ADDITIONAL EVIDENCE OF COUNTRY SIZE AND WORLD TRADE: A TIME SERIES ANALYSIS OF CROSS-SECTIONAL DATA -- PROVISIONAL ESTIMATES

by

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The size of countries has been shown empirically to influence the degree of imports and exports within economies in a one-year period. [2, 4, 5] Authors seem to agree that there exists a negative relationship between size and exports and/or imports as percentages of GDP. Although this relationship of size of country to trade does play a role in explaining international trade, it is probably a very limited one, because there are a wide variety of other influences (such as political policy) on the trade patterns of individual countries. Therefore, caution must be exercised in making application of this phenomenon for prediction.

In Country Size and World Trade, I explained that population, GDP and commodity concentration or specialization, exert significant influence on the degree to which countries export. This is statistically significant and is logical when one considers the economies of scale arguments. However, before placing too much importance on a "general" theory of trade from these findings, it is feasible to analyze the results in other ways.

Certain problems arise when countries' trade patterns are judged on the basis of population, area or income alone, without reference to import demand patterns over time. (Initial findings

of the influence of country size on trade were usually made in one year periods of analysis.) These problems arise because some countries exhibit changes in patterns over time and these changes are not recognizable in one year analyses.

The point of this study is to analyze by cross-sectional data over time the import demand patterns of certain countries. The world is considered as a set of import-income patterns and countries which comprise subsets within that set are analyzed. Secondly, with the country size and world trade argument in mind, economic characteristics are shown for countries included in each subset.

METHODOLOGY

The per capita incomes and per capita imports of twenty-three developed countries were graphed for 1958-1971. This information was used to combine the countries into three testable groups (Table 1). The groups were formed primarily on the basis of observed breaks in import patterns as incomes increase and on observed import/income slopes. These breaks are marked in Figure 1 by the letters A, B, and C. Numbers represent countries.

Table 1

Group I	No.	Group II	No.	Group III	No.
Bel-Lux	2	Austria	1	Australia	22
Denmark	4	Finland	5	Canada	18
Iceland	23	Greece	8	France	6
Ireland	9	New Zealand	20	Germany	7
Netherlands	11	Portugal	13	Italy	10
Norway	12	Sweden	15	Japan	19
Switzerland	16			Spain	14
				United Kingdom	3

I hypothesize that these countries demand total imports in a manner which places them into a homogeneous group, and that each group differs distinctly in its income elasticity of demand for imports. (Income elasticity of demand for imports is the percentage change of imports associated with each one percent change in income.)

Simple linear regressions are run on each group for the period 1958-1971. The results are listed in Table 2. The regressions are shown in Figures 2, 3, and 4. The regressions were for all cases of the form $M = a + bY$ where M is per capita imports and Y is per capita income. These equations are listed below.

Table 2

Developed Countries

Linear	I	II	III
b_2	0.2876	0.2031	0.1577
r^2	0.8162	0.9530	0.9089
se	0.0138	0.0049	0.0047
k	77.84	20.2334	-25.8668
t	20.78	41.0429	33.30
F	431.85	1684.5193	1109.2504
DW	0.7494	1.0585	0.6507

Log	I	II	III
b	0.8557	0.9766	1.1687
r^2	0.8645	0.9740	.9306
s	0.0343	0.0174	0.0300
k	0.0113	-0.6008	-1.4025
t	24.90	55.8637	38.9031
F	620.12	3120.7578	1513.4539
DW	0.629	1.3345	0.6693

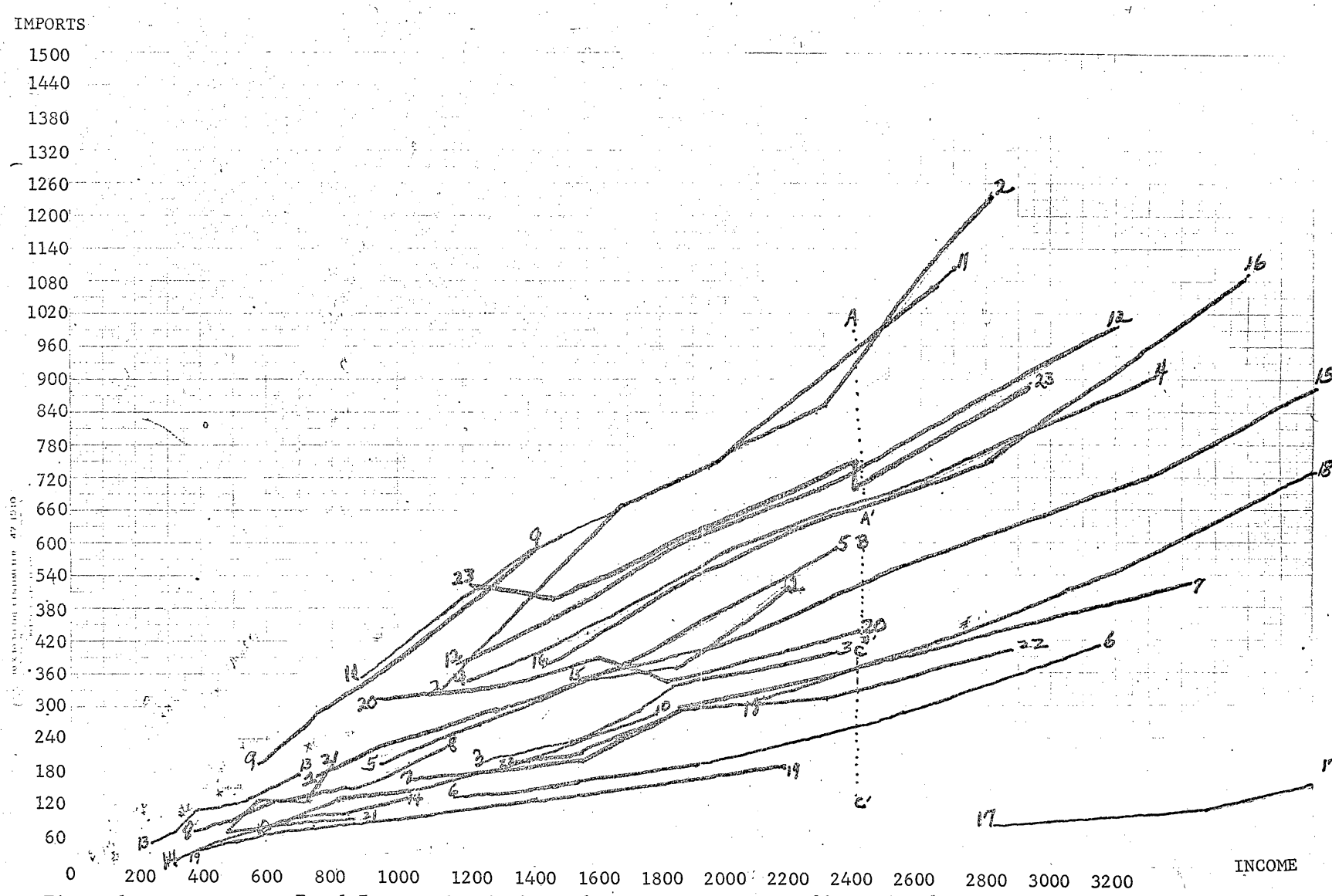


Figure 1. Total Imports Per Capita and Incomes Per Capita, 23 Developed Nations
(Points are multi-year 1958-1971 averages-58-60, 61-63, 64-66, 67-69, 70-71)

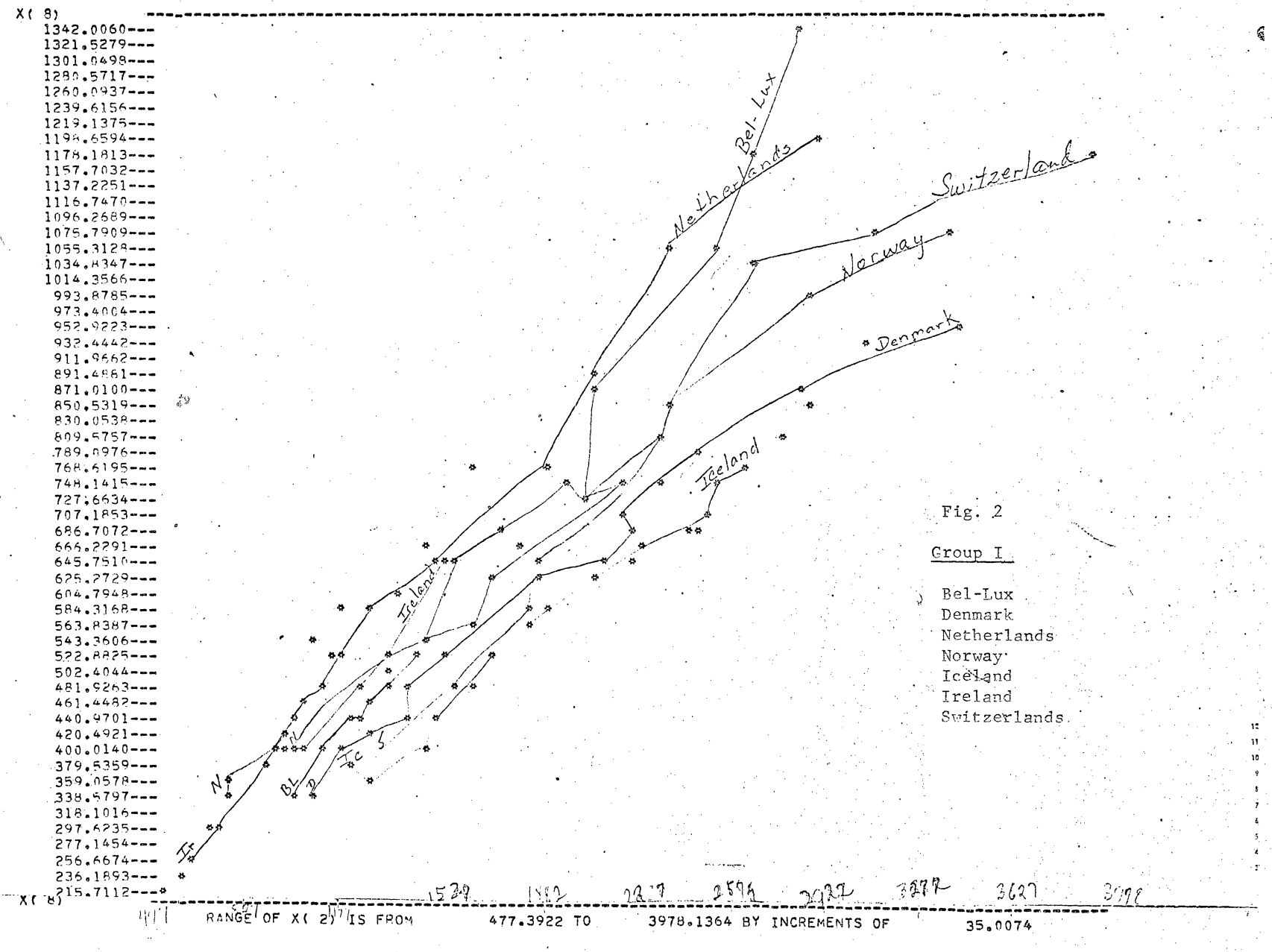


Fig. 2

Group I

Bel-Lux
Denmark
Netherlands
Norway
Iceland
Ireland
Switzerlands

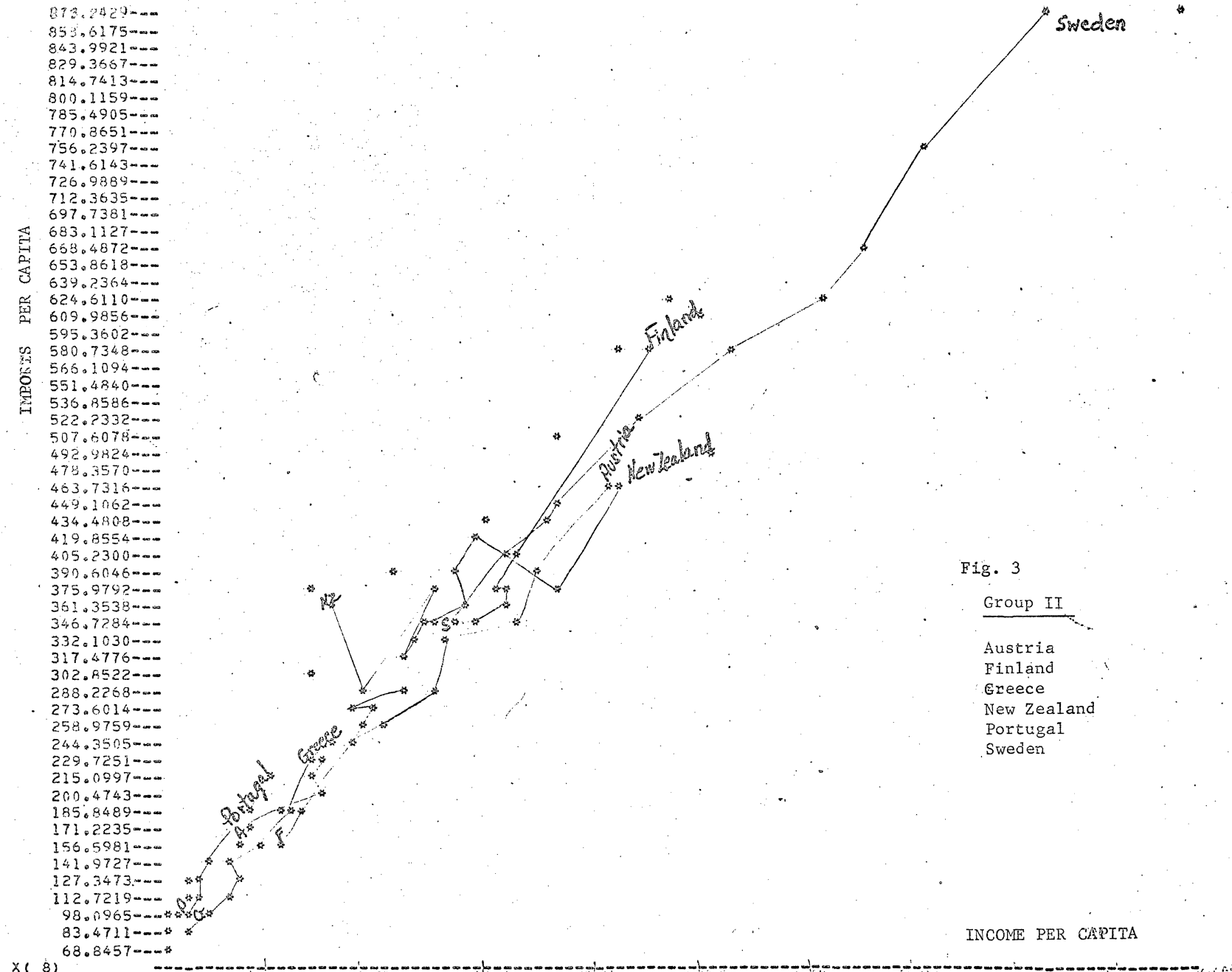


Fig. 3

Group II

Austria
Finland
Greece
New Zealand
Portugal
Sweden

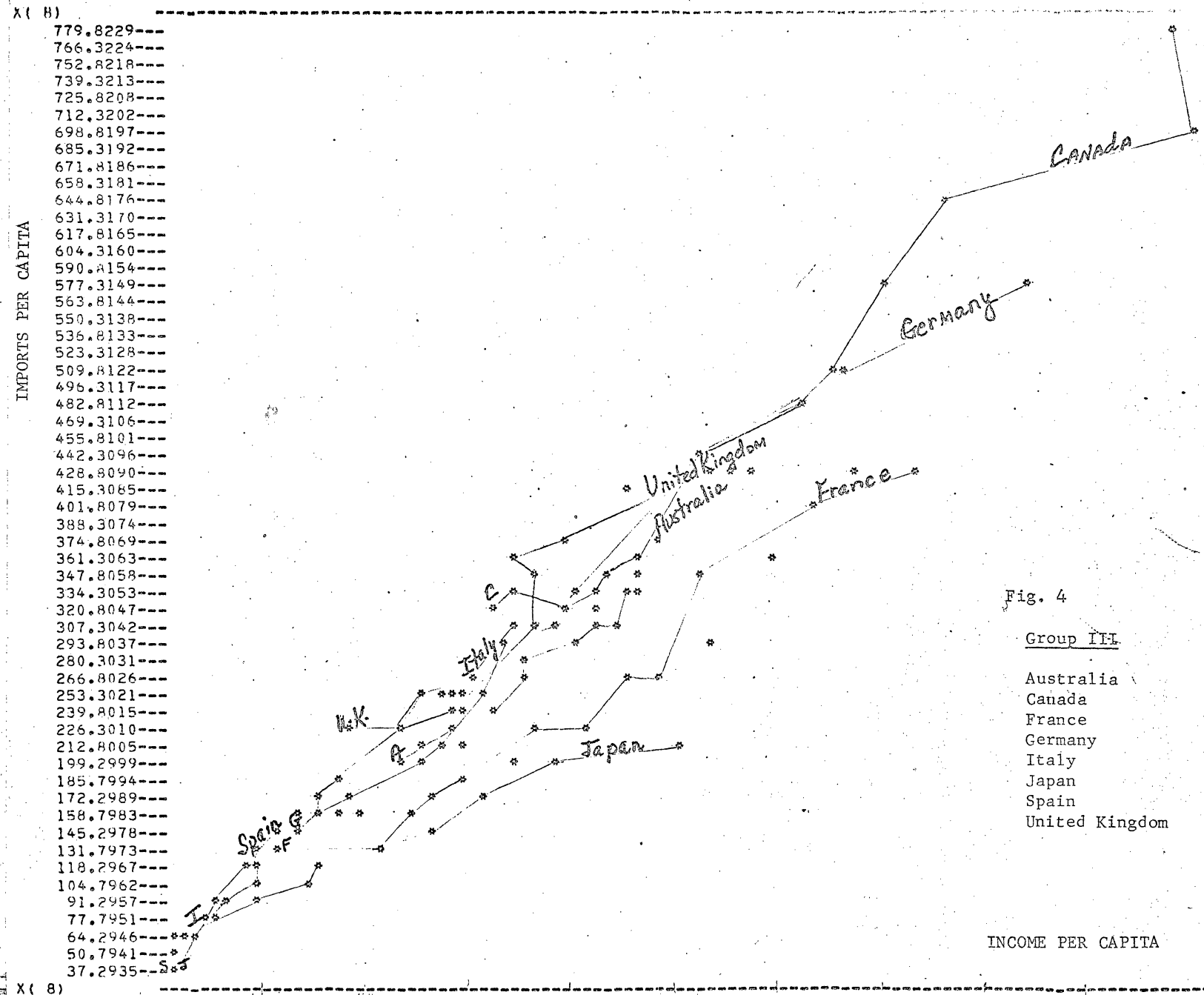


Fig. 4

Group III

Australia
Canada
France
Germany
Italy
Japan
Spain
United Kingdom

The estimates of the slopes for the linear equations, the beta coefficients, "b", differ as do the constants, "k". The equations for each group are listed above and are graphed in Figure 5.

The R^2 of .85, .95, and .91 respectively are all high. The t-statistics indicate that beta is highly significant. The F ratio is merely the t-statistic squared in this case of one independent variable, so it adds no additional information.

The betas of the log-log transformations are the elasticities of the marginal propensities to consume imports and are markedly different--Group I = .85; Group II = .97; Group III = 1.16. At this point in the analysis, a separate regression does seem to exist for each group.

Analysis of Covariance

Because these three groups have been determined on the basis of observation and because the regressions seem to differ from each other in slope and intercepts, an analysis of covariance is applied to test the significance of the differences of the slopes and intercepts of these groups.

For example, it is of interest to determine if these three groups of countries import in similar patterns as incomes increase. In this case, each group is a continuation of the regression in the other

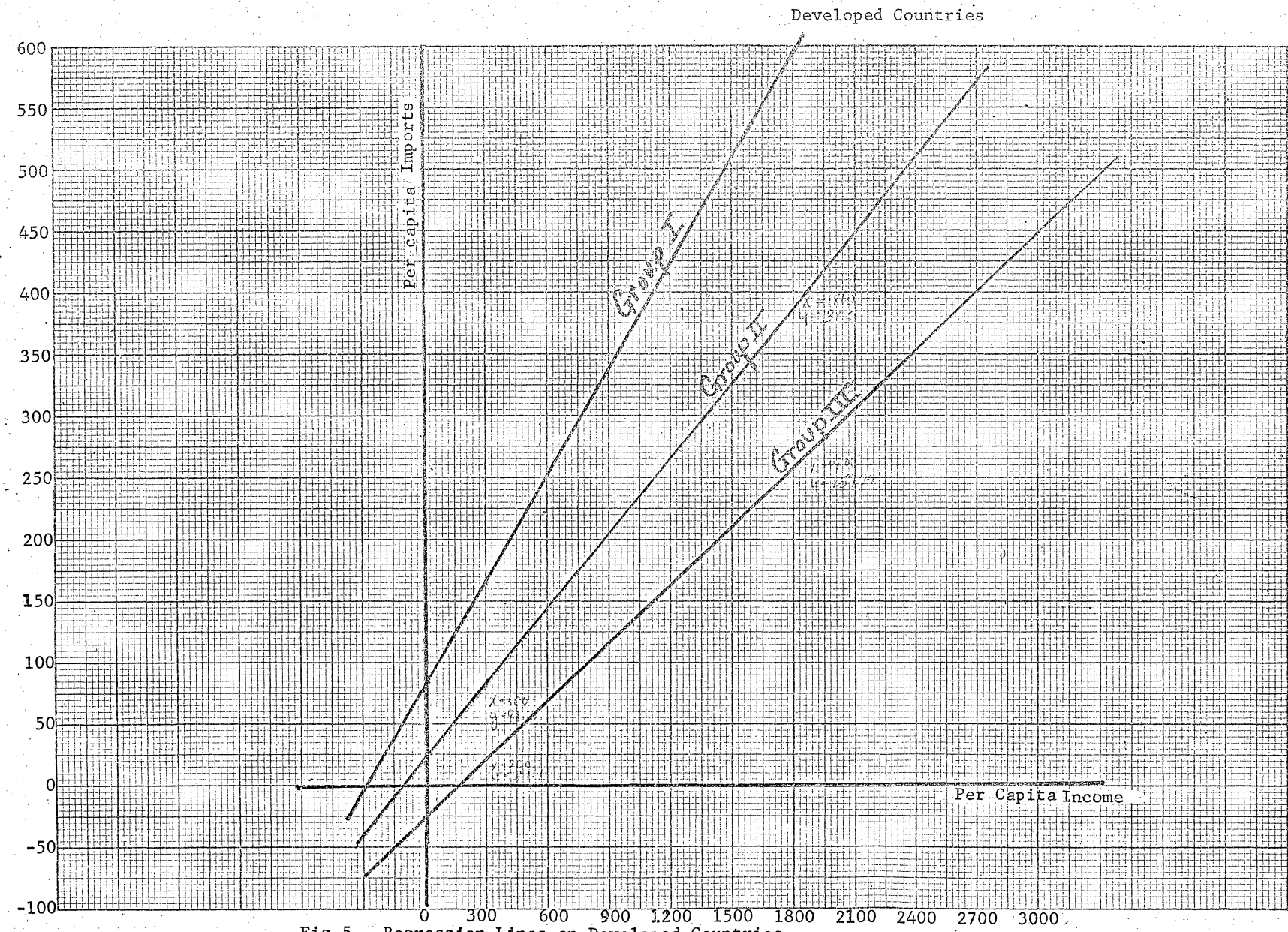
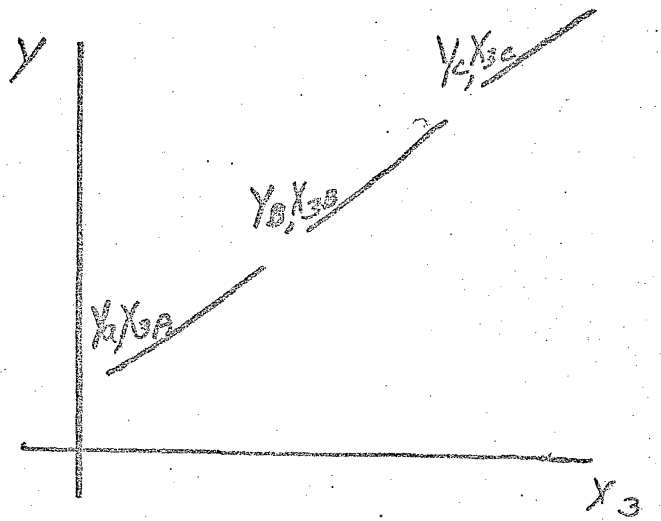
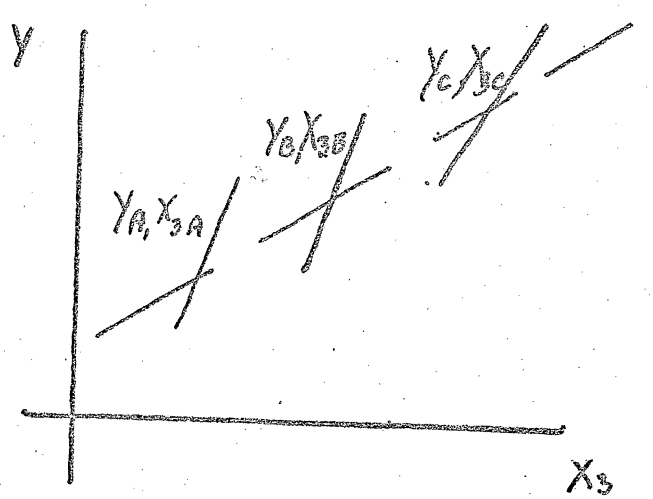


Fig 5. Regression Lines on Developed Countries

groups. In this case given below, it is obvious that one regression can be used for all groups.



However, by referring again to Figure 5, it seems helpful to test the significance of the variance in means because the three groups do appear to be represented by different regressions. It is also important to test whether any two of the groups are represented by one regression, although the slopes may be the same. This case is represented below.



No significant deviations exists between the slopes of equations A and B, and it is apparent that the same regression line cannot be fitted to each equation.

The test of significance of differences between regression coefficients is accomplished by use of the F ratio. If the F ratio is large enough for significance, then the hypothesis that one regression fits all groups is rejected.

In this case, the F ratio is large and the hypothesis that one regression fits all observations is rejected. In addition, this analysis of covariance established that per capita income is not responsible for all the variance in the error terms. Since the difference between the groups' means is significant, these three groups do follow separate import-income patterns over time. Table 3 gives the results of the Analysis of Covariance.

Table 3

Results of Analysis of Covariance

Tests of Hypothesis	F ratio
One Regression Fits all observations	337.770
Coefficients of Groups same	60.060
Regression of Means Linear	638.998
Coefficient means= error B	189.442

Estimation by Joint-Generalized Least Squares

The pooling of time series and cross-sectional data causes some difficulty with estimation (4). As data is pooled for time, the error term has three components. These three components are an error for time, N_i; an error for the cross-section, W_e; and a random error, V_{ie}. Therefore, $e_{it} = (N_i+W_e+V_{ie})$. These individual errors may be independent as is normally assumed, but when time series is combined with cross-sectional observation, serial correlation does occur. Although consistent and unbiased, the estimators of the parameters are not the most efficient. One problem is that the variances of these countries' variables are underestimated and the t-statistic is overestimated. To produce efficient estimators, the methodology chosen is an application of a three-stage least squares technique called joint generalized least squares, or seemingly unrelated regression (6).

In this procedure, regression coefficients in all equations are estimated simultaneously. This yields coefficient estimators which are more efficient than least-square estimators for marginal propensities to consume imports over time. The parameters obtained are set out for comparison in Table 4. Data in this table show results from cross-sectional data fit by years. This approach ignores much of what we determined in terms of country groupings. However, it may be of some use in observing the change in total marginal propensity to import over time.

Table 4.--Estimation by Joint-Generalized Least Squares and Ordinary Least Squares for 1958-1971, 21 developed countries

Time Series Equations (all countries)	Coefficient	Joint Generalized L.S.	Ordinary L.S.
1958	b	.18	.23
	s	.02	.05
	t	9.82	4.54
1959	b	.15	.20
	s	.01	.05
	t	9.97	4.01
1960	b	.17	.19
	s	.01	.04
	t	13.72	4.25
1961	b	.17	.20
	s	.01	.05
	t	14.71	4.06
1962	b	.18	.21
	s	.01	.04
	t	17.40	4.44
1963	b	.17	.20
	s	.01	.05
	t	14.94	4.07
1964	b	.18	.23
	s	.01	.05
	t	17.25	4.63
1965	b	.18	.22
	s	.01	.04
	t	19.46	4.79
1966	b	.17	.21
	s	.01	.05
	t	15.91	4.01
1967	b	.18	.22
	s	.01	.04
	t	17.13	5.05
1968	b	.18	.21
	s	.01	.05
	t	17.72	4.31

continued --

Table 4.--Estimation by Joint-Generalized Least Squares and Ordinary Least Squares for 1958-1971, 21 developed countries-continued

Time Series Equations (all countries)	Coefficient	Joint Generalized L.S.	Ordinary L.S.
1969	b	.19	.22
	s	.01	.05
	t	16.85	4.44
1970	b	.18	.20
	s	.01	.05
	t	13.80	3.74
1971	b	.17	.20
	s	.01	.06
	t	10.67	3.51

Where b = beta coefficient
s = standard error
t = t-statistic

ADDITIONAL EVIDENCE - SIZE AND TRADE

Thus far, it has been argued that the influence of country size on world trade for a one year period is an inadequate approach to predicting why countries import at certain levels. The reasons for this center primarily around the part unpredictable influences play, and the part time plays in income-import demand patterns. We have observed that groups of countries import in similar patterns and we have found efficient estimators for these income-import patterns over time.

Lastly, some question arises as to why these certain groups import in similar patterns. It has been suggested that countries with similar demand patterns and therefore, similar income levels tend to demand imports in like manner (4), but all these countries have similar income levels. It may be fruitful then to give casual observance to what national characteristics they have in common. In Table 5, the national statistics for population, area, arable land and income are given for each country, as is the mean for each national statistic. By simply comparing the average population, the average area, and average arable land of all groups, we see that Group I with the highest propensity to import possesses the smallest group means of these three characteristics. The means of all the characteristics, including GDP, are larger for Group III than for the Groups I and II. These traits are approximations of

Table 5
National Statistics of 21 Developed Countries

Group I	Pop TH '71	GDP Mil. $ '71	Area TH hectares	Arable Land TH hectares
Bel-Lux	10,070	29,437	3,309	1,621
Denmark	4,970	17,390	4,307	3,017
Iceland	205	586	10,300	2,280
Ireland	2,970	4,656	7,028	4,783
Netherlands	13,190	39,313	3,662	2,227
Norway	3,910	13,584	32,422	994
Switzerland	5,885	25,102	4,129	2,178
(mean)	5,885	18,581	9,308	2,442
per capita income mean	$3,157			
per capita imports mean	$1,040			
Group II				
Austria	7,460	17,525	8,385	3,922
Finland	4,680	11,486	33,701	2,834
Greece	8,810	10,700	13,194	9,090
New Zealand	2,870	7,571	26,867	13,624
Portugal	9,730	7,242	8,886	4,900
Sweden	8,110	37,390	44,979	3,479
(mean)	6,943	15,319	22,668	6,308
per capita income mean	$2,206			
per capita imports mean	$ 487			
Group III				
Australia	12,728	39,317	768,681	489,569
Canada	21,569	94,337	997,614	64,361
France	51,250	172,990	54,703	33,629
Germany	61,290	232,435	24,797	13,857
Italy	54,800	100,538	30,123	20,355
Japan	104,660	251,191	36,976	6,632
Spain	34,130	36,300	50,474	34,189
United Kingdom	55,900	138,800	24,403	19,414
(mean)	49,540	133,238	248,471	85,250
per capita income mean	$2,689			
per capita imports mean	$ 401			

Source: Population figures came from AID, Dept. of State; GDP from International Financial Statistics, IMF, November 1973; Area and Arable Land from 1968 UN Statistical Yearbook and from FAO Production Yearbooks.

country size and again we observe that the smaller countries by varying definitions of size fall into Group I, the group with the highest marginal propensity to import.

Other avenues for research are as follows:

1) What income elasticities of demand exist for U.S. agricultural products within these three groups of countries?
2) What further refinement of resource base within countries can be determined to explain varying import demand elasticities?
3) What does this further refinement of resource base tell us about future demand for particular U.S. agricultural products?
4) What demand for U.S. agricultural products will exist as developing nations propel themselves along import-income patterns perhaps already traced out by developed nations?

APPENDIX

DATA

Data for the 23 countries was derived from several sources. Population figures came from Agency for International Development compilation submitted to USDA in 1972. The total import figures for 1958-1969 came from UN Statistical Yearbooks 66, 67, 68 and 1970. Imports and GDP for 1970-1971 are found in IMF International Financial Statistics, May, 1973. The Gross Domestic Product for 1958, 1959, 1961 and 1962 came from UN Statistical Yearbooks 1966, '67, and '68. GDP for 1960, 1963, 1965-69 came from Yearbook of National Accounts Statistics 1970. The figures are given in current U.S. dollars and the exchange rates were generally taken from IMF International Financial Situations.

NOTES

1. Balestra, Pietro, and Nerlove, Marc, "Pooling Cross Section and Time Series Data in the Estimation of a Dynamic Model: The Demand for Natural Gas". Econometrica, vol. 34, no. 3, July, 1966, pp. 585-612.

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