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The Relationship Between International Trade and Transportation: Theory and Developments

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The importance of international trade to United States agriculture is well recognized today when nearly one out of every three acres in crop production finds its market overseas. Consequently, transportation considerations including international transportation developments are important research and policy issues from the standpoint that they affect significantly agriculture's ability to service overseas markets on a competitive basis. This paper will be concerned with international trade and transportation from the standpoint of surveying how their relationship has been viewed by economists in the past, what are some of the important developments today in the international transportation arena, and what are some of the approaches applicable to future research efforts in the area of international trade and transportation.

Received International Trade Theory and Transportation

The first part of this paper reviews the historical position of transportation considerations in international trade theory literature. Economists have a tradition tracing back to Adam Smith of allocating a substantial portion of their attention to developing a theoretical framework to explain the role and reasons for the existence of international trade. Consequently, an extensive body of literature is available to researchers and policy analysts

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today on the subject of international trade. The question in this session is, does this body of received trade literature offer any insights to researchers concerned with transportation research as it applies to agricultural trade today and in the future? This is a logical question to raise but after one surveys the information received from this body of trade theory, one discovers that very modest attention has been given to the role of transportation by economists associated with international trade issues. In fact, the premise that will be developed in this paper is that transportation matters need to be investigated conceptually and empirically with regard to how they might fill a void in international trade research.

Returning to the development of international trade theory, world trade expanded to unprecedented proportions in the nineteenth century with England assuming the role of lead player. Concomitantly the classical English economists turned their attention to the subject of world trade. Specifically, Torrens, Ricardo, Mill, and others focused in on the gains of trade derived from specialization. Important points were scored for the cause of liberalizing England's international trade policy as a result of the articulation of the principles of comparative advantage and reciprocal trade during this era. These principles served then, and continue to serve now, as underpinnings for policy subscriptions to remove governmentally created barriers and distortions to international specialization and trade between regions and peoples separated by national boundaries. The abolishment of the so-called Corn Laws in England was a precedent to unilateral and multilateral efforts later to remove restrictions that impose constraints upon international specialization. The multinational trade negotiations in Geneva today are a continuation of efforts in this direction.

International trade theory historically has put considerable emphasis upon the issues of what goods a country will trade and at what relative prices, or

terms of trade. Which goods a country exports and which it imports according to classical trade theory is dictated by the law of comparative advantage as first set forth, almost simultaneously, by Ricardo and Torrens.[1/] This doctrine states simply that a country will specialize in production and export the product in which it has the greater comparative advantage or least comparative disadvantage and import the product in which its comparative advantage is least or comparative disadvantage is highest. While this notion is straightforward enough, it begs the question of what underlies or accounts for relative cost differences between countries. The standard answer provided by modern trade economists is taken from the Heckscher-Ohlin factor proportions theory that different goods require different intensities or ratios of factor inputs and different countries have different factor endowments.[2/] Accordingly, wheat which requires considerable land inputs relative to labor and capital, will be produced and exported by countries which have a relative abundance of land suitable to wheat production. The theory goes on to say that trade takes place and continues until relative price of commodities and factors of production, aside from transportation costs, are equalized between countries (factor price equalization theorem). The interesting part of this principle is that while transportation cost is

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[1/] For a discussion about the debate among historians of economic doctrine as to which of these two economists in the classical school deserve credit for initiating the principle see: John S. Chipman. "A Survey of the Theory of International Trade: Part I, The Classical Theory", Econometrica, XXXIII, (July, 1965), pp. 479-482.

[2/] The results of a study by Leontief contradicted the prediction of the factors proportions theory and set off a series of empirical and theoretical investigations that have thus far been inconclusive except to demonstrate that the theory in its simplist version is inadequate. For a review of this debate see: H. Robert Heller. International Trade: Theory and Empirical Evidence, (Englewood Cliffs, New Jersey: Prentice Hall, Inc., 1968), pp. 34-43.

acknowledged, it is so only in a passive manner.[3/] As a matter of fact, in general equilibrium versions of trade theory, transportation considerations are abstracted entirely out of the analysis. Markets are treated as single points in space and transportation and other transfer costs are accordingly assumed to be zero.[4/] Transport costs are not considered to be active determinants of the size and composition of international trade flows.

This treatment sets with considerable difficulty and particularly so with those affiliated with agricultural commodity trade. Because of special characterisitcs of its products such as perishability, seasonality, and bulkiness, it has been said that agriculture is uniquely dependent on a dependable and flexible transportation system.[5/] Factor proportions probably do dominate the determinants giving rise to relative costs and price differences of such commodities as processed fruits and vegetables, dehydrated potatoes, coffee, tea, sugar, and cotton. With respect to these kinds of goods, the degree of specialization would still be modestly affected by transport costs. However, in the instance of perishable commodities requiring refrigeration and rapid transit times, transportation costs are frequently the dominant element in final delivered overseas sales prices. In one instance, the case of

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[3/] It should be noted that Ohlin himself placed considerable emphasis on transportation considerations, though that part of his work went relatively unnoticed by later trade economists: see Bertin Ohlin. Interregional and International Trade, (Cambridge: Harvard University Press, 1933), (especially Chapter VIII).

[4/] Transport costs are implicitly recognized in the classical proposition that international trade differs from interregional trade in that factors are immobile between states, but as Chipman noted the inference is that they are infinite in this instance and zero otherwise, with nothing in between: Chipman, p. 511.

[5/] T.E. Nichols. "Transportation and Regional Development in Agriculture," AAEA, (December, 1969), p. 1455.

Washington State apple exports to Stockholm, Sweden, the value of the apples at the packing house was found to be about seven cents per pound and an additional nine cents per pound was required to cover handling and shipping costs to the overseas markets.[6/]

The enigma of international trade economists' tendency to downplay transportation considerations is further underscored by the fact that interregional trade and regional development theories have accorded much more importance to transportation considerations, even when the spatial obstacle is of a lesser degree of absolute importance there than for international trade. In contrast to the practice of classical trade theory which almost ignores entirely the transport cost in traversing space, these branches of economics accord major attention to transportation oriented location of industry.[7/] Presumably the explanation lies in the fact that interregional trade within political boundaries is not complicated by trade restrictions and currency differences as is the case with international trade, and consequently transportation considerations are more clearly recognizable.

Furthermore, historical perspective presents a curious dichotomy when the relegation of transportation considerations by the classical trade theorists, in the nineteenth century, is contrasted against transportation developments during that era. The growth of world trade in the nineteenth century was an involved process, but one of the major causes of that expansion was a revolution in transport connected with the development of

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[6/] Dale Anderson. "Transportation Research Cuts Delivery Time," Foreign Agriculture, (May 24, 1971), p. 4.

[7/] For example see: Walter Isard. Location and Space Economy, (New York: John Wiley and Sons, 1956), Chapter 5. Also see: Raymond G. Bressler and Richard A. King, Markets, Prices, and Interregional Trade, (New York: John Wiley and Sons, Inc., 1970), Chapter 6.

railroads and steam ocean transport. New territories including the formerly underdeveloped regions of the United States, Canada, Argentina, and Australia were opened up to become exporting areas of agricultural and other products with the development of railroad transportation. At the same time, development of steam ocean transport made possible an increased level of trade between countries separated by considerable water distances.

Transportation and Spatial Equilibrium Models

Neoclassical and so-called modern trade theories have all suffered from the same lack of applicability or usefulness in empirically analyzing factors underlying trade patterns in international commerce as did the classical theory. The single point in space treatment of trade between countries led one student of international trade theory to comment: "So radical an idealization is this that it is any wonder that the theory has any bearing on reality at all".[8/] While largely unnoticed by international trade economists, some fairly recent attempts have been made to introduce transport considerations into international trade models by incorporating transportation costs either directly, or indirectly, through inclusion of distance or spatial aspects of trade between entities. Isard and Peck (1954) attempted to fuse the opportunity cost doctrine of trade theory with location theory in a model and demonstrate how variation of the distance factor shapes geographical specialization and composition of trade.[9/] Samuelson (1952) presented the trade problem within a spatial equilibrium framework that simultaneously considered supply, demand, and transport cost interrelations

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[8/] Chipman, Part I. P. 477.

[9/] Walter Isard and Merton J. Peck, "Location Theory and International and Interregional Trade Theory," Quarterly Journal of Economics, LXVIII, (February, 1954), pp. 97-115.

between different countries.[10] It has been within this latter framework that applied economists, and particularly agricultural economists, have made some of the most significant strides in modeling international trade flows and patterns.[11] It could also be argued that it is in this framework that transportation specialists have much to offer. Spatial equilibrium models and their precursors, transportation linear programming models, to date suffer from a simplistic presentation of transportation considerations almost exclusively in the form of freight and handling charges based upon geographical distances between ports. Back hauls, frequency of service, transit time, quality of service, suitability of support facilities, inland-overseas linkages and numerous institutional constraints are treated only in a token fashion if at all. Transportation specialists are at an advantage comparatively speaking in sensing the role of these factors and thus stand to offer a great deal in the further refinement of this potentially useful category of empirical techniques.

Transportation Costs and International Trade

Three types of effects can be traced from the influence of transport costs on prices and trade in the world economy. Transportation costs prevent

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[10] Paul Samuelson, "Spatial Price Equilibrium and Linear Programming," American Economic Review XXXXII, (June 1952), pp. 283-303.

[11] For example:
(1) T. Takayama and G.G. Judge, "International Trade Models," Illinois Agricultural Economics, Volume IV, No. 3, (December 1964), pp. 53-62.
(2) D. Lee Bawden, "A Spatial Price Equilibrium Model of International Trade," Journal of Farm Economics, XXXXVIII, (November 1966), pp. 862-874.
(3) Andrew Schmitz, "An Economic Analysis of the World Wheat Economy in 1980," (Ph. D. Dissertation: University of Wisconsin, 1968).
(4) B.M. Jellema, "Analysis of the World Market for Groundnuts and Groundnut Products," (Ph. D. Dissertation, Department of Economics, North Carolina State University, 1972).
(5) Frederick Georg Mack, "The Impact of Transfer Cost and Trade Policies on International Trade in Beef, 1967-1980," (Ph. D. Dissertation: Texas A&M, 1973).

the complete equalization of prices of traded goods that would otherwise occur under the assumed conditions of free trade in pure international trade theory. Secondly, they influence the volume of world trade. Thirdly, transportation costs affect the patterns of goods flowing in the world market channels.

The first point is primarily of academic interest. Transport costs are reflected in differential prices in international trade: prices in the importing country tend to be higher than in the export country by the amount of these costs.[12/] Stated somewhat differently, transportation costs create a spread between prices paid by importers and received by exporters. However, it is important to the extent that when the incidence of these costs fall upon the exporter he receives a lower price. Meanwhile, the portion borne by importers represents a higher price.

With regard to the second point, the existence of transport costs create a "natural tariff" that curtails the volume of trade. Since only those goods that can bear the transport costs (and still remain cheaper than the same domestically produced goods in the importing country) will be traded between countries, international specialization will be substantially less. Stated somewhat differently, the removal of transportation barriers has the same impact as the removal of governmentally imposed trade barriers; permission of greater international specialization and therefore a higher potential standard of living. Haberler and others have recognized this, "The necessity of paying transport charges makes the world poorer",[13/] but they have been hesitant to include policies or decisions that lower transport costs as instrumental variables in their models. Indeed a significant portion of this so-called

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[12/] For a general equilibrium and partial equilibrium demonstration of these effects, see Charles P. Kindleberger, International Economics, Homewood, Illinois, Richard D. Irwin, Inc., 1968, pp. 86-93.

[13/] Gottfried Von Haberler, The Theory of International Trade, London, William Hodge and Company, Limited, 1936, p. 142.

natural barrier is in fact imposed by government policies. Cargo preferences, steamship rate setting conferences, and other legislatively or administratively imposed practices that obstruct cargo moving by modes selected upon a competitive commercial basis are cases in point.

Finally, the third point is that transportation considerations can be an active determinant of the composition and pattern of trade. If trade between countries is viewed in a multinational setting, then spatial arrangement (and thus transportation costs) obviously becomes a potentially significant consideration in whether the United States Pacific Northwest or the Netherlands will export potatoes to the Federal Republic of Germany. Moreover, the efficiency of the internal transportation system in a country could help explain its competitive position vis a vis other exporters. Undoubtedly, Brazil's inferior interior transportation system relative to that in the United States is an element in the relative competitive status of soybean exports from the two countries. Furthermore, technological developments in international transportation systems are not neutrally and evenly dispersed among different countries or regions or commodities. Subsequently the evolution of LASH and SEABEA ships may alter the composition and pattern of trade for certain regions uniquely able to exploit the advantages of this integrated inland-ocean mode of water transportation.

Transportation may be viewed as a cost, and therefore, as a barrier restricting the realization of potential gains from specialization. Alternatively transportation may be viewed in the Isard tradition as simply another input whose services are "needed to move raw materials, equipment, labor, and finished products to appropriate places".[14/] Whichever view is taken, it is obvious that transportation plays an important role in international trade. Analysis of this role has been shyed away from by international trade economists. This is perhaps suggestive that transportation economists might

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14/ Walter Isard, Location and Space Economy, New York: John Wiley and Sons, 1956, p. 90.

have something to offer by looking at transportation matters in the context of their role in international trade. While the impact of trade on transportation is a logical consideration it is equally logical to recognize the mutually interdependent nature of the two and consider the impact of transportation considerations on international trade. After all the function served by transportation of goods is to facilitate the realization of welfare gains derived from specialization and division of labor between individuals, regions, and nations.

International Transportation Developments

We have considered international trade in the context of its theoretical relationship to transportation. In this section a series of relevant technological developments in international transportation will be discussed. For many, this would immediately bring to mind the large scale ocean movement of bulk grain in huge bulk carriers and super tankers. However, a series of developments affecting other categories of agricultural products will be primarily emphasized. These are products that historically would be included under the category of general cargo, break bulk, or mini-bulk cargoes because either the nature of the commodity, or small individual shipment volume, precludes the bulk techniques associated with grains, soybeans, etc. Agricultural commodities included in this list include fresh, frozen, and processed fruits and vegetables, hides, hay cubes, dry pulses, and chilled, frozen, or processed meat products.

If one looks at recent trends in international transportation of the commodities noted above, the most notable consideration is a technological revolution in general cargo movement that has transpired since the late sixties. Introduction of standardized modular containers has affected substantial economies, both in transportation systems and cargo handling systems.

The container revolution has advanced the intermodal concept to the point where door to door delivery of goods is practical on transoceanic voyages, as well as inland voyages, under one bill of lading. Variations of this series of integrated intermodal innovations are numerous. Among the more prominent developments are container carrying ocean freighters, roll-on roll-off ships that carry truck trailer rigs to overseas destinations, refrigerated ("reefer") and atmospherically controlled containers designed for intermodal shipment, lighter abroad ship (LASH) and SEABEA vessels that carry barges thereby integrating inland and ocean water transits, as well as land and mini-bridge systems of unitized rail transport across continents that short cut interoceanic canal and cape water routes. These technological developments are only one dimension, albeit an important one, of a movement away from general cargo freighters towards specialized shipping. The container revolution shares the trend toward specialized shipping with bulk liquid and dry cargo tankers and carriers that have had such enormous impact on oceanic transportation in recent years. Another facet of the revolution evolves from containerized intermodal transportation combined with wide hull jumbo aircraft, a development that promises to usher in an era of intense competition between ocean and air surface modes of transporting certain high value or perishable commodities that necessitate assigning high priority to rapid delivery.

Speaking now of the impact of these developments on inland transportation patterns and systems, the many changes in international transportation systems in the past decade have rendered many ports obsolete in location and design, thus creating demands for new facilities and locations. In addition, the intermodal container revolution has had enormous impact on the patterns of internal flow of commodity traffic as it moves to the interface port

segment of overseas transit. Two offshoots of containerized ocean shipping exemplify the consequences of this international transportation development on ports and inland systems character and development particularly well; the load center concept and mini-bridge.

Containerships, because of the large investments in the vessels, cannot afford to call on ports unless they offer substantial volumes of cargo and can provide for rapid turn around. This has given rise to the so-called "load center" concept where only a few major ports are called upon. As a result it is reported in a recent study[15] that Portland on the West Coast, and Philadelphia on the East Coast, have suffered from diversion of substantial portions of cargo to Seattle and New York respectively. However, in the total framework of transportation considerations this need to eliminate some port calls has run head on into the trade-off need to emphasize many ports of call to accommodate the emerging concepts of through transportation and total distribution.[16]

Of the various developments that have resulted from containerization, the so-called "mini-bridge" concept has perhaps been the most controversial. Mini-bridge involves the joint rail-ocean movement of cargo from East Coast points to Asian ports, and West Coast origins to Europe, as opposed to the cargo moving by ocean-vessel around through the Panama Canal. The rapid transit of containers on unit trains, coupled with shortened distances when cargo is routed across the continent as opposed to the Panama Canal, explains the major economy to be derived from this system. For example, approximately

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[15] Maritime Transportation Research Board of the National Research Council. Port Development in the United States. Washington, D.C.: National Academy of Sciences, 1976. p. 5.

[16] "Making Intermodalism Work", Intermodal World, January, 1975. p. 20.

2,000 miles and possibly four days are saved by routing cargo from the East Coast to Japan via railroad as opposed to the interoceanic Panama Canal route. Similar distance and time economies are available to shippers near the West Coast if their cargo is going to Western Europe.

This system suggests obvious advantages to areas shipping substantial quantities of perishable and containerizable products to overseas markets, particularly if previously they have had to rely on routing their cargo around the Panama Canal. The main impact of the domestic transportation system is that mini-bridge, of course, routes a relatively higher precentage of freight by rail, plus it obviously affects the port to be involved in the transshipment of the cargo to an ocean vessel for the waterborne leg of the journey.

The above mentioned developments only scratch the surface of technological developments that are unfolding in the international trade scene. They were alluded so as to dramatize the dynamic nature of development in the logistics of moving goods internationally and further point up that transportation costs and considerations perhaps deserve greater attention than historically accorded by international trade economists.

Approaches for Integrating International Trade Research with International Transportation Considerations

International trade models are apt to be bereft of much empirical application and meaningful interpretation if they assume a single point in space world. The spatial equilibrium framework suggested by Samuelson and fashioned by Takayama, Judge, and others into an empirical framework has the merit of incorporating factor endowment, demand, and transportation considerations into an interdependent framework. Moreover this framework is extremely versatile in that it allows a number of considerations,

transportation and otherwise, to be treated as instrumental variables and simulated so as to estimate their impact on trade. Bawden demonstrated the approach to be amenable to incorporation of ad valorem duties, variable import levies, export subsidies, import quotas, and domestic policies that affect trade movements.

The impact of international transportation developments upon trade flows, and supporting distribution facilities, can be estimated by specifying various alternative transportation cost data sets and pursuing their effect through these models. Sharp and McDonald, for example, used the transportation model to analyze the impact of vessel size on an optimal system of U.S. grain export support facilities.[17/] A project has just recently been initiated at the University of Idaho to estimate least cost modal combinations and routings with particular emphasis on the impact of LASH and container carrying barges on the Pacific Northwest export distribution system.[18/]

While spatial equilibrium and transportation models offer a potentially useful framework to incorporate transportation considerations into international trade models, there is a great deal of work to be done to improve their productivity. As suggested earlier it is commonly recognized that the

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17/ John W. Sharp and Hugh J. McDonald, The Impact of Vessel Size on an Optimal System of U.S. Grain Export Facilities, Ohio State Experiment Station Research Bulletin 1048, December 1971.

18/ "LASH and Other Intermodal Services in the Pacific Northwest Export Distribution System". The project was funded by CSRS for the period July 1, 1976 to June 30, 1981. A related project considering the impact of these developments upon the Columbia, Snake navigation system, particularly with regard to the implications for modifications in shore support facilities, is envisioned to be initiated, pending formal approval by the Sea Grant Office of the U.S. Department of Commerce.

diversity of influences involved in transportation considerations tends to be glossed over. Transportation costs are too narrowly defined when specified as a simple function of freight rates and distances.

Finally, as any researcher would naturally suspect, a most critical aspect of employing these models fruitfully hinges upon acquiring adequate data. A particular problem exists with regard to specific inland origin of U.S. exports to overseas destinations. Information indicating the origin of exports by states or regions is not reported on export declarations used by the Census Bureau to compile U.S. export statistics. Consequently, primary data must be collected in most instances to furnish the inputs for these models and this is an ambitious undertaking in its own right. However, it is necessary, particularly for studies concerned with efficient transportation and accompanying support facilities, to have this data. The Bureau of the Census in the Department of Commerce, in conjunction with the Department of Transportation and other agencies, has announced they are beginning a survey to obtain data on the movement of exported commodities within the U.S. A similar survey was conducted in 1970, but unfortunately it was too aggregative in scope for many purposes.[19/] A recent study by Hill and Brooks provides another example where a survey technique was utilized to gather primary data regarding in that case grain movements by specific mode to export points from Illinois. [20/]

In conclusion, I hope I have underscored the theme that transportation considerations are vital but sadly neglected in international trade research.

[19/] U.S. Bureau of the Census, Domestic and International Transportation of U.S. Foreign Trade: 1970, U.S. Government Printing Office, Washington, D.C., 1972.

[20/] Lowell D. Hill and Bruce L. Brooks, The Market for Illinois Grains, University of Illinois at Urbana, Champaign Agricultural Experiment Station Bulletin AERR 143, August 1976.

Furthermore, I have attempted to suggest some of the dimensions of this problem that might be tackled by transportation specialists.