Introduction

Robert C. Feenstra

With some notable exceptions, empirical research in international trade has been slow to develop. This volume aims to fill that gap by bringing together a wide range of empirical studies applied to various countries. A glance at the contents shows the main methods that are covered: cross-country analysis, which can be used to test assumptions or implications of trade models; industry studies, which have received renewed interest from the recent literature on market structure and trade; and dual methods, which extend the estimation of production and cost functions to incorporate trade flows. Descriptions of the papers are given at the beginning of each section. In this introduction I would like to offer a perspective relating the theory of international trade to empirical applications.

Consider the standby of international trade theory, the Heckscher-Ohlin model. If our objective is to confront this theory with data, then we are immediately faced with a formidable aggregation problem. Each good in the two-by-two model is not literally a single good but is usually interpreted as an aggregate, such as manufacturing, agriculture, or importables and exportables. Constructing such aggregates is enough to deter even the most diligent researcher. Leontief (1953) was the first to tackle this problem, followed by Baldwin (1971) and others, and recent progress has been made by Chipman (1981) and Leamer (1984) in higher-dimensional models. The papers by Aw and Roberts (chapter 10) and Cas, Diewert, and Ostensoe (chapter 11) in this volume use index numbers to construct consistent aggregates of traded goods prices. The latter authors demonstrate that the aggregate prices can be used to make welfare inferences.

Suppose that we have overcome the aggregation problem. Then one possible application of data to the Heckscher-Ohlin model is as follows. We could estimate industry production functions and consumer demand equations for each of several countries. Knowledge of the factor endowments in the countries would then allow us to solve for the trade equilibrium, that is, numerically compute the equilibrium prices and trade flows. Elegant extensions of this approach are the subject of computable general equilibrium models, described in Deardorff and Stern (1986), Srinivasan and Whalley (1986), and Norman (to be published). These models are especially useful in policy analysis because the effects of government interventions can be simulated. However, the models are not intended to test any hypothesis derived from trade theory. Indeed, because each computable model embodies various assumptions concerning the number of goods and factors, degree of factor mobility, etc., any proposition derived from the theory under like assumptions would be satisfied in the computable model by construction.

To test the Heckscher-Ohlin model statistically, we need to use other methods. The *first* approach is to test the underlying *assumptions*: homothetic tastes, identical across countries; linearly homogeneous production functions, identical across countries and without factor-intensity reversals; complete factor mobility within a country; and perfect competition. Hunter and Markusen (chapter 4) examine the assumption of homothetic tastes over thirty-four countries and find strong evidence to reject this hypothesis. The pioneering work on cross-country comparisons of technology was Minhas (1963) using the CES (constant elasticity of substitution) production function, which permitted points of factor-intensity reversal to be calculated. Dollar, Wolff, and Baumol (chapter 2) examine production functions across OECD countries, testing for the possibilities of increasing returns to scale and country-specific technological differences.

A *second* approach to evaluating the Heckscher-Ohlin model is to test *implications* arising from it. Leamer and Bowen (1981) and Deardorff (1984) have argued convincingly that a complete test of the Heckscher-Ohlin theorem is difficult, requiring data on trade, technologies, and factor endowments across countries (see Bowen, Leamer, and Sveikauskas 1986). Specific propositions are often considered instead. Brecher and Choudhri (chapter 1) examine the factor content of consumption in Canada and the United States, which the theory predicts should be equal. Dollar, Wolff, and Baumol (chapter 2) are concerned with factor-price equalization and implications from it. Perhaps the most sophisticated test is the linear relationship between trade flows and factor endowents, studied by Leamer (1984). In this volume Leamer (chapter 3) examines the validity of pooling across commodities when estimating the effects of trade barriers in the Heckscher-Ohlin model.

The studies mentioned use a cross-country analysis of data. But assumptions and implications of the Heckscher-Ohlin model can also be tested using data for a single country over time. A fruitful approach is to begin with the aggregate technology set $(y, v) \in S$, where y is the output vector and v is the factor-endowment vector, and derive the dual revenue or GNP function $r(p, v) \equiv \max_y \{p'y: (y, v) \in S\}$, where p is the price vector. Once we specify a functional form for $r(p, v)$, the parameters of this function can be estimated using time-series data. With two goods and two factors the Stolper-Samuelson and Rybczynski theorems imply that the second derivatives $\partial^2 r/\partial p_i \partial v_j$ are of opposite sign for i = goods 1, 2, and fixed j; or j = factors 1, 2, and fixed i. However, an aggregate revenue function $r(p, v)$ need *not* satisfy these restrictions in general. The reason is that $r(p, v)$ allows for any pattern of joint production of goods, in which case the Stolper-Samuelson and Rybczynski theorems need not hold (Jones and Scheinkman 1977). Thus, when we estimate an aggregate revenue function, the sign pattern of derivatives implied by these theorems become *testable* propositions. In higher-dimensional models we can investigate the signs of $\partial^2 r/\partial p_i \partial v_j$ to find which goods and factors are "friends" or "enemies."

Early applications of this dual approach were Burgess (1976) and Kohli (1978). More recent work on the Stolper-Samuelson relation, using another methodology, has been performed by Chipman (1983). Diewert and Morrison (chapter 8) estimate an aggregate revenue function for the United States and use it to study the effects of changes in the real exchange rate. Wong (chapter 9) estimates an indirect trade utility function, which combines information on technology and tastes (Woodland 1980). He uses it to examine the effects of factor inflows into the United States.

The final assumption of the Heckscher-Ohlin model mentioned before was that of perfect competition. The recent literature on market structure and trade [for example, Helpman and Krugman (1985)] is to be welcomed, not only for its controversial policy implications [see the viewpoints in Krugman (1986b)] but also for its empirical relevance. In models of imperfect competition a single good is to be taken literally, and there is no aggregation problem. Indeed, models of monopolistic competition are designed to face head on the product heterogeneity (and intra-industry trade) often observed in reality. The partial equilibrium nature of some of the theory lends itself to industry studies.

As with competitive trade models, several approaches can be taken to empirical research: simulation studies, testing of assumptions, and testing of propositions. A comprehensive simulation model for assessing tariff reductions in the Canadian economy, using a noncompetitive market structure, is presented in Harris (1984). Dixit (chapter 6) and Baldwin and Krugman (chapter 7) construct simulation models for the automobile and computer memory industries, respectively, focusing on trade between the United States and Japan. The theory gives ambiguous signs for nationally optimal trade policy, depending on the relative extent of "profit-shifting" between foreign and domestic firms (Brander and Spencer 1981; Dixit 1984; Eaton and Grossman 1986); terms of trade effects resulting from oligopolistic pricing abroad (Brander and Spencer 1984); and inefficient entry into the protected industry (Horstmann and Markusen 1986). The purpose of the simulation models is to give actual magnitudes for the welfare impact of policies, depending on initial numerical values for industry costs, conduct, and demand conditions. A study of this type for several British industries is provided by Venables and Smith (1986).

The testing of assumptions or propositions from noncompetitive trade models has only begun. Appelbaum and Kohli (1979) present a dual approach to testing whether prices are above marginal costs. Feenstra (1984, 1985, forthcoming), Anderson (1985), and Aw and Roberts (1986) have evaluated the hypothesis of quality upgrading under quota restraints, which is consistent with a competitive or a noncompetitive market structure. Feenstra (chapter 5) measures the gain to consumers from having available Japanese compact trucks, which differ in their characteristics from American full-size pickups. A number of researchers are examining the link between exchange rates and prices of traded goods, which can be used to infer the underlying market conduct. Future work will no doubt continue along these lines, drawing on empirical methods from industrial organization.

Finally, it is inevitable that in a conference volume some topics are covered only briefly. One of these is the political economy of trade barriers, mentioned by Leamer (chapter 3) and thoroughly examined in Baldwin (1986). Another is the interface between labor economics and trade, including the effects of import competition on wages and employment (Grossman 1986) and issues arising from international migration, as in Wong (chapter 9).