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## Introduction

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In the last decade or two, economic theory has struggled to understand and define the technology factor as an element in growth and change. A discipline that for so long had found it sufficient to think in terms of a taxonomy of factors consisting of land, labor, and capital has begun to see some utility in treating technology as a factor deserving separate analysis. This conference can be thought of as a step in that process—as a conscious effort to adapt and, if need be, to modify the received body of international trade theory to the existence of the technological variable.

The existence of a well-developed body of mutually consistent paradigms, it has often been noted, is both the prime strength of the discipline to which they relate and the prime weakness of that discipline. The strengths of a well-articulated taxonomy and an explicit set of models are obvious enough. They offer a structure by which new data may be observed and may be related to an existing body of observations. Lacking these tools, the observer would have to create some criteria for scanning the new data and for relating them to past experience. So trade theorists, scanning international trade out of a background to which Ricardo, Marshall, Heckscher-Ohlin, Samuelson, and others have contributed, tend to classify what they see in terms of capital-intensive, labor-intensive, or resource-intensive products, and tend to observe those flows in terms of their consistency or inconsistency with a set of theoretical expectations.

But there are also dangers in a set of well-developed models. Researchers have an extraordinary capacity to screen out the evidence that does not sit well with their preconceptions; to relegate uncomfortable observations to the dustbins of the subconscious; or, better still, to reshape the observations so that they may be perceived in a way that eliminates the discomfiture. "What a man sees," says Thomas S. Kuhn, "depends both upon what he looks at and also upon what his previous visual-conceptual experience has taught him to see."

Politicians, businessmen, journalists, and historians, possessing as a rule neither the strengths nor the vulnerabilities that go with an understanding of international trade theory, have been "seeing" the technological variable in international trade for a very long time. Economists, on the other hand, have been slow to incorporate that variable explicitly in the main body of trade theory. To assume that economists were not aware of the importance of that variable, however, would be a gross error. All one could say is that economists had great difficulty in finding a compatible and efficient way in which to handle the technological factor. As long as that was the case, there was a tendency to observe international trade and to analyze its causes in ways that did not require the specific manipulation of a technology variable.

International trade theory has been especially vulnerable to the risks of screening away inconsistent evidence, a vulnerability stemming from two factors. One is the great strength of the ruling models of trade theory. The doctrine of comparative advantage and the theory of the international equilibrating process have a simplicity, a strength, and a clarity that are not matched by many branches of economic theory. The second source of vulnerability has been the sheer physical difficulty, until quite recently, of testing trade theory hypotheses in any rigorous way. Rigorous tests of comparative advantage concepts generally require the handling of vast masses of data, on a scale that has only become feasible with modern data-handling devices. Accordingly, until a few decades ago, scholars were usually reduced to armchair speculation about the consistency between trade theory and trade patterns, selecting the illustrations that supported their preconceptions or provoked their doubts.

One might perhaps make out a case that the field of international trade theory has tended toward a certain complacency and sluggishness

in development, turning inward to refinements on Marshall rather than outward to the developments suggested by other branches of theory and by changes in the conditions of world trade itself. It is true, for instance, that the main body of international trade theory was not greatly disturbed in the 1930's either by the impact of Keynes or by the development of the various theories of imperfect competition.

On the other hand, even at that early date, economists were not wholly unaware of the limitations of trade theory. By 1929, Williams was expressing his misgivings over the efficiency and adequacy of trade theory as a vehicle for explaining the observed patterns of international trade and was suggesting that different national propensities for innovation might have something to do with the creation of trade disequilibria. Ohlin, with his characteristic subtlety, recognized the potential importance to trade theory of differences in the quality of existing factors. A revisionist gleam, kept alive through the depression era of the 1930's, was strengthened after World War II by policy-oriented economists concerned with the problems of economic development, of regional trading blocs, and of the dollar shortage. Leontief's well-known paradox added to the mounting sense of inadequacy. His "solution," being couched in terms that superficially appeared loyal to the ruling paradigm, made revisionism respectable. The floodgates having been pried open, a torrent of speculation and empirical testing followed.

As the evidence developed, there were occasional efforts at synthesis. One of these efforts, for which M. V. Posner was responsible in 1961, proved especially rich in insights. By 1966, however, new materials were piling up at such a rate that the time seemed ripe for some more extensive efforts to relate theory and evidence. The initiative of the Universities-National Bureau Committee for Economic Research in proposing a Conference on Technology and the Theory of International Trade was eagerly seized as an appropriate opportunity. Harry G. Johnson, H. B. Lary, Edwin Mansfield, and Jacob Schmookler joined me in planning the Conference; and after Jacob Schmookler's untimely death, Alfred H. Conrad took a laboring oar in the enterprise.

Now that the Conference has made its modest contribution to the academic understanding of technology in international trade, it is clearer than ever how much still remains to be explored before that understanding is secured. Many of the unsolved problems that loom over

this facet of trade theory are those that are endemic to economic theory in general. But some apply with very special force to the area of inquiry that is the subject of this conference volume.

The profession is still in its infancy, for instance, in its capability for the efficient theoretical handling of risk and uncertainty. Some exciting starts have been made, but there is still a considerable distance to go. Progress in this field is especially critical for the subject of this volume because, both empirically and intuitively, there are strong grounds for assuming that risk and uncertainty affect the trade in new products more than in old, and that these factors shape the behavior of exporters and importers more strongly than the behavior of traders within a single national market.

Related to questions of risk and uncertainty are questions of optimal investment in the acquisition of knowledge. The money-cost and time-cost of acquiring information affect all economic decisions in some degree. But there are grounds for supposing that they affect international trade, especially trade at the technological forefront, with special force.

On similar lines, the assumption of horizontal or rising cost curves proves an especially confining one for the international trade theorist concerned with the marketing of new products. It is one of the more firmly documented facts of international trade that such trade tends to be conducted by the larger firms in any industry; and it is fairly evident that scale economies play a role in that phenomenon. To make matters even more difficult, there are repeated hints in the empirical data that some of the scale economies that affect the international trade capabilities of national firms may be based in good measure on factors of agglomeration external to the firm. There are few concepts in economic theory more ill-defined and more resistant to precise formulation.

Finally, there is the difficult issue in international trade theory of defining the economic actor whose activities are to be explained and described. Few branches of economic theory can wholly disregard the fact that modern industrial processes usually involve a drawn out sequence of commodity transformations, rather than a single act of transformation. Sometimes these sequences—including the conversion of raw materials into intermediate products and components followed by incorporation in some final product—are undertaken from beginning to end within a single firm. The economics of these intrafirm transfers

may be important, but they can often be disregarded by the theorist when the transfer occurs inside a single national market. Where international trade is concerned, however, intrafirm transfers become disconcertingly prominent. About one-quarter of U.S. exports of manufactured goods, for instance, has consisted of transfers of goods between affiliates; and the proportion has been especially high in technically advanced products. At that level, the implicit assumption that international trade is the product of the arms' length behavior of independent buyers and sellers begins to have its obvious limitations as a basis for relevant and efficient theory. The economic theorist may then be confronted with the question whether he will eventually be obliged to master and assimilate a theory of the organizational behavior of the firm with the main body of trade theory in order to generate a credible model of international trade.

Sufficient unto the day, however, are the theories thereof. Increased understanding in a field as complex as trade theory is bound to be a slow and costly process. One can only hope that the contributions in this volume represent a modest step forward.



Technology and the  
Theory of International Trade



