt}$$

where D_{it} is the discrepancy (D is zero in year o.)

and estimate the model

$$(4.2.2.4) \quad D_{it} = a + b \text{ time} + c\left(\sum_i \left(C_{ijo}/I_{jo} \right) I_{jt} \right)$$

subject to

$$(4.2.2.5) \quad \sum_i D_{it} = \sum_i \hat{D}_{it}$$

Thus, this second approach is primarily an extension of the first only now we try to define more clearly the set T_i . The results will become embodied in our estimate of C.

Our second approach, which extends and refines the concept of the international trade variable I of the first one, constrains the coefficient on the trade model variable to unity. For this reason the second approach cannot be considered to be a better predictor in all cases.

The results of this second approach are shown in Table 5. Let us compare tables 4 and 5. The sum of the standard errors of the estimate is 4877; that of Table 5 3754 or 2.1% and 1.6%, respec-

Table 4: Approach 1

	sector	constant	t-value	I	t-value	time	t-value	see	rbarsq	c-rbarsq	1975 value
1	agriculture	225.8	(3.38)	0.3974	(4.57)	68.02	(4.01)	97.50	0.9667	0.9658	2079.
3	natural gas cons	13.3	(2.37)	0.1454	(1.25)	-0.09	(-0.30)	4.07	-0.0344	-0.2563	23.
5	coal mining	10.4	(0.33)	0.8526	(53.27)	2.94	(0.84)	33.63	0.9977	0.9971	3840.
6	other mining	155.7	(5.25)	0.2102	(2.84)	10.27	(1.95)	42.37	0.8096	0.7721	620.
8	chemicals	746.3	(1.81)	1.1096	(15.07)	-133.02	(-0.93)	639.04	0.9928	0.9922	29243.
9	petroleum produc	71.0	(4.99)	0.8205	(53.87)	-6.21	(-2.23)	22.07	0.9983	0.9983	2100.
10	plastics	-453.0	(-1.69)	19.5381	(4.01)	25.32	(0.23)	418.88	0.9421	0.9292	6228.
11	stone and clay p	-189.6	(-4.46)	0.4638	(9.69)	-27.75	(-2.19)	51.87	0.9795	0.9736	1671.
12	glass	156.4	(9.08)	1.8609	(29.53)	12.66	(2.96)	17.74	0.9988	0.9988	2382.
13	iron and steel	-61.0	(-0.13)	1.6886	(13.88)	109.93	(1.13)	738.65	0.9812	0.9759	21677.
14	nonferrous metal	-36.2	(-0.44)	1.0748	(17.87)	18.30	(0.99)	121.10	0.9912	0.9888	4531.
15	wrought steel	10.5	(0.48)	0.0466	(8.17)	7.17	(1.34)	33.71	0.9682	0.9649	920.
16	steel products	-222.7	(-2.63)	2.3115	(11.98)	-42.58	(-2.09)	132.54	0.9712	0.9692	3714.
17	nonroad vehicles	159.8	(0.63)	3.2162	(4.04)	105.34	(1.96)	378.60	0.9018	0.9020	5817.
18	machinery	-1532.3	(-4.44)	1.9251	(25.60)	129.33	(1.27)	439.72	0.9981	0.9973	45460.
19	road vehicles	154.0	(0.68)	0.7407	(17.83)	332.50	(3.83)	304.49	0.9981	0.9974	30391.
21	computing machin	1.4	(0.05)	0.9937	(21.32)	6.85	(0.54)	41.02	0.9984	0.9983	3566.
22	electrical machi	74.0	(0.32)	0.5833	(16.88)	186.15	(2.46)	353.11	0.9957	0.9950	22556.
23	special tooling	511.8	(5.30)	0.4623	(5.62)	4.27	(0.12)	141.37	0.9763	0.9785	4816.
24	sports equipment	773.1	(3.15)	0.9789	(6.97)	22.53	(0.32)	240.64	0.9840	0.9853	9320.
25	wood and timber	100.0	(6.58)	0.7145	(35.77)	10.30	(2.06)	23.06	0.9989	0.9986	2765.
26	paper and paper	-39.6	(-1.86)	0.9712	(36.57)	5.63	(0.98)	32.89	0.9983	0.9980	2571.
27	printing	105.4	(7.04)	0.2738	(8.22)	30.14	(4.38)	23.52	0.9946	0.9939	1422.
28	leather products	231.2	(4.27)	0.1582	(1.14)	38.48	(3.25)	39.77	0.9583	0.9660	929.
29	textiles	-290.6	(-2.01)	0.5267	(7.82)	96.71	(1.75)	212.17	0.9883	0.9857	7169.
30	clothing	-122.7	(-3.17)	1.0526	(9.53)	-72.70	(-3.12)	57.82	0.9895	0.9884	2332.
31	food, nes	-118.8	(-1.19)	1.2306	(13.35)	58.69	(2.58)	149.76	0.9873	0.9884	4537.
32	dairy products	6.2	(0.58)	1.0249	(71.06)	1.49	(0.61)	13.46	0.9996	0.9994	2354.
33	meat products	61.3	(1.47)	0.6101	(5.73)	-10.64	(-0.64)	59.86	0.9653	0.9577	1391.
34	beverages	11.6	(2.59)	0.8593	(21.45)	0.82	(0.58)	6.85	0.9965	0.9961	537.
35	tobacco	-6.9	(-1.74)	1.0875	(19.16)	-0.47	(-0.47)	6.12	0.9924	0.9896	326.

Table 5: Approach 2

sector	constant	t-value	time	t-value		t-value	see	rbarsq	c-rbarsq	1975 value
1 agriculture	54.8	(0.65)	73.3545	(2.87)	-0.47	(-2.41)	128.14	0.3395	0.9431	2079.
3 natural gas cons	13.6	(2.50)	-0.1297	(-0.40)	-0.53	(-1.38)	4.08	0.0529	-0.1799	23.
5 coal mining	98.0	(2.54)	-5.3612	(-1.16)	0.00	(0.10)	43.12	0.0327	0.9948	3840.
6 other mining	131.6	(4.17)	6.3077	(1.08)	-0.53	(-3.62)	40.20	0.6691	0.8607	620.
8 chemicals	-95.6	(-0.22)	-289.3051	(-1.82)	0.15	(1.85)	666.25	0.1007	0.9908	29243.
9 petroleum produc	37.5	(2.64)	-4.4969	(-1.64)	0.04	(1.98)	21.90	0.1297	0.9978	2100.
10 plastics	-152.0	(-1.60)	91.9110	(3.45)	-0.23	(-4.35)	147.74	0.5866	0.9947	6228.
11 stone and clay p	-109.1	(-4.61)	-2.3997	(-0.38)	0.04	(0.57)	32.70	-0.1343	0.9920	1671.
12 glass	310.1	(5.98)	27.5531	(1.83)	-0.21	(-2.01)	65.11	0.1389	0.9787	2382.
13 iron and steel	556.8	(3.61)	-1.8935	(-0.06)	0.00	(0.18)	240.58	-0.1747	0.9973	21677.
14 nonferrous metal	-19.8	(-0.24)	3.4996	(0.18)	0.01	(0.15)	121.38	-0.1342	0.9885	4531.
15 wrought steel	-45.4	(-2.00)	-1.3935	(-0.23)	0.01	(0.10)	32.17	-0.1674	0.9729	920.
16 steel products	-627.2	(-3.33)	-103.0765	(-1.89)	0.39	(1.50)	260.78	0.1399	0.9013	3714.
17 nonroad vehicles	318.4	(5.35)	-4.5742	(-0.29)	-0.03	(-0.61)	92.80	0.1304	0.9933	5817.
18 machinery	23.8	(0.08)	258.7304	(2.65)	-0.06	(-1.65)	443.67	0.4619	0.9973	45468.
19 road vehicles	-546.1	(-3.06)	75.5801	(1.05)	-0.02	(-0.55)	219.15	0.2013	0.9988	10391.
21 computing machin	2.2	(0.08)	7.3918	(0.58)	-0.01	(-0.12)	41.17	0.1185	0.9979	3566.
22 electrical machi	-169.7	(-1.21)	131.8976	(2.81)	-0.05	(-1.62)	213.05	0.5352	0.9979	22556.
23 special tooling	443.6	(4.31)	3.1034	(0.08)	-0.17	(-1.37)	143.95	0.5810	0.9817	4816.
24 sports equipment	1190.4	(6.20)	-3.1750	(-0.05)	-0.10	(-0.79)	229.45	0.4170	0.9842	9320.
25 wood and timber	129.5	(8.25)	23.3802	(4.93)	-0.19	(-8.00)	23.46	0.8923	0.9991	2765.
26 paper and paper	-155.2	(-5.37)	-7.9415	(-0.94)	0.14	(3.15)	45.41	0.7062	0.9956	2571.
27 printing	103.2	(5.92)	32.9889	(4.21)	-0.45	(-5.51)	27.40	0.7808	0.9939	1422.
28 leather products	212.0	(3.81)	33.9919	(2.78)	-0.66	(-2.89)	38.42	0.3281	0.9575	929.
29 textiles	-372.0	(-2.49)	61.9271	(1.03)	-0.06	(-0.53)	213.72	0.1385	0.9857	7169.
30 clothing	-75.0	(-2.85)	-49.1040	(-3.45)	0.34	(3.54)	40.59	0.4473	0.9941	2332.
31 food, nes	-116.5	(-2.08)	-26.2641	(-1.67)	0.15	(3.11)	94.23	0.5563	0.9944	4537.
32 dairy products	8.5	(0.56)	-4.8834	(-1.37)	0.04	(1.80)	18.97	0.1181	0.9988	2354.
33 meat products	36.8	(0.89)	-15.6368	(-0.87)	0.07	(0.38)	61.18	0.1382	0.9624	1391.
34 beverages	11.6	(2.59)	0.8232	(0.58)	-0.04	(-0.93)	6.85	-0.0405	0.9962	537.
35 tobacco	1.2	(0.29)	-3.1425	(-2.61)	0.11	(1.85)	6.51	0.3349	0.9902	326.

tively, of the 1975 level of trade. The SEE was lower in sixteen cases for Approach 1 and in fifteen for Approach 2. There was no systematic improvement of Approach 2 over Approach 1 by type. Most of the largest categories of export (Iron and Steel(13), Transportation Equipment(17and19) and Electrical Machinery(22) preferred Approach 2 by a substantial margin. Those that preferred approach 1 (Chemicals(8) and Machinery(22)) did so only slightly. The results indicate that improvement in the specification of the C matrix is useful but that neither approach is dominant.

The second approach was also used for the conversion of FRG imports from the national to the trade model. In so doing we developed a matrix C^m.

4.3 Further Uses of the C matrices

The matrices, C and C^m, developed for the export and import linkages also provide us with a method for the price conversion to and from the trade model. For example, we will now define the domestic price for country A in trade sector I in year t as

$$(4.3.1) \qquad {}^{T}P_{A_i}^{t} = \sum_{j=1}^{N} \left(C^m_{ij}/C^m_{ij}\right) P^{Dt}_{Aj} \qquad i = 1,2,\ldots,119.$$

and to convert the world prices of the trade model to import prices for use in the domestic models we have

$$(4.3.2) \qquad P_{Aj} = \sum_{i=1}^{119} \left(C_{ij}/C_i\right) P^t_{wi} \qquad j = 1,2,\ldots,N$$

4.4 Future Developments

It is well to state now that the C matrices derived above can and will be substantially improved upon in the future. For the example above no specific knowledge was called for from the FRG to help us obtain the C matrix that was used. We used only our best guesses. The method is, however, a practical step in the linkage process. Work will now begin on developing C matrices for the other countries involved in the system.

REFERENCES

Almon, C. and Nyhus, D., The INFORUM International System of Input-output Models and Bilateral Trade Flows, Inforum Research Report No. 21, September, 1977

Balassa, B., Export Incentives and Export Performance in Developing Countries: A Comparative Analysis, Weltwirschaftliches Archiv, Band 1, 1978

Nyhus, D., The Trade Model of a Dynamic World Input-Output System, Inforum Research Report No. 14, July, 1975.

Nyhus, D., A Detailed Model of Bilateral Commodity Trade and the Effects of Exchange Rate Changes, in Econometric Contributions to Public Policy, ed. Richard Stone, Macmillan, London, 1978

Wulf, L., Fiscal Incentives for Industrial Exports in Developing Countries, National Tax Journal (XXXI,No.1), March, 1978