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The major theoretical and empirical studies of international trade have paid relatively little attention to the influences of distance and protectionist barriers on the global pattern of trade. It is the contention of this study that valuable insights are to be obtained from an understanding of the determinates of international trade patterns, and that the variables of distance and protectionist barriers to trade are important determinates of international trade patterns.

The method of investigation chosen is an ordinary least squares multiple regression model. The sixty-one nation study consists of three measures of trade intensity: those of import, export, and total trade volume as a percentage of national incomes, four measures of distance and a proxy measure of protectionist barriers to trade. Each trade intensity measure is regressed in turn against each distance measure and the appropriate protectionist barrier variable, if any. This produces four sets (one set for each distance measure) of three multiple regression equations (one equation for each trade intensity measure) for each of the seven nations selected for analysis.

The statistical tests of the estimated coefficients and of the multiple regression equations consistently reveal high levels of significance. The results of the study support the contention that the variables of distance and protectionist barriers are important in determining the patterns of international trade.

AN EMPIRICAL STUDY OF THE EFFECTS OF GEOGRAPHIC DISTANCE AND INSTITUTIONAL BARRIERS ON THE PATTERNS OF INTERNATIONAL TRADE

By

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CHAPTER I

INTRODUCTION TO THE STUDY

Introduction

Over the years, economists have produced many theories purporting to explain why goods and services are traded among nations. Economic explanations of international trade include theories of varying degrees of complexity, and these theories have subsequently and quite naturally been subjected to empirical investigation

Three theories of international trade have received major attention by economists. The Classical Theory of Comparative Advantage attempts to explain why trade occurs by comparative costs of production. The Factor Proportions Theorem or Heckscher-Ohlin Hypothesis is more elegant and attempts to explain the direction of trade and comparative cost differences by differences in resource endowments. The Linder Hypothesis explains trade in manufactured goods in terms of similarities of demand structures, using similar income levels as a proxy for these demand structures.

A brief review of several empirical studies attempting to verify these theories is undertaken in Chapter II of this study. Research by G.D.A. MacDougall, Bela Balassa and R. Stern are examined with respect to the validity of the Classical Theory of Comparative Advantage. And W. W. Leontief's well known study of the Heckscher-Ohlin Hypothesis is also reviewed.

As will become clear when the above reviews are completed, theories of international trade are complex, the construction of their tests arduous, and the test results debatable. This study is less ambitious than previous research efforts. Rather than attempting to test any particular test of a theory, an effort is made to measure the influence of variables that the major theories of international trade, and hence their tests, have usually assumed away, i.e., the effects of distance and barriers to trade.

The Hypothesis of the Study

No matter how much importance may be attached to labor costs, factor endowments, product life cycles, or the values of human capital, a set of basis realities has always existed in international trade. Goods and services move through geographical space and across political boundaries. Geographical space, i.e., distance, creates the economic variables of transportation costs and imperfect market knowledge. Political boundaries translate into the economic considerations of tariffs, quotas, and numerous other barriers to the free flow of goods and services. The major theories of international trade have chosen to either assume away or give tertiary consideration to the realities of distance and protectionist barriers.

This study will ignore the complexity of the debates surrounding the major theories, and will instead examine the basic realities that goods and services move through geographical space and across political boundaries. Instead of attempting to define factor endowments or per unit labor cost, as have previous studies, the existence

of these relationships will be assumed to be fixed at a given point in time. Attention is in this way solely focused on distance and protectionist trade barriers, and their contribution to the explanation of the international movement of goods and services.

Outline of the Study

Chapter II considers the major theories of international trade. The assumptions of these theories are examined with special regard to the aims of the present study.

Chapter III sets forth the statistical model used in this study. In this chapter, the variables are defined, and their method of selection specified.

Chapter IV analyzes the regression equations generated by the model. Analysis of both the overall results and the results of selected nations are presented.

Chapter V is a summary and evaluation of the results of the study. A discussion of the relationship of the present study to those preceeding it places the current study in perspective.

Appendixes listing the nations in the model, the cities used to compute the distance measures, the data sources, and, for easy reference, a review of the variables are found at the end of the study.

Summary

The present study makes no attempts to enter into the debates surrounding the major theories of international trade or the empirical research connected with their verification. Rather, it assumes that

production relationships exist and are fixed at a given point in time. Thus, the study is able to focus on distance and barriers to trade in an effort to ascertain their impact upon the actual pattern of international trade.

CHAPTER II

A REVIEW OF THE BASIC THEORIES OF INTERNATIONAL TRADE

This chapter shall review the basic theories of international trade. Following the review of each theory, is a review of the empirical literature pertaining to it.

The Ricardian Theory of Comparative Advantage

The earliest general hypothesis concerning international trade is attributed to David Ricardo known as the Theory of Comparative Advantage. Ricardo couched his theory of why trade occurs in terms of differences in relative labor costs of production between nations in a two country-two good model. Ricardo's example was Portuguese-English trade involving the exchange of wine and cloth.

The following numerical example served as the basis for his Comparative Cost thesis (1,p.55). Number of man years of labor required to produce one unit of:

	Cloth	Wine
In Portugal:	90	80
In England:	100	120

This example assumes a Portuguese absolute advantage in the production of both cloth and wine. Ricardo explained this example in the following manner: (2,p.82)

> England may be so circumstanced that to produce the cloth may require the labor or 100 men for one year; and if she attempts to make the wine, it might require the labor of 120 men for the same time. England would therefore find it her interest to import wine, and to purchase it by the exportation of cloth.

> To produce the wine in Portugal might require only the labor of 80 men for one year, and to produce the cloth in the same country might require the labor of 90 men for the same time. It would therefore be advantageous for her to export wine in exchange for cloth. The exchange might even take place notwithstanding that the commodity imported by Portugal could be produced there with less labor than in England. Though she could make the cloth with the labor of 90 men, she would inport it from a country where it required the labor of 100 men to produce it, because it would be advantageous to her rather than to employ her capital in the production of wine, for which she would obtain more cloth from England than she could produce by diverting a portion of her capital from the cultivation of wines to the manufacture of cloth.

The example works basicly in this manner. The Portuguese produce wine at a cost of 80 labor units per barrel and produce cloth at 90 labor units per bolt. Thus, in the absence of international trade, one bolt of cloth exchanges for 1.125 barrels of wine.

In England, one bolt of cloth can be produced at a cost of 100 labor units while one barrel of wine requires 120 labor units. Hence without international trade, one bolt of cloth exchanges for 0.833 barrels of wine.

The Portuguese would be quite happy to exchange one barrel of wine for one bolt of cloth as a 1:1 exchange ratio of cloth to wine is to be preferred to a 1:1.15 exchange ratio. In like manner, the English would prefer to exchange cloth for wine at the 1:1 ratio possible in the presence of international trade rather than the .83:1 ratio existing in purely internal trade.

Thus, both England and Portugal gain if cloth is exchanged for wine at a 1:1 ratio. Both will gain if the exchange takes place at any ratio between the two domestic ratios. This holds true despite

the Portuguese absolute advantage in the production of both commodities.

Ricardo ignores distance, i.e. transportation costs, and its effects on relative costs. Not so important for the present study, but worthy of note, are Ricardo's use of the Labor Theory of Value to explain costs of production and his assumption of constant costs of production.

Ricardo's Theory of Comparative Advantage provides a reason for the movement of goods internationally. It cannot state at what terms trade will occur and it cannot predict the direction trade.

Empirical Tests of the Ricardian Theory of Comparative Advantage

The primary empirical tests of the Ricardian hypothesis include the pioneering work of MacDougall (3,4), studies by Balassa (5), Stern (6) and again by MacDougall (3,4). MacDougall's study is the primary investigation, mainly because Balassa and Stern followed MacDougall's lead in both general methodology and in the results of their investigations.

MacDougall examined British and American exports to third markets. He used average wage rates for all industries considered and productivity ratios from each industry considered. When the average American wage was twice that of the average British Wage, he found that in industries where the American output per worker "was more than twice the British, the United States had in general the bulk of the export market, while for products where it was less than twice as high the bulk of the market was held by Britian" (3p.698). Stern (6) reaches the same general conclusion when the average American wage is 3.4 times the average British wage. Balassa (5) adds wage ratios as a separate variable to determine if wage ratios increase explanation of relative market shares beyond those obtained

by MacDougall and Stern using average wages and productivity ratios. He found that the explanation was not improved.

The above empirical tests involve export market shares in a bilateral model. They exclude distance and protectionist barriers and do not consider trade patterns. Bhagwati (7) states that the above tests only mildly support their hypothesis of international trade.

The Hecksher-Ohlin Hypothesis

What may be termed the modern theory of international trade, the Heckscher-Ohlin hypothesis, expands the Ricardian model by addressing itself to the question of why comparative cost differences exist. It is still comparative advantage which provides the impetus for the international flow of goods. Comparative advantage arises from differing relative resource endowments.

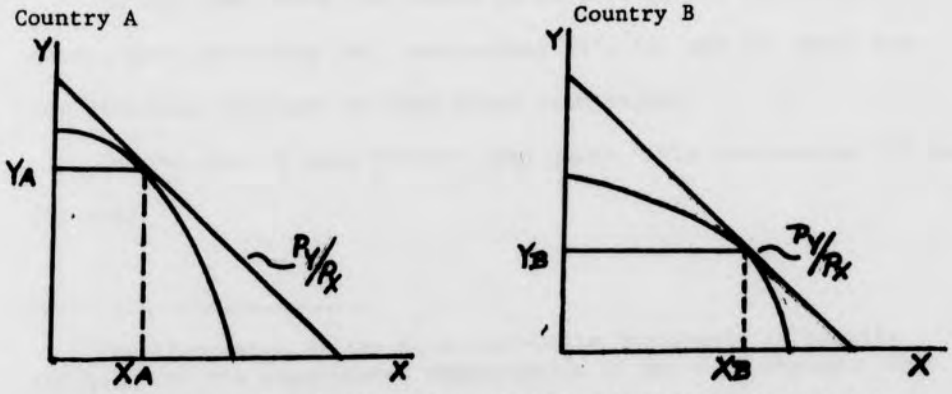
The hypothesis makes the following assumptions:

1. The world consists of two countries producing two good requiring two factor of production such that;
2. The factors are homogeneous and similar in both countries;
3. The production function of each good is linear homogeneous;
4. The production functions for the two goods use different amounts of the factors;
5. The production function for each good is the same in each country;
6. The good produced intensively with say, the first factor, is always produced intensively with that factor relative to the other good regardless of factor prices;

7. Factors are completely mobile intranationally and completely immobile internationally;
8. Factors can be substituted for each other in production but follow the law of diminishing marginal returns to factors;
9. There exists neither transport cost nor trade barriers;
10. Neither country is completely specialized in producing one good;
11. Tastes in the two countries are similar;
12. The two countries have different endowments of the two factors.

Each country tends to have lower comparative costs in the production of that good which uses relatively more of that factor of which it has a relative abundance. It is that good which will be exported for the other.

A brief example will illustrate the case of two countries, two goods and two factors.



Good X is produced labor intensively and good Y is produced capital intensively. Then Country A is relatively capital

abundant and Country B is relatively labor abundant. Let P_y/P_x be the relative price of Y.

Under these conditions the Heckscher-Ohlin model reaches the following conclusions:[1]

1) Commodity prices are equalized both relatively and absolutely;

2) Country A exports good Y and imports good X, while Country B imports good Y and exports good X;

3) Factor prices are equalized both relatively and absolutely;

4) Country A on balance exports capital (embodied in its exports of good Y) and Country B on balance exports labor (embodied in its exports of good X).

When the model is expanded beyond two countries, the direction of trade is no longer clear. Although the other conclusions, (1), (2), and (4) hold (9).

When the model is expanded to include more than two factors and two goods the direction of trade becomes increasingly undefined.

In the case where the number of factors equals the number of goods, both exceeding two, conclusions (1), (3) and (4) hold, but the direction of trade is less clear than before.

In the case of more factors than goods, only conclusions (1) and (4) hold.

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[1]The discussion of the Heckscher-Ohlin Hypothesis is heavily endebted to the unpublished dissertation of Dr. J. Hoftyzer. See reference (9).

In the case of more goods than factors, conclusions (1), (3) and (4) hold, but the direction of trade has become quite arbitruary. It is now possible that a labor abundant nation will export capital intensive goods.[2]

The expansion of the basic model leads to the following general conclusions:

The model's conclusions are not really open to empirical investigation unless further restrictive assumptions are made. Of the four conclusions, above, only (1) and (4) hold for all cases. These can be tested.

Leontief has tested conclusion (4). Had his results supported the conclusion, it would not have implied support for the other three conclusions. As his results did not support conclusion (4), it casts doubt on all the conclusions of the model.

Thus, the Heckscher-Ohlin model does not predict the direction of trade beyond the two good-two country-two factor case. Further, it has explicitly assumed away the variables of distance and trade barriers.

Empirical Tests of the Heckscher-Ohlin Hypothesis

The pioneer study by Leontief (10) attempts to ascertain the factor intensity of United States exports relative to imports in a

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[2]For a good discussion of this case, see Melvin, J. R., "Production and Trade with Two Factors and Three Goods," American Economic Review, 58, 1968, pp.1249-1268.

bilateral model.[3] According to the Leontief results, American exports are labor intensive while her imports are capital intensive. As the United States is generally considered to be capital abundant, the results of the study tend to run counter to the predictions of the Heckscher-Ohlin Hypothesis.

Leontief's study was critized for unrealiable capital-output ratios for the agricultural sector (11), for the method of aggregating intensities for the United States export industries (12), and the very use of an input-output model caused objections (13). However, none of the critics nor their criticisms have been able to reverse the study's conclusions. The Leontief Paradox remains unrefuted, although still questioned.

More important than the criticisms, the Leontief study produced a re-examination of the Heckscher-Ohlin hypothesis and several Leontief-type studies of other nations. Bharadwaj (14) studied Indian trade with the United States. He found that India exports capital intensive goods to the United States and imports labor intensive goods. Like the Leontief study, this contradicts the Heckscher-Ohlin hypothesis. Wahl (15) produced a similar study for Canadian-United States trade and Canadian-United Kingdom trade.

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[3]The empirical tests of the Heckscher-Ohlin hypothesis considered here are all of the bilateral two country type. With a multi-country model, the difficulty of ranking a country's abundant factor when Country I is capital abundant relative to Country II but labor abundant relative to country III have not been overcome. Hence, no multi-country-multi-good test of the hypothesis exists.

As with the previous studies, the results contradict the hypothesis. Stolper and Roskamp (16) studied East German trade. They found that East Germany exports capital intensive goods and imports labor intensive goods. This study tends to support the Heckscher-Ohlin hypothesis especially as most of East Germany's trade is with the less developed Communist bloc nations. An interesting study of Japan was produced by Tatemoto and Ichimura (17). The aggregate results show Japanese exports to be capital intensive and her imports to be labor intensive, again a contradiction of the Heckscher-Ohlin hypothesis. However, when Japanese trade is disaggregated between trade with underdeveloped nations (assumed to be labor abundant nations) and developed nations (assumed to be capital abundant nations) a different picture emerges. Illustrating with the case of Japan-United States trade, Japanese exports to the United States were found to be labor intensive and imports from the United States to be capital intensive. Here the disaggregated results support the Heckscher-Ohlin hypothesis. (7,pp.27-34).

Clearly attempts at empirical verification of sub-conclusions of the Heckscher-Ohlin hypothesis are far from over. The available studies appear to contradict the hypothesis as often as they support it. However, fundamental questions concerning such things as the definitions of the basic concepts of labor and of capital are still unanswered. It is difficult to conceive of a truely convincing study prior to establishing satisfactory definitions and measurement techniques for the factors under study.

The Linder Hypothesis

Linder (18) divides international trade into the two sectors of primary products and manufactured goods. The causes of trade in primary products, Linder asserts, are satisfactorily explained by the factor proportions theorem of Heckscher and Ohlin outlined above. Linder asserts, however, that trade involving manufactured products requires a different explanation. Linder begins with the observation that before a good is traded internationally it must first be traded domestically, that is, a domestic demand exists for all goods produced and consumed within a nation. The kinds and quality of goods demanded are said to be a function of per capita income.

Demand may be satisfied by either domestically-produced commodities or by imports. Thus, the set of goods demanded at any given income level will be the set of potential import goods and domestically produced goods. They will also comprise the set of potential export goods, because, clearly, for a good to be exported it must be produced domestically. And, according to Linder, in order to be domestically produced a good must have representative domestic demand. Hence, the set of potential imports and potential exports is defined by the domestic demand structure which is itself determined by per capita income levels.

In order for a good to be an actual import, it must first be produced for another nation's domestic market. This entails the

existence of a domestic demand in the other country. Likewise, for a potential export to become an actual export, it must be demanded' in another nation. This other nation's demand structure overlaps with that of the first to define the actual set of imports and exports based on similarities of demand structures. The demand structure, in turn, rests upon the respective per capita incomes. Hence, with respect to trade in manufactured goods, Linder concluded that similar per capita incomes generate similar demand structures which produce overlapping sets of potential imports and exports, those products within the overlap comprising the set of actual imports and actual exports.

Thus Linder maintains that nations with similar demand structures will trade more intensely. He uses similar per capita incomes as a proxy for similar demand schedules. In the Linder model, demand is the dominate variable, with supply being essentially passive. This contrasts with the dominate role of supply in the Heckscher-Ohlin model where demand is assured passive through the similar tastes assumption.

Empirical Test of the Linder Hypothesis

Sailors, Qureshi and Cross (19) claim to have found support for the Linder Hypothesis in their recent study. Hypothesising a negative correlation between a ranking of per capita GNP differences and trade intensities, they used a Spearman rank order test for thirty-one nations. Of the correlations, sixteen were significant at the .05 level or above. They concluded that "Linder's hypothesis is well supported by the finding of this test" (19,p.266). The re-

sults for the United States were not significant, this result being attributed to the belief that 1958 (the time of the data) was not a normal year for United States trade. The results for the EEC countries were significant. However, no attempt was made to judge the influence of the EEC's trade barrier reduction program nor of the close geographic position of the EEC nations. Given the geographical clustering of nations with similar per capita incomes, it may very well be that the impact of geographic distance is what is really measured in this test.

Human Capital Theories

One of the explanations of the Leontief paradox may be that labor is not homogeneous across national boundaries. In fact, Leontief ventured that American labor was three times as efficient as non-American labor. These observations have led to the recalculation of capital:labor ratios in an effort to incorporate skill levels into the coefficients. This effort is understandable for at least two reasons. First the training of skilled labor requires capital investment in facilities and educational aids. Second, skilled personnel are usually considered more efficient at utilizing capital equipment. The increased productivity of capital goods stemming from their use by skilled workers as well as the capital investment embodied in the workers' skills tend to increase the capital intensity of American industry, but is not reflected in the capital stock figures. Hence, the concept of human capital evolved. In general, the wage differential between skilled and unskilled labor is treated as the return to human capital, and is capitalized and

added to existing capital stock estimates (7,p.107).

Empirical Tests of Human Capital Theories

Studies utilizing the human capital concept have been undertaken for the United States by Kenen and Yudin (20), for India by Bharadwaj and Bhagwati (21), and for West Germany by Roskamp and McMeekin (22). However, the incorporation of human capital adjustments have not yet produced a notable reversal of the Leontif Paradox. (7,p.107-108).

Morrall stated (23) in his review of the human capital theory and the empirical tests of the Heckscher-Ohlin model that the model is "improved" and that human capital intensities are "a good indicator of export performance" (23,p.46), for the American industries. It should be noted that unlike the studies considered above, the studies reviewed by Morrall were not of the Leontief type, rather they were attempts at explaining the American trade pattern. His conclusion is that "four factors, tangible capital, human capital, unskilled labor and natural resources are needed before respectible support is attained" (23,p.17) for the Heckscher-Ohlin hypothesis.

Product Life Cycle Theory

While not a general theory of international trade, the Product Life Cycle Theory directly addresses the question of the direction of trade. The life cycle model (24) divides into four phases.

In the first phase a new product or major product improvement is developed in a country of innovation. Normally, the life cycle theory assumes origination in the United States. As production

begins and continues, design improvements are incorporated in response to consumer demands, the market expands as the product becomes known, and scale economies are obtained. As the good becomes established domestically, foreign export begins to develop. Eventually foreign demand becomes sufficiently large that foreign companies will begin production of a similar product in order to compete in their home markets. This initiates Phase II, the start of foreign production.

As foreign demand increases and foreign companies become more efficient in the production of the good, they will begin a compete with American producers in their markets. This begins Phase III. As the foreign companies expand production, they will encounter scale economies as did their American forerunners. At this point Phase IV begins.

In this phase American companies lose not only the major share of the export market but begin to lose increasing portions of the American market. Phase IV is based on the assumption that foreign producers will have lower labor costs. Thus, once economies of sale are reached and assuming identical production functions foreign total costs will be lower than American total costs. When foreign costs are sufficiently lower, to absorb transportation costs and any tariff, then Phase IV is in full swing with American producers losing varying portions of the American market to foreign competition. The extent of loss would depend on the actual cost differences.

Empirical Tests of the Product Life Cycle Theory

When the Product Life Cycle Theory is used to explain United States export performance, Morrall (23, pp.47-56) finds that the

highest degree of explanation is obtained with a four variable Product Cycle model. The four variables are: (1) the number of scientists and engineers engaged in research and development, which is used as an indicator of America's propensity to develop new products; (2) value added in 1965 divided by value added in 1947, which is used to indicate recent growth rates for selected industries; (3) "an index of the rate of growth of labor efficiency minus the rate of growth of physical capital efficiency" (23, p.49) for the period 1948 - 1962; and 4) a Census Bureau index of the costs of materials and payroll to the total value of shipments which is used "as a composite index which reflects various had-to-measure characteristics of the product cycle" (23, p.51).

Morrall concludes that at least three factors influence United States export performance. "The United States' propensity to develop new, presumably income elastic, consumer products and labor-saving capital goods and techniques in conjunction with an abundance of external economies provide the United States with an initial comparative advantage in both new consumer and capital goods" (23, p.56).

Empirical Studies Incorporating Distance

In a study of the effect of the EEC and EFTA on European trade, Aitken (25) incorporated a measure of geographical distance in his regression equation. The Aitken distance measure is drawn from the same source as the nautical distance measure in this study. He computes the distances between commercial centers and uses distance as "a proxy variable for natural resistance which in turn is a composite

of transportation cost, transport time and economic horizon" (25,p.882). The generated coefficients for the distance variable all display the hypothesised negative correlation, with trade levels and showed significance at the .01 level in the test. Aitken draws no separate conclusion concerning the power of the distance variable in his model.

While working in the area of Location Theory, Isard (26) examined the relationship between distance and transportation costs. He compared distance and tonnage transported by ship and rail carriers. He found a step function relationship with tonnage decreasing as distance increased (26 p.70-76). This, of course, was the prior expectation.

Earlier studies by Linnemann (27) and by Tinbergen (28) incorporated a distance measure as part of cross-sectional models of international trade. Again, distance was not considered separately, as it was not the primary variable.

Summary

The Ricardian Theory attempts to explain why international trade occurs, but does not attempt to explain the direction of trade. The Heckscher-Ohlin Hypothesis attempts to explain how international trade occurs and to predict the direction of trade. Both of these theories seek their explanation in the supply side of production. Linder attempts to explain international trade by focusing on demand considerations.

The various empirical studies discussed above test particular sub-conclusions of the theories. The results of the studies are

often in disagreement with each other, and the tested hypotheses are not always in agreement with the theories being examined.

Of the empirical studies, the Leontief study of the Heckscher-Ohlin Hypothesis has given impetus to the rise of additional theorical and empirical work. The Human Capital Theories attempt to remove the Leontief Paradox by accounting for the capital investment required to produce a more efficient labor force. The approach is to incorporate skill levels into the capital:labor ratios. The results of empirical research utilizing the Human Capital approach have been mixed, producing no clear reversed of the Leontief Paradox.

A new theory which does not directly stem from the previously examined theories is the Product Life Cycle Theory. This theory attempts explanation of the direction of international trade through an understanding of the various stages through which a new product passes as it goes from American origination to American exportation to foreign imitation to American importation. The empirical studies claim to have produced meaningful results.

The theories discussed above assume away the variables considered in this study. These variables are not always included in the empirical tests. Those tests which do include distance and protectionist barriers do not give them the same degree of emphasis the present study does.

CHAPTER III

THE STATISTICAL MODEL

Introduction

This chapter sets forth the statistical model used in the study. The variables are defined, and the methods of selection and measurement are discussed. The sources of the data set and the nations in the model are included in the Appendixes to the study.

The Statistical Model

The statistical results consist of seven sets of three multiple regression equations. The equations are of the general form: Intensity of Trade = f (distance, protectionist barriers). Data was collected for sixty-one nations. The trade pattern of seven of these nations was selected for study.[1] Attention is focused on the relationships between each of these seven nations, taken individually, and the other nations in the model. These seven nations are termed base countries. Each of the base countries is used to generate three intensity of trade equations[2]; one for base country exports, a second

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[1]The United States, Japan, West Germany, Denmark, the United Kingdom, Columbia and Argentina.

[2]Each is of the general form $X_1 = a_{1i} + a_{2i} X_{2i} + a_{3i} X_{3i}$; where X_1 is a measure of trade intensity, X_2 is a measure of distance, and X_3 is the dummy variable for protectionist barriers.

for base country imports, and a third for both exports to and imports from the base country. Each equation included a measure of geographical distance. The inclusion of a protectionist barrier variable in any given equation is dependent on membership by the base country in an economic association as discussed below.

The present model differs from those that have preceded it, not only in its simplity, but most importantly in its focuses on distance and protectionist barriers, variables assumed away in the three theories discussed earlier. This aim is to demonstrate that distance and protectionist barriers are significant in explaining the patterns of international trade; indeed, they are much too important to receive the same degree of neglect in the future as they have in the past.

Selection of the Statistical Model

The multiple regression equations were generated by an ordinary least squares regression of each dependent variable upon each distance variable and the appropriate protectionist barrier variable, if any. For each of the three dependent variables, one independent variable from the distance group and the appropriate protectionist barrier variable were selected for incorporation into the multiple regression model. The criteria used for selection of the particular form of the independent variables was based on observation of the correlation matrix, those forms giving the largest simple correlation coefficient with the dependent variable in question being selected. Naturally, this method tends to maximize the value of the multiple coefficient of determination, R^2. But then an estimate of the

maximum amount of trade intensity variation that can be explained by the independent variables of geographical distance and protectionist barriers is the primary objective and interest of this study. The general forms of these equations are discussed below. The specific equations generated by the model are examined in Chapter IV.

The Dependent Variables

There are three dependent variables, each representing a measure of trade intensity. Variable X_1 measures the average propensity of the non-base country to import from the base country. It is the ratio of the dollar value of imports (29) of the non-base country from the base country to the dollar national income (30) figure of the non-base country. All data are for 1970. This figure is then multiplied by 1000 simply to remove excessive decimal points. Thus:

$$(1)\quad X_{1_i} = \frac{\text{\$ value of i's imports from b}}{\text{\$ value of i's national income}} \times 1000;\ i = 1,\ldots,60.$$

There are 60 non-base countries, and b in equation (1) represents the base country.

Variable X_2 measures the intensity of trade in the other direction, namely the average propensity of the non-base countries to export (29) to the base country.

Thus:

$$(2)\quad X_{2_i} = \frac{\text{\$ value of i's exports to b}}{\text{\$ value of i's national income}} \times 1000;\ i = 1,\ldots,60.$$

Finally, X_3 is the arithmetic average of X_1 and X_2 . It takes into account trade in both directions and weights them equally. Thus:

(3) $X_3 = 1/2 (X_1 + X_2)$

The advantage of utilizing an intensity of trade measure rather than simply the volume, i.e, dollar value, of trade is its ability to remove the natural bias of high income, high demand nations, which tend to trade more heavily than lower income nations in an absolute sense. The study is not particularly interested in the observation that rich nations have a greater volume of trade but, in the proportion of national income which is spent in trade by the nations in our model. The use of trade intensities accomplishes this quite satisfactorily.

The Independent Variables

The model includes two sets of independent variables. The first set consists of four measures of geographical distance. The second set consists of the dummy variable proxies for protectionists barriers to international trade.

The Distance Variables

Four distance variables are considered:

(4) $X4_i$ = Steamer distance from base country, i = 1,...,57.

(5) $X_{5_i} = \log (X_{4_i})$

(6) $X6_i$ = Great Circle distance from the base country, i = 1,...60

(7) $X_{7_i} = \log (X_{6_i})$

Steamer distances are measured in nautical miles, while Great Circle distances are measured in statute miles. Steamer distance are used for the distances between the closest major ports over the established ocean routes as listed in the United States Navy's publication, Distance Between Ports, (31). Great Circle distances are generally computed near the approximate geographical center of the various countries using the shortest distance. Exceptions are made when there is no major city near the geographical center or when the country's "economic center of gravity" is located elsewhere. The Great Circle distances were obtained from the mileage manual of the International Air Transport Association, (32). The log values are intended to remove scale or threshold effects of large distances on the four distance variables. The one of these four distance variables having the highest simple correlation coefficient with the dependent variable was incorporated into the multiple regression equation.

The distance variables function as a proxy not only for transportation costs, which are expected to increase as distance increases, but also for the extent of market knowledge. Knowledge that a demand exists and the nature and extent of the demand are important prerequisites to international trade. It appears logical that as physical distance increases, market knowledge decreases.

The Protectionist Barriers Variable

For a variety of reasons nations impose barriers to foreign products. These barriers may be in the form of a tariff, usually an ad valorem duty or possibly a fixed rate duty; or of a quota, or possibly other non-tariff barriers such as health restrictions. The ability of such barriers to distort the pattern of international trade is clear. Tariffs directly affect the price of imported goods in the domestic market, while quotas directly limit the supply of foreign goods. Both barriers alter the patterns of trade, as they can effectively offset a foreign producer's comparative advantage over domestic producers.

To measure the extent of trade distortion caused by protectionist barriers would be no easy matter. It would require detailed knowledge of the tarrif and quota schedules of each nation in the model. It would require the disaggregation of the trade intensities by commodity as well as a knowledge of the elasticities of demand for each commodity. While this would yield a fairly accurate measure of trade distortion, it would make the present study unmanageable.

The method used to obtain a measure of the power of protectionist barriers in influencing trade patterns was to focus attention on free trade areas where protectionist barriers have been eliminated or decreased. The simplist statistical method to accomplish this is to incorporate a dummy variable into the model.

The procedure is to define X_8 as follows:

(8) $X_8 = 0,1;$

Where X_8 = 1, if the non-base country is a member of the base country's economic association, and X_8 = 0, if the non-base country is not a member.

(9) X_9 = 0,1;

Behaves in the same manner as X_8, but is used when the base country is a member of a second economic association.

Economic Associations

For the base counties in the model, in 1970, Germany was a member of the European Economic Community, Columbia and Argentina were members of the Latin American Free Trade Association, Denmark and the United Kingdom belonged to the European Free Trade Area. Additionally the United Kingdom was a member of the British Commonwealth of Nations. The United States and Japan belonged to no such organizations in 1970.

There are three basic types of economic association. They will be briefly defined.

A free trade area consists of a group of nations who have removed trade restrictions among themselves. Each nation maintains its own trade policy with respect to non-member nations. Temporary retention of trade barriers toward member nations may also be permitted.

A customs union goes one step beyond a free trade area. Not only are internal trade restrictions removed, but member nations are no longer allowed to maintain separate trade policies toward non-member nations. Instead, a common tariff and quota schedule is established with non-member nations.

A common market proceeds beyond a customs union by allowing free mobility of factors of production among member nations. Thus factors of production may seek the highest rates of return available within the membership. Such mobility should lead to maximum efficiency in the employment of productive factors.

With respect to the present study, the European Free Trade Area and the Latin American Free Trade Association are examples of free trade areas, while the European Economic Community is an example of a common market. The British Commonwealth of Nations is not truly an economic association of the types discussed above. Rather it is an affiliation of nations sharing some historical, social, political and economic ties. While preferential trade treatment is shown by Commonwealth members, it does not strictly qualify as a free trade area.

Each of the economic associations considered in this study are discussed below. A brief history and comment on the associations success will be included along with the membership.

Latin American Free Trade Association (LAFTA)

The Latin American Free Trade Association was formed by the Treaty of Montevideo in 1961. The original members were Argentina, Brazil, Chile, Mexico, Paraguay, Peru and Uraguay. Later Columbia, Ecuador, Venezuela and Bolivia joined. By 1970, LAFTA included Mexico and all of South America except the Guayannas.

LAFTA is notable primarily for its failure. As Hoftyzer (9) has shown, the levels of internal imports actually declined between

1966 and 1970, while the level of internal exports increased only slightly. The failure of LAFTA to increase the internal levels of trade stems from its failure to reduce internal trade barriers. This is generally attributed to the wide disparity in levels of economic development of its members. The less developed members felt the need to protect their industrial beginnings from the exports of the more economically developed members.

A good performance of the LAFTA dummy variable should be viewed with some suspicion. Rather than measuring the influence of LAFTA, the variable may show instead the influence of the cultural bonds and similarities of tastes which exists among the LAFTA members.

European Economic Community (EEC)

The European Economic Community was created by the Treaty of Rome in 1957. It was an outgrowth of the successful operation of the European Coal and Steel Community (ECSC). Started in 1951, the ECSC was intended to reduce tariff barriers relating to trade in coal and steel among six European nations. The six members of the ECSC and founders of the EEC were West Germany, the Netherlands, Belgium, Luxemburg, France and Italy. In 1970, the membership of the EEC was unchanged.

As several studies have shown (9,25), the EEC rapidly moved toward economic integration. Internal trade levels steadily increased both during the period of trade barrier reduction and afterwards. By 1970, nearly 50% of the total EEC trade was internal (9). The European Economic Community is the most successful of all

attempts at economic integration

European Free Trade Area (EFTA)

Another successful economic association is the EFTA. Formed in 1960, EFTA originally included Austria, Denmark, Norway, Portugal, Sweden, Switzerland and the United Kingdom. It was expanded later to include Iceland and, as a de facto member, Finland.

Internal trade levels grew rapidly between 1966 and 1970. By 1970, internal imports were approximately 25% of total imports and internal exports were approximately 28% of total exports (9).

The Commonwealth of Nations

The British Commonwealth of Nations is an association of 28 former members of the British Empire. The common symbol of the Commonwealth nations is the British monarch. The common ties are those of the English language, British style of governmental and educational institutions, and a general British cultural heritage.

This loose association was formed in Ottawa in 1932 as a system of mutual trade preferences designed to stimulate trade among the then present and former British colonies.

During the 1960's the Commonwealth's vitality began to decline. Britian's attempt to enter the EEC undermined confidence in the association, causing its members to begin diversification of their markets. The devaluation of the pound in 1967 and the general decline in competitiveness of British goods further weakened the bonds of the Commonwealth. Moreover, many members among the less developed

nations began to move away from British style political systems, further loosening their cultural ties.

These factors tended to further weaken the economic ties among the Commonwealth members. British exports to and imports from the other members declined, so that by 1970, of total British exports only about 17% were to Commonwealth members, and of British imports only about 20% were from Commonwealth nations.

As an economic association, the Commonwealth has not been particularly successful over the past several years. The performance of the Commonwealth variable should be viewed with this realization in mind.

Summary

The construction of the set of three multiple regression equations has been described above. Emphasis has been placed on the formation of the nine variables, the method of selection of their particular final forms and construction of the data set supporting them. The sixty-one nations in the study are all the nations for which data was available. The primary limitation was availability of per capita national income data. While one may argue for the deletion or addition of any particular nation, the final model is considered to be a reasonably representative of the geographic dispersion, commodity mix and the economic associations which characterize modern international trade.

CHAPTER IV

THE EMPIRICAL RESULTS

Introduction

This chapter presents the estimated equations and test statistics of the multiple-regression model, and a discussion of the results.

Equations Generated by the Model

The overall results are found on pp.34-51. The values shown in parentheses ( ), in both the overall results and in the results by the base country, are the t-statistics.

Four sets of equations were produced for each base country with the exception of the United Kingdom, for which twelve sets of equations were generated. From among these sets of equation, one set was chosen for each base country for inclusion in the final model. These final sets are discussed below for each base country.

Several items should be noted about the equations in this section. The performance of the distance variable is generally superior when it is in logarithmetic form, i.e., variables X_5 and X_7, where the scale or threshold effects of long distances have been removed. The difference between the values for equations using the Great Circle distance measure and those using the nautical distance measure is usually rather small. Of the individually

TABLE - 1

OVERALL RESULTS FOR JAPAN

Nautical Distance
non-log

$X_1 = 28.15 - .00097X$
$(4.009)^{**} \quad (-1.872)$

$R^2 = .0643 \quad F_{1,51} = 3.503$

$X_2 = 22.38 - .00069X_4$
$(5.499)^{**} \quad (-2.447)^{**}$

$R^2 = .0879 \quad F_{1,51} = 4.916$

$X_3 = 25.26 - .00083X_4$
$(5.499)^{**} \quad (-2.447)^{**}$

$R^2 = .1051 \quad F_{1,51} = 5.989^{**}$

Nautical Distance
log

$X_1 = 309.59 - 32.29X_5$
$(5.302)^{**} \quad (-5.005)^{**}$

$R^2 = .3294 \quad F_{1,51} = 25.052^{**}$

$X_2 = 174.03 - 17.60X_5$
$(4.684)^{**} \quad (-4.287)^{**}$

$R^2 = .2649 \quad F_{1,51} = 18.378^{**}$

$X_3 = 241.81 - 24.95X_5$
$(6.769)^{**} \quad (-6.320)^{**}$

$R^2 = .4392 \quad F_{1,51} = 39.945^{**}$

* Denotes significance at the .05 level.

** Denotes significance at the .01 level.

Great Circle Distance
non-log

$X_1 = 21.66 - .0052X_6$
$(3.818)^{**} \quad (-1.076)$

$R^2 = .0206 \quad F_{1,55} = 1.157$

$X_2 = 19.36 - .00019X_6$
$(3.337)^{**} \quad (-0.382)$

$R^2 = .0027 \quad F_{1,55} = 0.146$

$X_3 = 20.51 - .00036X_6$
$(4.572)^{**} \quad (-0.928)$

$R^2 = .0154 \quad F_{1,55} = .8610$

Great Circle Distance
log

$X_1 = 332.37 - 35.99X_7$
$(4.423)^{**} \quad (-4.195)^{**}$

$R^2 = .2424 \quad F_{1,55} = 17.59^{**}$

$X_2 = 74.37 - 6.46X_7$
$(0.853) \quad (-0.649)$

$R^2 = .0076 \quad F_{1,55} = .4217$

$X_3 = 203.369 - 21.22X_7$
$(3.213)^{**} \quad (-2.937)^{**}$

$R^2 = .1356 \quad F_{1,55} = 8.627^{**}$

* Denotes significance at the .05 level

** Denotes significance at the .01 level

TABLE 2

OVERALL RESULTS FOR DENMARK

Nautical Distance
non-log

$$X_1 = \underset{(3.337)^{**}}{2.28} - \underset{(-1.472)}{.00015X_4} + \underset{(7.712)^{**}}{12.90X_8}$$

$$R^2 = .5992 \quad F_{2,50} = 37.382^{**}$$

$$X_2 = \underset{(4.834)^{**}}{3.54} - \underset{(-2.829)^{**}}{.00029X_4} + \underset{(6.689)^{**}}{12.60X_8}$$

$$R^2 = .5829 \quad F_{2,50} = 34.945^{**}$$

$$X_3 = \underset{(4.465)^{**}}{2.91} - \underset{(-2.361)^{*}}{.00022X_4} + \underset{(7.799)^{**}}{12.45X_8}$$

$$R^2 = .6283 \quad F_{2,50} = 42.252^{**}$$

Nautical Distance
log

$$X_1 = \underset{(3.384)^{**}}{9.49} - \underset{(-2.893)^{**}}{.097X_5} + \underset{(7.216)^{**}}{11.81X_8}$$

$$R^2 = .6418 \quad F_{2,50} = 44.799^{**}$$

$$X_2 = \underset{(4.755)^{**}}{14.03} - \underset{(-4.173)^{**}}{1.47X_5} + \underset{(6.235)^{**}}{10.74X_8}$$

$$R^2 = .6412 \quad F_{2,50} = 44.673^{**}$$

$$X_3 = \underset{(4.503)^{**}}{11.76} - \underset{(-3.911)^{**}}{1.22X_5} + \underset{(7.397)^{**}}{11.27X_8}$$

$$R^2 = .6836 \quad F_{2,50} + 54.016^{**}$$

Great Circle Distance
non-log

$X_1 = 2.79 - .00032X_6 + 8.14X_8$
$(3.567)^{**} \quad (-1.992) \quad (5.389)^{**}$

$R^2 = .4673 \quad F_{2,54} = 23.690^{**}$

$X_2 = 3.59 - .00044X_6 + 8.06X_8$
$(4.362)^{**} \quad (-2.628)^{**} \quad (5.078)^{**}$

$R^2 = .4770 \quad F_{2,54} = 24.623^{**}$

$X_3 = 3.19 - .00037X_6 + 8.10X_8$
$(4.256)^{**} \quad (-2.482)^{**} \quad (5.601)^{**}$

$R^2 = .5061 \quad F_{2,54} = 27.664^{**}$

Great Circle Distance
log

$X_1 = 12.34 - 1.35X_7 + 6.93X_8$
$(3.547)^{**} \quad (-3.145)^{**} \quad (4.538)^{**}$

$R^2 = .5167 \quad F_{2,54} = 28.870^{**}$

$X_2 = 16.48 - 1.83X_7 + 6.46X_8$
$(4.653)^{**} \quad (-4.184)^{**} \quad (4.153)^{**}$

$R^2 = .5545 \quad F_{2,54} = .33608^{**}$

$X_3 = 14.41 - 1.59X_7 + 6.69X_8$
$(4.437)^{**} \quad (-3.965)^{**} \quad (4.694)^{**}$

$R^2 = .5738 \quad F_{2,54} = 36.354^{**}$

* Denotes significance at the .05 level

** Denotes significance at the .01 level

TABLE - 3

OVERALL RESULTS FOR THE UNITED STATES OF AMERICA

Nautical Distance
non-log

$X_1 = 72.56 - .0623X_4$
$(7.593)^{**} \quad (-3.451)^{**}$

$R^2 = .1893 \quad F_{1,51} = 11.907^{**}$

$X_2 = 71.55 - .0075X_4$
$(6.954)^{**} \quad (-3.847)^{**}$

$R^2 = .2249 \quad F_{1,51} = 14.799^{**}$

$X_3 = 72.01 - .0069X_4$
$(7.808)^{**} \quad (-3.931)^{**}$

$R^2 = .2325 \quad F_{1,51} = 15.449^{**}$

Nautical Distance
log

$X_1 = 332.94 - 33.67X_5$
$(5.093)^{**} \quad (-4.417)^{**}$

$R^2 = .2767 \quad F_{1,51} = 19.511^{**}$

$X_2 = 386.20 - 42.11X_5$
$(5.866)^{**} \quad (-5.322)^{**}$

$R^2 = .3570 \quad F_{1,51} = 28.319^{**}$

$X_3 = 354.40 - 37.87X_5$
$(5.971)^{**} \quad (-5.309)^{**}$

$R^2 = .3559 \quad F_{1,51} = 28.180^{**}$

Great Circle Distance
non-log

$X_1 = 73.79 - .0058X_6$
$(6.728)^{**} \quad (-3.036)^{**}$

$R^2 = .1436 \quad F_{1,55} = 9.219^{**}$

$X_2 = 79.21 - .0084X_6$
$(7.202)^{**} \quad (-4.430)^{**}$

$R^2 = .2630 \quad F_{1,55} = 19.627^{**}$

$X_3 = 76.45 - .0071X_6$
$(7.591)^{**} \quad (-4.069)^{**}$

$R^2 = .2314 \quad F_{1,55} = 16.555^{**}$

Great Circle Distance
log

$X_1 = 336.36 - 34.66X_7$
$(5.068)^{**} \quad (-4.434)^{**}$

$R^2 = .2624 \quad F_{1,55} = 19.568^{**}$

$X_2 = 448.30 - 48.93X_7$
$(7.221)^{**} \quad (-6.675)^{**}$

$R^2 = .4476 \quad F_{1,55} = 44.561^{**}$

$X_3 = 392.14 - 41.78X_7$
$(6.793)^{**} \quad (-6.130)^{**}$

$R^2 = .4059 \quad F_{1,55} = 37.571^{**}$

* Denotes significance at the .05 level

** Denotes significance at the .01 level

TABLE - 4

OVERALL RESULTS FOR THE UNITED KINGDOM - EFTA VARIABLE

Nautical Distance
non-log

$$X_1 = 25.30 - .0014X_4 + 25.07X_8$$
$$(2.945)^{**} \quad (-1.085) \quad (2.098)^{*}$$

$$R^2 = .0927 \quad F_{2,50} = 2.554$$

$$X_2 = 27.96 - .0019X_4 + 26.17X_8$$
$$(3.230)^{**} \quad (-1.481) \quad (2.174)^{*}$$

$$R^2 = .1109 \quad F_{2,50} = 3.118$$

$$X_3 = 26.57 - .0017X_4 - 25.67X_8$$
$$(3.230)^{**} \quad (-1.343) \quad (2.244)^{*}$$

$$R^2 = .1104 \quad F_{2,50} = 3.103$$

Nautical Distance
log

$$X_1 = 88.28 - 8.64X_5 + 24.40X_8$$
$$(2.545)^{**} \quad (-2.044)^{*} \quad (2.115)^{*}$$

$$R^2 = .1429 \quad F_{2,50} = 4.169^{*}$$

$$X_2 = 96.04 - 9.59X_5 + 25.02X_8$$
$$(2.743)^{**} \quad (-2.248)^{**} \quad (2.148)^{*}$$

$$R^2 = .1571 \quad F_{2,50} = 4.660^{*}$$

$$X_3 = 92.16 - 9.12X_5 + 24.76X_8$$
$$(2.781)^{**} \quad (-2.259)^{*} \quad (2.247)^{*}$$

$$R^2 = .1637 \quad F_{2,50} = 4.893^{*}$$

Great Circle
non-log

$X_1 = 27.72 - .0024X_6 + 22.36X_8$
$(3.284)^{**} \quad (-1.353) \quad (2.114)^{*}$

$R^2 = .1008 \quad F_{2,54} = 3.028$

$X_2 = 25.52 - .0021X_6 + 30.72X_8$
$(2.680)^{**} \quad (-1.047) \quad (2.573)^{**}$

$R^2 = .1218 \quad F_{2,54} = 3.745^{*}$

$X_3 = 26.59 - .0022X_6 + 26.59X_8$
$(3.152)^{**} \quad (-1.270) \quad (2.515)^{**}$

$R = .1243 \quad F_{2,54} = 3.834^{*}$

Great Circle
log

$X_1 = 90.29 - 9.09X_7 + 21.36X_8$
$(2.613)^{*} \quad (-2.089)^{*} \quad (2.066)^{*}$

$R^2 = .1398 \quad F_{2,54} = 4.390^{*}$

$X_2 = 83.55 - 8.37X_7 + 29.82X_8$
$(2.129)^{*} \quad (-1.693) \quad (2.540)^{**}$

$R^2 = .1491 \quad F_{2,54} = 4.733^{*}$

$X_3 = 87.02 - 8.75X_7 + 25.64X_8$
$(2.517)^{**} \quad (-2.010) \quad (2.480)^{**}$

$R^2 = .1609 \quad F_{2,54} = 5.178^{**}$

* Denotes significance at the .05 level.

** Denotes significance at the .01 level.

TABLE - 5

OVERALL RESULTS FOR THE UNITED KINGDOM - COMMONWEALTH VARIABLE

Nautical
non-log

$X_1 = 27.42 - .00087X_4 + 9.60X_9$
$(2.861)^{**} \quad (-0.612) \quad (0.464)$

$R^2 = .0170 \quad F_{2,50} = 0.433$

$X_2 = 29.95 - .0013X_4 + 11.23X_9$
$(3.093)^{**} \quad (-0.940) \quad (0.538)$

$R^2 = .0325 \quad F_{2,50} = 0.839$

$X_3 = 28.62 - .0011X_4 + 10.48X_9$
$(3.101)^{**} \quad (-0.807) \quad (0.527)$

$R^2 = .0263 \quad F_{2,50} = 0.674$

Nautical
log

$X_1 = 90.61 - 8.25X_5 + 0.61X_9$
$(2.297)^{*} \quad (-1.741) \quad (0.030)$

$R^2 = .0662 \quad F_{2,50} = 1.774$

$X_2 = 96.32 - 8.96X_5 + 3.38X_9$
$(2.417)^{*} \quad (-1.871) \quad (0.163)$

$R^2 = .0798 \quad F_{2,50} = 2.168$

$X_3 = 93.44 - 8.61X_5 + 2.04X_9$
$(2.467)^{**} \quad (-1.891) \quad (0.103)$

$R^2 = .0794 \quad F_{2,50} = 2.157$

Great Circle
non-log

$X_1 = 32.86 - .0022X_6 + .46X_9$
$(3.418)^{**} \quad (-1.105) \quad (0.027)$

$R^2 = .0264 \quad F_{2,54} = .734$

$X_2 = 31.96 - .0017X_6 + 2.92X_9$
$(2.894)^{**} \quad (-0.754) \quad (0.148)$

$R^2 = .0146 \quad F_{2,54} = 0.399$

$X_3 = 32.38 - .0020X_6 + 1.72X_9$
$(3.318)^{**} \quad (-0.973) \quad (0.099)$

$R^2 = .0220 \quad F_{2,54} = 0.607$

Great Circle
log

$X_1 = 103.32 - 9.96X_7 - 5.98X_9$
$(2.599)^{**} \quad (-2.014) \quad (-0.355)$

$R^2 = .0740 \quad F_{2,54} = 2.158$

$X_2 = 97.05 - 9.04X_7 - 3.84X_9$
$(2.108)^{*} \quad (-1.580) \quad (-0.197)$

$R^2 = .0482 \quad F_{2,54} = 1.367$

$X_3 = 100.29 - 9.52X_7 - 4.90X_9$
$(2.481)^{**} \quad (-1.894) \quad (-0.285)$

$R^2 = .0668 \quad F_{2,54} = 1.933$

* Denotes significance at the .05 level.

** Denotes significance at the .01 level.

TABLE - 6

OVERALL RESULTS FOR THE UNITED KINGDOM - EFTA COMMONWEALTH VARIABLES

Nautical
non-log

$$X_1 = \underset{(3.100)^{**}}{28.61} - \underset{(-1.415)}{.0021X_4} + \underset{(2.266)^{*}}{33.97X_8} + \underset{(0.475)}{9.45X_9}$$

$$R^2 = .1102 \quad F_{3,49} = 2.024$$

$$X_2 = \underset{(3.348)^{**}}{31.16} - \underset{(-1.747)}{.0026X_4} + \underset{(2.300)^{*}}{34.77X_8} + \underset{(0.552)}{11.07X_9}$$

$$R^2 = .1267 \quad F_{3,49} = 2.370$$

$$X_3 = \underset{(3.376)^{**}}{29.82} - \underset{(-1.657)}{.0023X_4} + \underset{(2.398)^{*}}{34.41X_8} + \underset{(0.543)}{10.33X_9}$$

$$R^2 = .1285 \quad F_{3,49} = 2.409$$

Nautical
log

$$X_1 = \underset{(2.975)^{**}}{114.27} - \underset{(-2.524)^{**}}{11.85X_5} + \underset{(2.613)^{**}}{36.65X_8} + \underset{(.046)}{.89X_9}$$

$$R^2 = .1805 \quad F_{3,49} = 3.597^{*}$$

$$X_2 = \underset{(3.073)^{**}}{119.66} - \underset{(-2.629)^{**}}{12.51X_5} + \underset{(2.542)^{**}}{36.15X_8} + \underset{(0.186)}{3.65X_9}$$

$$R^2 = .1870 \quad F_{3,49} = 3.758^{*}$$

$$X_3 = \underset{(3.188)^{**}}{116.98} - \underset{(-2.718)^{**}}{12.19X_5} + \underset{(2.721)^{**}}{36.46X_8} + \underset{(.125)}{2.31X_9}$$

$$R^2 = .2003 \quad F_{3,49} = 4.090^{*}$$

Great Circle
non-log

$X_1 = 34.29 - .0042X_6 + 37.73X_8 + 0.51X_9$
$(3.778)^{**} \quad (-2.084)^{**} \quad (2.787)^{**} \quad (.031)$

$R^2 = .1509 \quad F_{3,53} = 3.140$

$X_2 = 33.87 - .0043X_6 + 50.22X_8 + 2.98X_9$
$(3.333)^{**} \quad (-1.941) \quad (3.313)^{**} \quad (0.165)$

$R^2 = .1836 \quad F_{3,53} = 3.974^{*}$

$X_3 = 34.05 - .0043X_6 + 44.04X_8 + 1.77X_9$
$(3.786)^{**} \quad (-2.151)^{*} \quad (3.283)^{**} \quad (0.111)$

$R^2 = .1873 \quad F_{3,53} = 4.070^{*}$

Great Circle
log

$X_1 = 130.14 - 14.17X_7 + 38.60X_8 - 5.01X_9$
$(3.416)^{**} \quad (-2.945)^{**} \quad (3.027)^{**} \quad (-.319)$

$R^2 = .2105 \quad F_{3,53} = 4.711^{**}$

$X_2 = 132.48 - 14.61X_7 + 51.00X_8 - 2.56X_9$
$(3.085)^{**} \quad (-2.693)^{**} \quad (3.548)^{**} \quad (-0.144)$

$R^2 = .2308 \quad F_{3,53} = 5.302^{**}$

$X_3 = 131.46 - 14.42X_7 + 44.87X_8 - 3.76X_9$
$(3.487)^{**} \quad (-3.027)^{**} \quad (3.556)^{**} \quad (-0.242)$

$R^2 = .2466 \quad F_{3,53} = 5.782^{**}$

* Denotes significance at the .05 level.

** Denotes significance at the .01 level.

TABLE - 7

OVERALL RESULTS FOR COLUMBIA

Nautical
non-log

$$X_1 = \underset{(2.298)*}{1.40} - \underset{(-1.793)}{.00017X_4} + \underset{(2.239)*}{1.82X_8}$$

$$R^2 = .2078 \quad F_{2,50} = 6.557**$$

$$X_2 = \underset{(1.468)}{0.39} - \underset{(-0.874)}{.00036X_4} + \underset{(3.901)**}{1.37X_8}$$

$$R^2 = .3018 \quad F_{2,50} = 10.806**$$

$$X_3 = \underset{(2.111)*}{0.90} - \underset{(-1.599)}{.00011X_4} + \underset{(2.803)**}{1.59X_8}$$

$$R^2 = .2432 \quad F_{2,50} = 8.032**$$

Nautical
log

$$X_1 = \underset{(2.860)**}{7.68} - \underset{(-2.711)**}{0.86X_5} + \underset{(2.021)*}{1.58X_8}$$

$$R^2 = .2648 \quad F_{2,50} = 9.006**$$

$$X_2 = \underset{(1.815)}{2.14} - \underset{(-1.667)}{0.23X_5} + \underset{(3.699)**}{1.27X_8}$$

$$R^2 = 0.3285 \quad F_{2,50} = 12.228**$$

$$X_3 = \underset{(2.635)**}{4.97} - \underset{(-2.489)**}{0.56X_5} + \underset{(2.600)**}{1.43X_8}$$

$$R^2 = .2921 \quad F_{2,50} = 10.318**$$

Great Circle
non-log

$X_1 = 1.46 - .00017X_6 + 1.68X_8$
$(2.189)^* \quad (-1.710) \quad (2.012)$

$R^2 = .2039 \quad F_{2,54} = 6.913^{**}$

$X_2 = .36 - .000027X_6 + 1.36X_8$

$(1.233) \quad (-0.618) \quad (3.740)^{**}$

$R^2 = .2911 \quad F_{2,54} = 11.086^{**}$

$X_3 = .92 - .00010X_6 + 1.52X_8$
$(1.957) \quad (-1.447) \quad (2.595)^{**}$

$R^2 = .2364 \quad F_{2,54} = 8.361^{**}$

Great Circle
log

$X_1 = 9.56 - 1.07X_7 + 1.15X_8$
$(3.029)^{**} \quad (-2.907)^{**} \quad (1.424)$

$R^2 = .2743 \quad F_{2,54} = 10.206^{**}$

$X_2 = 2.75 - 0.30X_7 + 1.13X_8$
$(1.959) \quad (-1.827) \quad (3.127)^{**}$

$R^2 = .3276 \quad F_{2,54} = 13.156^{**}$

$X_3 = 6.22 - 0.69X_7 + 1.14X_8$
$(2.800)^{**} \quad (-2.676)^{**} \quad (2.001)$

$R^2 = .2997 \quad F_{2,54} = 11.553^{**}$

* Denotes significance at the .05 level.

** Denotes significance at the .01 level.

TABLE - 8

OVERALL RESULTS FOR ARGENTINA

Nautical
non-log

$$X_1 = \underset{(2.166)*}{2.55} - \underset{(-1.510)}{.00025X_4} + \underset{(3.111)**}{2.99X_8}$$

$$R^2 = .3254 \quad F_{2,50} = 12.056**$$

$$X_2 = \underset{(1.798)}{1.52} - \underset{(-1.327)}{.00016X_4} + \underset{(4.835)**}{3.35X_8}$$

$$R^2 = .4757 \quad F_{2,50} = 22.680**$$

$$X_3 = \underset{(2.151)*}{2.03} - \underset{(-1.533)}{.00020X_4} + \underset{(4.099)**}{3.17}$$

$$R^2 = .4233 \quad F_{2,50} \; 18.353**$$

Nautical
log

$$X_1 = \underset{(1.464)}{7.01} - \underset{(-1.292)}{0.70X_5} + \underset{(3.136)**}{3.07X_8}$$

$$R2 = .3173 \quad F_{2,50} = 11.622*$$

$$X_2 = \underset{(1.567)}{5.36} - \underset{(-1.441)}{0.56X_5} + \underset{(4.695)**}{3.28X_8}$$

$$R^2 = .4789 \quad F_{2,50} = 22.971**$$

$$X_3 = \underset{(1.611)}{6.18} - \underset{(-1.448)}{0.63X_5} + \underset{(4.047)**}{3.18X_8}$$

$$R^2 = .4205 \quad F_{2,50} = 18.142**$$

Great Circle
non-log

$$X_1 = \underset{(1.678)}{1.75} - \underset{(-0.922)}{.00013X_6} + \underset{(3.019)^{**}}{3.15X_8}$$

$$R^2 = .3072 \quad F_{2,54} = 11.971^{**}$$

$$X_2 = \underset{(1.181)}{0.89} - \underset{(-0.606)}{.000064X_6} + \underset{(4.66)^{**}}{3.53X_8}$$

$$R^2 = .4564 \quad F_{2,54} = 22.673^{**}$$

$$X_3 = \underset{(1.572)}{1.32} - \underset{(-0.844)}{.000099X_6} + \underset{(3.969)^{**}}{3.34X_8}$$

$$R^2 = .4044 \quad F_{2,54} = 18.334^{**}$$

Great Circle
log

$$X_1 = \underset{(2.760)^{**}}{13.24} - \underset{(-2.592)^{**}}{1.14X_7} + \underset{(1.543)}{1.70X_8}$$

$$R^2 = .3741 \quad F_{2,54} = 16.141^{**}$$

$$X_2 = \underset{(2.702)^{**}}{9.37} - \underset{(-2.576)^{**}}{1.01X_7} + \underset{(2.935)^{**}}{2.33X_8}$$

$$R^2 = .5126 \quad F_{2,54} = 28.400^{**}$$

$$X_3 = \underset{(2.951)^{**}}{11.30} - \underset{(-2.789)^{**}}{1.12X_7} + \underset{(2.294)^{**}}{2.01X_8}$$

$$R^2 = .4725 \quad F_{2,54} = 24.187^{**}$$

* Denotes significance at the .05 level.

** Denotes significance at the .01 level.

TABLE - 9

OVERALL RESULTS FOR GERMANY

Nautical
non-log

$$X_1 = 30.25 - .0018X_4 + 51.13X_8$$
$$(6.731)^{**} \quad (-2.824)^{**} \quad (5.362)^{**}$$

$$R^2 = .5120 \quad F_{2,50} = 26.2290^{**}$$

$$X_2 = 33.80 - .002X_4 + 46.81X_8$$
$$(3.667)^{**} \quad (-1.524) \quad (2.393)^{*}$$

$$R^2 = .1902 \quad F_{2,50} = 5.870^{**}$$

$$X_3 = 32.03 - .0019X_4 + 48.97X_8$$
$$(5.643)^{**} \quad (-2.355)^{*} \quad (4.066)^{**}$$

$$R^2 = .3894 \quad F_{2,50} = 15.9452^{**}$$

Nautical
log

$$X_1 = 101.57 - 9.84X_5 + 41.44X_8$$
$$(5.650)^{**} \quad (-4.593)^{**} \quad (4.564)^{**}$$

$$R^2 = .6020 \quad F_{2,50} = 37.82^{**}$$

$$X_2 = 77.90 - 6.70X_5 + 43.98X_8$$
$$(1.900) \quad (-1.372) \quad (2.124)^{*}$$

$$R^2 = .1833 \quad F_{2,50} = 5.611^{**}$$

$$X_3 = 89.73 - 8.27X_5 + 42.71X_8$$
$$(3.646)^{**} \quad (-2.820)^{**} \quad (3.436)^{**}$$

$$R^2 = .4148 \quad F_{2,50} = 17.719^{**}$$

Great Circle
non-log

$X_1 = 42.07 - .0047X_6 + 39.14X_8$
$(7.491)^{**} \quad (-4.015)^{**} \quad (3.116)^{**}$

$R^2 = .4188 \quad F_{2,54} = 19.453^{**}$

$X_2 = 35.03 - .0028X_6 + 44.60X_8$
$(3.959)^{**} \quad (-1.502) \quad (2.255)^{*}$

$R^2 = .1683 \quad F_{2,54} = 5.463^{**}$

$X_3 = 38.55 - .0037X_6 + 41.87X_8$
$(6.630)^{**} \quad (-3.082)^{**} \quad (3.220)^{**}$

$R2 = .3584 \quad F_{2,54} = 15.080^{**}$

Great Circle
log

$X_1 = 162.42 - 17.52X_7 + 16.80X_8$
$(7.468)^{**} \quad (-6.444)^{**} \quad (1.421)$

$R2 = .5733 \quad F_{2,54} = 36.281^{**}$

$X_2 = 91.62 - 8.52X_7 + 35.51X_8$
$(2.305)^{*} \quad (-1.715) \quad (1.643)$

$R2 = .1783 \quad F_{2,54} = 5.857^{**}$

$X_3 = 127.02 - 13.02X_7 + 26.16X_8$
$(5.138)^{**} \quad (-4.213)^{**} \quad (1.946)$

$R^2 = .4321 \quad F_{2,54} = 20.546^{**}$

* Denotes significance at the .05 level.

** Denotes significance at the .01 level.

analyzed multiple regression equation sets, four base countries are represented by Great Circle measures and three by nautical measures. Frequently the differences in the equation sets were very minor, as in the case of the United States.

The signs of the distance variable are all negative, as expected. In fact, all the signs in the estimated equations are of the proper direction. The only possible exception would be the coefficient of the dummy variable for the Commonwealth of Nations X_9, in the United Kingdom equations where it frequently has a negative value. However, this variable is never statistically, significant.

In general, the variables and the equations display a high level of significance. Even in the equations not selected for inclusion in the final model, the performance of these variables was good. This all seems to speak well for the role of distance and protectionist barriers in providing an explanation of the trading patterns of the nations in the model.

Equations by Base County

Japan

TABLE 10 Final Equations for Japan

(1) $X_1 = \underset{(5.302)^{**}}{309.59} - \underset{(-5.005)^{**}}{32.29X_5}$

$R^2 = .3294 \quad F_{1,51} = 25.052^{**}$

(2) $X_2 = \underset{(4.684)^{**}}{174.03} - \underset{(-4.287)^{**}}{17.60X_5}$

$R^2 = .2649 \quad F_{1,51} = 18.378^{**}$

(3) $X_3 = 241.81 - 24.95X_5$
$\quad\quad (6.769)^{**} \quad (-6.320)^{**}$

$R^2 = .4392 \quad F_{1,51} = 39.945^{**}$

* Denotes significance at the .05 level
** Denotes significance at the .01 level

The best results for Japan were obtained from the nautical distance measure, X_5. All t and F values are significant at the .01 level of confidence. The results for equation (3) show an unadjusted R^2 approaching .44 and large t and F values, indicating a strong role for the distance variable in the overall pattern of Japanese trade.

In terms of imports and exports, distance is somewhat stronger in determining the import pattern. As a heavy importer of raw materials and an exporter of finished goods to distant industrialized markets, it is expected that distance would have a greater impact on the import pattern, as Japanese raw materials markets exhibit nearness to Japan and a wider choice of alternative suppliers than do her export markets.

Denmark

Table 11 Final Results for Denmark

(1) $X_1 = 9.49 - 0.97X_5 + 11.81X_8$
$\quad\quad (3.384)^{**} \quad (-2.893)^{**} \quad (7.216)^{**}$

$R^2 = .6418 \quad F_{2,50} = 44.799^{**}$

(2) $X_2 = 14.03 - 1.47X_5 + 10.74X_8$
$(4.755)^{**} \quad (-4.173)^{**} \quad (6.235)^{**}$

$R^2 = .6412 \quad F_{2,50} = 44.673^{**}$

(3) $X_3 = 11.76 - 1.22X_5 + 11.27X_8$
$(4.503)^{**} \quad (-3.911)^{**} \quad (7.397)^{**}$

$R^2 = .6836 \quad F_{2,50} = 54.016^{**}$

* Denotes significance at the .05 level.
** Denotes significance at the .01 level.

The best results for Denmark were obtained by using the nautical distance measure, X_5. All t and F values, are significant at the .01 level. When viewed in combination with the high R^2 values, the results for Denmark are the most consistently significant, having the highest significance found in this study. In equation (3) the unadjusted R^2 reaches .68, with equations (1) and (2) having R^2's of about .64.

The dummy variable for the European Free Trade Area, X_8, performed quite well, with t-values consistently highly significant. Given the relatively short distances between Denmark and the other EFTA members, X_8 may well have absorbed some of the explanation otherwise attributable to X_5.

An examination of the residuals shows unusually large values for the other Scandanavian nations, Norway, Finland and Sweden. Given the historical trading patterns and cultural similarities of taste and consumption patterns, it is no surprise to find these extreme values. The introduction of an additional dummy variable for these nations would be expected to increase the overall

significance of the Denmark equations.

The United States

TABLE 12 Final Results for the United States

(1) $X_1 = 336.36 - 34.66X_7$
$(5.068)^{**} \quad (-4.434)^{**}$

$R^2 = .2624 \quad F_{1,55} = 19.568^{**}$

(2) $X_2 = 448.30 - 48.93X_7$
$(7.221)^{**} \quad (-6.675)^{**}$

$R^2 = .4476 \quad F_{1,55} = 44.561^{**}$

(3) $X_3 = 392.14 - 41.78X_7$
$(6.793)^{**} \quad (-6.130)^{**}$

$R^2 = .4059 \quad F_{1,55} = 37.571^{**}$

* Denotes significance at the .05 level.
** Denotes significance at the .01 level.

The best results for the United States were obtained by using the Great Circle distance variable, X_7. All t and F values were significant at the .01 level.

Equation (2) had the best performance of the distance measure and produced an unadjusted R^2 approaching .45. Comparing equation (1) with equation (2) shows that the distance variable is stronger in explaining the export patterns.

Equation (3) indicates a strong role for distance in the overall pattern of United States trade. The unadjusted R^2 is .40.

The United Kingdom

TABLE 13 Final Results for the United Kingdom

(1) $X_1 = 130.14 - 14.17X_7 + 38.60X_8 - 5.01X_9$
$(3.416)^{**} \quad (-2.945)^{**} \quad (3.027)^{**} \quad (-0.319)$

$R^2 = .2105 \quad F_{3,53} = 4.711^{**}$

(2) $X_2 = 132.48 - 14.61X_7 + 51.00X_8 - 2.56X_9$
$(3.085)^{**} \quad (-2.693)^{**} \quad (3.548)^{**} \quad (-0.144)$

$R^2 = .2308 \quad F_{3,53} = 5.302^{**}$

(3) $X_3 = 131.46 - 14.42X_7 + 44.87X_8 - 3.76X_9$
$(3.487)^{**} \quad (-3.027)^{**} \quad (3.556)^{**} \quad (-0.242)$

$R^2 = .2466 \quad F_{3,53} = 5.782^{**}$

* Denotes significance at the .05 level.
** Denotes significance at the .01 level.

The best results for the United Kingdom were produced by the Great Circle distance measure, variable X_7. Better results were obtained by including both dummy variables, X_8 and X_9 for the European Free Trade Area and the British Commonwealth respectively, than when the regression was tried with only X_8 or X_9. Even though the British Commonwealth variable, X_9, shows a consistent negative correlation with the trade levels, this negative correlation indicates that membership in the Commonwealth has a slight trade reducing effect. However, variable X_9 has a notable lack of statistical significance.

It should be noted that an examination of the residuals reveals an extremely large value for Ireland, a geographically close non-Commonwealth member, who is heavy trading partner of the United Kingdom.

With the exception of X_9 the variables exhibit significant t-value at the .01 level. The unadjusted R^2's range from .21 in equation (1) to .24 in equation (3). They are the lowest R^2's of the developed base countries in the study with the exception of the German export equation.

The overall pattern of British trade described in equation (3), shows the best performance of the distance variable, with the export equation (2) following closely. In general, the results of the equations indicate that the British trade pattern is more strongly influenced by historical factors and economic considerations other than distance than are the other base countries in the model. This is not surprising in view of the United Kingdom's long trading history.

Columbia

TABLE 14 Final Results for Columbia

(1) $X_1 = \underset{(3.029)^{**}}{9.56} - \underset{(-2.907)^{**}}{1.07X_7} + \underset{(1.424)}{1.15X_8}$

$R^2 = .2743 \quad F_{2,54} = 10.206^{**}$

(2) $X_2 = \underset{(1.959)}{2.75} - \underset{(-1.827)}{0.30X_7} + \underset{(3.127)^{**}}{1.13X_8}$

$R^2 = .3276 \quad F_{2,54} = 13.156^{**}$

(3) $X_3 = 6.22 - 0.69X_7 + 1.14X_8$
$(2.800)^{**} \quad (-2.676)^{**} \quad (2.001)$

$R^2 = .2997 \quad F_{2,54} = 11.553^{**}$

* Denotes significance at the .05 level.
** Denotes significance at the .01 level.

The best results for Columbia were obtained by using the Great Circle distance measure. The F statistic exhibited valued significant at the .01 level. The distance variable, X_7, performed best in the import equation (1), and the Latin American Free Trade Area, X_8, performed best in the export equation (2). The unadjusted R^2's range from .27 in equation (1) to .32 in equation (2).

The rather mediocre results for Columbia may be attributed to a geograhpic location, relative to both the developed nations and the other LAFTA members, which has few sizeable distance variations.

Argentina

TABLE 15 Final Results for Argentina

(1) $X_1 = 13.24 - 1.41X_7 + 1.70X_8$
$(2.760)^{**} \quad (-2.592)^{**} \quad (1.543)$

$R^2 = .3741 \quad F_{2,54} = 16.141^{**}$

(2) $X_2 = 9.37 - 1.01X_7 + 2.33X_8$
$(2.702)^{**} \quad (-2.576)^{**} \quad (2.935)^{**}$

$R^2 = .5126 \quad F_{2,54} = 28.40^{**}$

$$(3)\quad X_3 = \underset{(2.951)^{**}}{11.30} - \underset{(-2.789)^{**}}{1.21X_7} + \underset{(2.294)^{**}}{2.01X_8}$$

$$R^2 = .4725 \quad F_{2,54} = 24.187^{**}$$

* Denotes significance at the .05 level.
** Denotes significance at the .01 level.

The best results for Argentina are produced by using the Great Circle distance measure, variable X_7. With the exception of X_8 in equation (1), the t-values are all at the .01 level of significance. The F values are all significant at the .01 level.

The unadjusted R^2's range from .37 in equation (1) to .51 in equation (2). In all equations the distance variable, X_7, is highly significant. The Latin American Free Trade Area variable, X_8, shows highly significant levels in both equation (2) and equation (3), but is non significant in equation (1). Since Argentina is the most heavily industrialized member of LAFTA, the highly significant showing of variable X_8 in equation (2), exports, is not surprising. Its lack of significance in the import equation (1) raises the question of raw materials markets. This seems to imply that those raw materials Argentina does not obtain internally, are obtained from non-LAFTA nations. With the resultant manufactured goods being exported to the LAFTA nations. The export of Argentine raw materials and agricultural products to the LAFTA nations must be considered as contributing to the differences between the LAFTA variables performance in equations (1) and (2). The equations imply that with respect to the LAFTA countries, trade with Argentina is heavily concentrated in manufactured products.

Germany

TABLE 16 Final Results for Germany

(1) $X_1 = 101.57 - 9.84X_5 + 41.44X_8$
$(5.650)^{**} \quad (-4.593)^{**} \quad (4.564)^{**}$

$R^2 = .6020 \quad F_{2,50} = 37.83^{**}$

(2) $X_2 = 77.90 - 6.70X_5 + 43.98X_8$
$(1.900) \quad (-1.372) \quad (2.124)^{*}$

$R^2 = .1833 \quad F_{2,50} = 5.61^{**}$

(3) $X_3 = 89.73 - 8.27X_5 + 42.71X_8$
$(3.646)^{**} \quad (-2.820)^{**} \quad (3.436)^{**}$

$R^2 = .4148 \quad F_{2.50} = 17.719^{**}$

* Denotes significance at the .05 level.
** Denotes significance at the .01 level.

The best results for the Germany equations were obtained by utilizing nautical distance variable X_5, although the Great Circle results were very similar.

The F-statistics are all significant at the .01 level. All t-values in equation (1) are significant at the .01 level.

The combination of high t and F values with an R^2 of .6020 in equation (1) lends much confidence to the explanatory power of distance and protectionist barriers in determining the German import pattern.

The results of equation (3) indicates an important role for the distance variable and the EEC variable in the overall pattern of German trade.

The export equation (2) is especially interesting, largely because of the general absence of significant t-values. Only the EEC variable, X_8, is significant and then only at the .05 level. The F-statistic, however, is significant at the .01 level. The R^2 is .1833. This seems to indicate that German exports are of such a nature as to be relatively insentive to transportation costs and to institutional barriers. This is in marked contrast to the results of the equation (1). German's historic reputation for the efficient production of goods of high quality and advanced technology may account for this. The significance of the EEC variable X_8 may indicate that within the Common Market, German exports are shown a degree of preference over competive products of non-members such that X_8 will be significant, because the distance among the EEC nations is relatively small, the impact of the distance variable (X_5) is reduced by the inclusion of X_8 in the estimated equations.

Summary

In general, the results indicate a strong role for distance and protectionist barriers in explaining the patterns of international trade. Overall, the variables show high levels of significance in the t-test. All the equations in the final model exhibit F-test values which are significant at the .01 level, indicating that the overall estimated equations are highly significant. The signs of the variables are all consistent with prior expectations.

The calculated values of R^2 take on magnitudes which are moderate to high throughout the study. This is especially notable given that only two types of variables are included in the equations, i.e., distance and protectionist barriers. Given the complexity of international trade, the ability of these variables to produce highly significant results, with R^2's ranging from .18 in the German export equation to .68 in the Danish overall trade equation, speaks well for their power and importance.

CHAPTER V

SUMMARY AND CONCLUSIONS

Summary

The present study consists of a model of sixty-one nations; measures of trade intensity i.e., imports, export, and total trade volume as a percentage of national income; measures of geographic distance; and a proxy measure of protectionist barriers. Each trade intensity measure was regressed in turn, in an ordinary least squares regression, against each distance measure and the protectionist barrier proxy, if any. This produced four sets (one set for each distance variable) of three multiple regression equations (one equation for each trade intensity measure) for each of the seven base countries. Of the four equation sets, the set providing the largest degree of explanation of the base country's international trade pattern was selected for analysis.

The theories of international trade discussed earlier in this study do not consider the variables of distance and protectionist barriers, which are the major focus of this study. Most of the empirical tests also exclude these variables. The empirical tests are constructed to examine portions of the theories which inspired them, rather than as examinations of observed patterns of international trade. Thus, the present study differs in at least two important ways from those preceeding it. First, it devotes attention to variables not previously considered as primary, i.e., distance

and protectionist barriers. Second, it examines an observed international trade pattern rather than a theoretical framework. It neither proports to verify a theory, nor does it propose one.

The present study examines the neglected variables of geographic distance and protectionist barriers, in order to ascertain how much of the variation of the trade intensities the variables may be able to explain. Overall, the results indicate that they explain a sizeable proportion of the variation.

An examination of the equation sets selected for analysis reveals high levels of significance in the statistical tests and strong consistency of behavior for all the equations. The t-test shows high levels of significance throughout. All the equations in the final model exhibit F-test values which are significant at the .01 level of significance, indicating that the overall estimated equations are highly significant. The signs of the variables are all consistent with a prior expectations. The calculated values of R^2 take on magnitudes which are moderate to high throughout the study. This is especially notable given that only two types of variables are included in the equations.

Conclusions

The statistically significant results forces the somewhat simplistic conclusion that the variables of distance and protectionist barriers are too powerful to continue to be neglected when international trade flows are considered. It would appear, that by excluding these variables from international trade theory, a sizeable

proportion of the explanation of international trade is lost. Historically, international trade theory has first addressed itself to the production of commodity classes in a domestic economy. These goods then become traded internationally because of some domestic economic consideration. The present study has not approached the question of domestic production. It has taken a given pattern of international trade and attempted to explain part of why the pattern exhibits a particular form. Hence, the theories and this study do not approach international trade from the same vantage point. The strong results of the study suggest that distance and trade barriers are sufficiently important to warrant further investigation in their own right. However, the strong results also suggest that new insights into international trade may be obtained by a shift in vantage point, i.e., viewing international trade principally as an international phenomena in which goods move through space and across borders.

If this study presents any meaningful conslusions, and I believe that it does, they are twofold. First, if deeper understanding of international trade is to be obtained hopefully with greater predictive abilities, then distance and protectionist barriers must be explicitly considered as integral to further study. Second, if greater knowledge of the mechanisms of international trade is sought, then productive new insights may be obtained by switching vantage points and examining international trade first as an international phenomena and second as an extension of domestic economics.

Suggestions for Further Research

The present study suggests several possible paths for further investigation. Disaggregation of trade intensities into fairly broad commodity groups could provide insights into the sensitivity of various commodities to distance and protectionist barriers. While such a measure as sensitivity is largely another version of price elasticity of demand, such a concept may hold interesting implications for nations heavily involved in the production or consumption of commodities at either end of a sensitivity scale. The rise of the multi-national corporation, which splits stages of production among nations, introduces new influences on trade patterns. An attempt to isolate and measure the effects of distance and protectionist barriers on this dispersion of production should give better insight into not only the mechanisms of international trade, but also, the role of the multi-national corporation in setting patterns of trade.

The type of simple model used in this study is conducive to the building of time series models. The construction of time series data would permit simulation of trade patterns over future time periods and under varying economic conditions. Such a model might be a useful step toward a predictive model of international trade.

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APPENDIX A

NATIONS IN THE MODEL

Nations	Cities Used to Compute Distance	
	Nautical Distance	Great Circle Distance
Ivory Coast	Abidjan	Abidjan
Kenya	Mombasa	Nairobi
Malagasy Republic	Tamatave	Tananarive
Morocco	Tangier	Casablanca
Republic of South Africa	Cape Town	Johannesburg
Tunisia	Tunis	Tunis
Tanzania	Dar es Salaam	Dar es Salaam
United States of America*	New York City	Chicago
Canada	Montreal	Montreal
Argentina*	Buenos Aires	Buenos Aires
Brazil	Rio de Janeiro	Rio de Janeiro
Chile	Valparaiso	Santiago
Columbia*	Cartagena	Bogota
Costa Rica	Limon	San Jose
Dominican Republic	Santo Domingo	Santo Domingo
Ecuador	Guayaquil	Quito
El Salvador	Acajutla	San Salvador
Guatemala	Puerto Barrios	Guatemala City
Honduras	Puerto Cortez	Tegucigalpa

* Denotes a Base Country

APPENDIX A - continued

NATIONS IN THE MODEL

Nations	Cities Used to Compute Distance	
	Nautical Distance	Great Circle Distance
Mexico	Tampico	Mexico City
Nicaragua	Bluefields	Managua
Peru	Pisco	Lima
Uruguay	Montevideo	Montevideo
Venezuela	La Guaria	Caracas
Iran	Bushehr	Tehran
Israel	Haifa	Tel Aviv
Lebanon	Beirut	Beirut
Syria	Al Ladhiqiyah	Damascus
Turkey	Istanbul	Istanbul
Ceylon	Colombo	Colombo
Indonesia	Djakarta	Djakarta
Japan*	Yokohama	Tokyo
Republic of Korea	Pusan	Seoul
Phillippines	Manila	Manila
Singapore	Singapore	Singapore
Belgium	Antwerp	Brussels
France	Le Havre	Paris
Federal Republic of Germany*	Hamburg	Hamburg

* Denotes a Base Country

APPENDIX A - continued

NATIONS IN THE MODEL

Nations	Cities Used to Compute Distance	
	Nautical Distance	Great Circle Distance
Italy	Genoa	Rome
Netherlands	Rotterdam	Amsterdam
Austria	---	Vienna
Denmark*	Esberg	Copenhagen
Finland	Helsinki	Helsinki
Norway	Oslo	Oslo
Portugal	Lisbon	Lisbon
Sweden	Goteborg	Stockholm
Greece	Piraievs	Athens
Ireland	Dublin	Dublin
Spain	Cadiz	Madrid
Australia	Sydney	Sydney
Egypt	Port Said	Cairo
India	Bombay	Calcutta
Switzerland	---	Zurich
Hong Kong	Hong Kong	Hong Kong
New Zealand	Wellington	Auckland
United Kingdom*	London	London
Ghana	Accra	Accra
Libya	Banghazi	Tripoli
Sudan	Port Sudan	Khartoum

* Denotes a Base County

APPENDIX A - continued

NATIONS IN THE MODEL

Nations	Cities Used to Compute Distance	
	Nautical Distance	Great Circle Distance
Zambia	---	Lusaka
Jordan	---	Amman

APPENDIX B

VARIABLES IN THE MODEL

Variable X_1, measures the average propensity of the non-base country to import from the base country. It is the ratio of the dollar value of imports of the non-base country from the base country to the dollar national income of the non-base country.

Variable X_2, measures the average propensity of the base country to import from the non-base country. As with variable X_1, it is the ratio of the dollar value of the base country's imports to the dollar value national income of the non-base country.

Variable X_3, is a measure of both directions of trade. It is the arithmetic average of variables X_1 and X_2.

Variable X_4, is the steamer distance from the base country to the non-base country.

Variable X_5, is the logarithem of variable X_4.

Variable X_6, is the Great Circle distance from the base country to the non-base country.

Variable X_7, is the logarithem of variable X_6.

Variable X_8, is the first dummy variable indicating membership or non-membership in the same economic association as the base country.

Variable X_9, is the second dummy variable indicating membership status in base country economic associations. This variable is used when the base country is a member of two economic associations.

APPENDIX C

DATA SOURCES

The data sources for the study have all been noted separately earlier, but are repeated here for ready reference.

(1) National income data for 1970, expressed in United States dollars:

United Nations, Yearbook of National Accounts Statistics, 1971, Vol. III, New York, 1973.

(2) Import and export data for 1970, expressed in United States dollars:

International Monetary Fund, Direction of Trade Annual, 7th ed., Washington, D. C., 1971.

(3) Ocean shipping lane distances, expressed in nautical miles, utilizing the routes which permit the quickest passage:

U. S. Naval Oceanographic Office, Distance Between Ports, Washington, D. C., 1965.

(4) Great Circle (international air lane) distances, expressed in statute miles:

International Air Transport Association, Tabulation of Great Circle Distances, 4th ed., Montreal, Canada, 1966, revised thru April, 1974.