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COMPARATIVE ADVANTAGE: THEORY AND APPLICATION TO DEVELOPING COUNTRY AGRICULTURE

by

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Research programme on:
Changing Comparative Advantage in Food and Agriculture

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SUMMARY

This paper investigates the application of the principle of comparative advantage to policy analysis and policy formulation. It is concerned with both the theory and the measurement of comparative advantage. Despite its central role in economics, the theory is found to be at an impasse, with its usefulness confined mainly to the illustration of economic principles which in practice are not borne out by the evidence.

The considerable methodological problems associated with the measurement of comparative advantage are highlighted in the paper. Attempts to derive indicators of comparative advantage, such as those associated with "revealed comparative advantage", "direct resource cost", "production cost" and "trade liberalisation" studies are reviewed. These methods are enlightening, but are unable to provide general perspectives which allow an analysis of dynamic comparative advantage. Comparative advantage, despite its centrality to economics, remains remote from policy analysis.

The study was conducted by Ian Goldin, Head of Programme at the Development Centre.

RÉSUMÉ

Cet ouvrage s'intéresse à l'application du principe de l'avantage comparatif à l'analyse et l'expansion politiques, à la fois sur le plan de la théorie et sur celui de la mesure de l'avantage comparatif. Malgré son rôle essentiel en économie, cette notion se trouve dans une impasse puisqu'elle sert surtout à illustrer des principes économiques qui, dans la pratique, ne paraissent pas évidents.

Les difficiles problèmes méthodologiques liés à la mesure de l'avantage comparatif sont donc mis en lumière. L'étude passe en revue les tentatives de définition d'indicateurs de l'avantage comparatif, par exemple les travaux sur "l'avantage comparatif révélé", "le coût direct de ressources", "le coût de production" et "la libéralisation des échanges". Malgré leur pertinence, ces méthodes restent cependant incapables d'apporter une perspective d'ensemble susceptible de concourir à l'analyse de l'avantage comparatif dynamique, lequel, en dépit de sa place centrale dans les théories économiques, reste en marge de l'analyse politique.

Cette étude a été rédigée par Ian Goldin, Chef de Programme au Centre de Développement.

PREFACE

Research at the OECD Development Centre is concerned with the identification of appropriate policy interventions in favour of sustainable development and growth. The question of comparative advantage is thus at the heart of much of the research, providing both an economic yardstick and an organising principle for policy analysis. In the Centre's research on agriculture, this concern is explicit in the programme title: Changing Comparative Advantages in Food and Agriculture.

Notions of comparative advantage have informed much of development economics. Rather surprisingly therefore, relatively little has been said of what is actually meant by comparative advantage or how it may be measured. This paper represents an effort to fill these lacunæ.

The theory and the practice of comparative advantage both suffer from shortcomings and these will continue to offer fertile ground for further research. Comparative advantage is, and no doubt will remain, a vital weapon in economists' intellectual armoury; the challenge is to ensure that it evolves into a dynamic and operational concept. The alternative, as the paper soberly reminds us, is that it will remain within the realm of academia, and that the vital insights, in terms of allocative efficiency and growth, will be lost to policy makers.

Louis Emmerij
President
OECD Development Centre
June 1990

INTRODUCTION

This paper aims to stimulate discussion about the application of notions of comparative advantage to policy analysis. It examines the theory and the measurement of comparative advantage with a view to understanding trends in agricultural production and trade in developing and OECD countries.

Notions of comparative advantage are implicit in many explanations of development and inform much of the debate concerning trade and competitiveness. In Part One, we examine the extent to which economic theory may assist us in understanding and measuring comparative advantage. Part Two is concerned with the methodological issues and the translation of theory into practice. It reviews the various attempts to measure comparative advantage in agriculture. The concluding section of the paper, Part Three, draws attention to the importance of trade and macroeconomic policy as determinants of comparative advantage and economic growth.

PART ONE

COMPARATIVE ADVANTAGE: THE THEORY

The Theory of Comparative Advantage

The principle of comparative advantage according to Samuelson is perhaps the only proposition in all of the social sciences which is both true and non-trivial [1]. It provides an explanation of specialisation and gains from trade and, viewed as a positive theory, yields predictions about the direction and the terms of trade.

The notion of comparative advantage as a determinant of international trade was popularised by Ricardo. Ricardo invoked factor endowments to explain why Portugal exported wine and Britain cloth. Subsequently, the principle of comparative advantage has come to be accepted as an almost universal law of economics.

While Ricardo placed emphasis on physical and natural influences over competitiveness, technological and human factors were given weight by later economists. A reading of the literature on comparative advantage, reveals the continuity of the theoretical development from Ricardo via Mill and Marshall to Heckscher, Ohlin and Samuelson.

The modern treatment, and a foundation for much empirical work, begins with the Heckscher-Ohlin model that explains the international division of labour in terms of different endowments of different countries with two factors of production - labour and capital. The two fundamental hypotheses of the standard Heckscher-Ohlin model are that factors of production are immobile between countries and that these factors are used in different combinations to produce different goods. A country will then possess a comparative advantage in good X if the country is relatively well endowed with factors that are used intensively in the production of X.

The Heckscher-Ohlin two-factor model lends itself to easy presentation and the analytical-geometrical extensions devised by Samuelson and Meade have become a standard feature of modern textbooks. With a few additional simplifying assumptions - two commodities, two countries, constant returns to scale and identical factors and identical production functions in both countries - a highly abstract but suggestive model of world trade can be constructed.

The logic underlying Heckscher's conclusions emerges clearly from the "two by two by two" model that Samuelson and Lerner independently developed. This model shows that commodity price equalisation must lead to full equalisation of the prices of the completely immobile factors that each country is endowed with, if technology is identical, both countries produce both goods and "factor intensity reversals" are ruled out.

The Lerner-Samuelson model was used by Robinson and Johnson to rigorously deduce the conditions under which a country with a relatively abundant endowment of a factor would export the commodity in which this factor is used relatively more intensively. In the Lerner-Samuelson model, both factors are regarded as freely transferable between sectors within a country. Alternatively, it is possible to identify a specific input in each sector, such as wheat-land and cotton-land, and another factor such as labour which is freely transferable between both sectors. Such an approach was developed by Haberler but is usually dubbed the Viner-Ricardo model of comparative advantage.

Testing the theory

Several economists in the late 1950s and early 1960s used the Lerner-Samuelson model to examine long run comparative advantage. Results from some of the work tended to highlight the distortions arising from the simplifications of the Heckscher-Ohlin theory. The famous theorem of factor price equalisation through free commodity trade has to be severely qualified if there are many factors. This is in addition to the simplifying assumptions such as that factors are qualitatively the same and production functions identical in both trading countries, that production functions are homogeneous to the first degree and that there are no factor intensity reversals. With these assumptions and the fundamental static nature of the model in mind, it appears that what the theory really proves is not that factor prices will be equalised, but on the contrary, that in practice there cannot be factor price equalisation.

Leontief's famous demonstration that USA export industries are largely labour-intensive and import-competing industries capital intensive seemed so counter-intuitive a result as to cast doubt on the empirical validity of the theory. Leontief's conclusion that US exports embodied a lower ratio of capital to labour inputs than US imports was subsequently extended to Canada, West Germany and Japan.

In their search for an escape from Leontief's paradox, applied economists were forced to move away from two-factor models and to distinguish between different types of labour and capital and to pay attention to dynamic, institutional and policy determinants of international trade. Three factor models, with human capital as the third factor, along with physical capital and raw labour inputs, provided scholars with a means of unravelling Leontief's paradox. By differentiating different skill levels, Harkness, Kenen and others rescued the factor-endowment hypothesis as it applied to US, Canadian, West German and Japanese trade.

The arguments rehearsed in the 1950s and early 1960s continue to be played out in the contemporary scholarly literature on comparative advantage. Among the recent contributions, Lipsey's qualitative evaluation of the forces shaping comparative advantage and Leamer's quantitative examination of the sources of international comparative advantage, provide some new perspectives on old debates. Leamer and others, after calculating the ratio of 23 countries' endowments to their global supply and examining their trade, found that for nearly half the factors of production trade ran in the opposite direction to that which would have been predicted on the basis of the Heckscher-Ohlin hypothesis.

The negative results of tests of the factor-proportions theory have left international economists searching for alternative explanations of trade patterns. The studies in the comparative statics of growth and trade were followed by the Oniki-Uzawa dynamic model in which the capital-labour ratios of the countries became the endogenous variables, whose ultimate values are derived from the technology, the savings functions and population growth. These models facilitated the comparison between short run comparative advantage, determined by the capital-labour ratio, and long run comparative advantage, determined by the propensity to save and population growth. More recently, Paul Krugman has challenged the underlying assumptions of international trade, focusing on the institutional, technological and other historical factors accounting for the imperfectly competitive nature of international trade. The "New Trade Theory" developed by Krugman and others does not negate comparative advantage, but it does emphasise that factor endowments are themselves inadequate explanations of international trade.

The Theory and Agriculture

The original Ricardian concern with agriculture appears to have been of peripheral interest in the subsequent literature on comparative advantage, which, almost without exception, focuses on industry in the developed world. The recent interest in comparative advantage has tended to renew the emphasis on technological explanations of trade in manufactures. To the extent that developing countries have been included in the analysis, the concern has been with industrial competitiveness and not with developing country agriculture.

In his contribution to the 1976 Nobel seminar on international trade, Haberler remarked that "no sophisticated theory is necessary to explain why Kuwait exports oil, Bolivia tin, Brazil coffee and Portugal wine"[1]. These he regards as simply "natural resource trade" and much easier to explain than trade in manufacturers. Haberler, in common with virtually all his contemporaries, then goes on to examine comparative advantage in manufactured products, leaving the reader none the wiser as to why Bolivia lacks a metallurgical industry, why Portugal exports wine not industrial alcohol or grapes, why Britain exported cloth not wool, why wet Ireland exported maize to drier Britain, why Brazil exports ethanol and Cuba sugar, why China has turned from a rice importer to rice

exporter, and so forth. Although natural resource trade may well be easier to explain than trade in manufactures, the neglect of key issues in natural resource trade is perplexing and only recently is receiving the attention it deserves, and even this tends to be from economic geographers, and not trade or resource economists.

To the extent that economists have applied the theory of comparative advantage to agriculture and to developing countries they may be broadly categorised as falling within one of two schools. On the one hand there are those who appear keen to defend the guiding classical principle of comparative advantage, according to which growth is promoted by specialisation. The neo-classicists draw their inspiration from Ricardo, Mill and Marshall, while their critics are inspired by Schumpeter, Williams and others who have argued that comparative advantage is essentially a static concept that ignores a variety of dynamic elements. They have shown that the modern version of the comparative cost doctrine is essentially a simplified version of static general equilibrium theory. The optimum pattern of production and trade for a country is determined from a comparison of the opportunity cost of producing a given commodity with the price at which the commodity can be imported or exported.

In his examination of the doctrine of comparative advantage as applied to conditions in developing countries, Viner criticised the Heckscher-Ohlin model for its assumptions of comparable quality in the factors. He emphasised the importance of interpreting comparative advantage in a dynamic setting in which the efficiency of production may change over time, external economies may exist, and the market price of commodities and factors may differ from their opportunity cost. However, as Nurkse points out, these considerations rob the original doctrine of much of its value as they require that it is necessary to have an explicit analysis of the growth process before it is possible to determine, even theoretically, where comparative advantage lies; market prices and opportunity costs are no longer sufficient.

In recent years, Abbott, Thompson and Haley have directed their attention to the lacunae in the literature and specifically addressed the question of comparative advantage in agriculture. They draw on the Ricardo-Viner modelling tradition in the development of a three-factor (including land) model of agricultural trade. Emphasis is placed on the role of the short-run rigidity of sector-specific capital stocks, the role of qualitative differences in land endowments, and on non-homothetic preferences. The model is comparative static, in that long-run, full equilibrium adjustment is considered, and not the path of that adjustment.

The question of the adjustment path is the focus of a recent investigation by Haley and Abbott into the determinants of comparative advantage in agriculture. Their adaptation of the "state variable" approach by Mundlak, and the Thompson-Schuh meta-demand approach for consumption, provides insights into the dynamic determinants of changing trade patterns. Their study indicates that nations dependent on agricultural trade tend to have capital-intensive agricultural systems and that demand factors

(population and income growth) differentiate net agricultural exporters from importers. Also important is their finding that on the margin, natural resource conditions alone do not serve to differentiate nations on the basis of production or trade. For natural resources to have an impact on production, there must be investment; agricultural capital complements rather than substitutes for land or other natural resources endowments.

The role of investment, as well as natural resource endowment, in determining comparative advantage is clearly revealed in the recent work of Abbott and others. Their model cannot however be used to operationalise the analysis of changing comparative advantage. This is particularly the case for developing countries, where analysis of comparative advantage needs to include a recognition of the possibility of structural disequilibrium in factor markets; the inclusion of indirect (market and nonmarket) effects of expanding a given type of production; simultaneous determination of levels of consumption, imports and consumption and allowance for variations in the demand for exports.

Such an framework has not yet been constructed. Neither are we able to assume, as is the case in the literature cited above, that trade is a proxy for comparative advantage. Due to distortions, it need not reflect factor endowments or costs. It is to a consideration of these elements - and competitive, rather than comparative, advantage - that we now turn.

PART TWO

COMPETITIVE ADVANTAGE: THE PRACTICE

Costs and Prices

Among the strengths of the neo-classical relation between factor costs and trade is its logical coherence. In a neo-classical world production will tend to be determined on a basis of costs. In such a world, costs and prices are synonomous and trade is determined by comparative advantage. However, it is generally agreed that costs of labour, land and capital, especially in developing countries, do not reflect their opportunity costs with any accuracy because of market imperfections, although there is wide disagreement as to the extent of the typical discrepancies and how these may change over time.

The estimation of factor costs poses serious difficulties, if the results are to be used as the basis for international comparisons. In order to bypass the problems posed by production costs estimates, international comparisons may be based simply on production data. For example, it is possible to compare yields, labour productivity, energy use or other production parameters without reference to input costs or prices.

For those interested in comparative advantage, this data is of vital importance. Technical data does not however provide an adequate account of the allocation of resources. Some measure of the efficiency of production and the allocation of scarce resources within a country is required in order to assess comparative advantage. To the extent that costs present the best guide to the demand and supply for resources, they are an essential element in an analysis of comparative advantage.

Numerous problems arise when attempting to derive production cost comparisons. Leaving aside the problem of finding comparable cost data, initial difficulties include the question of whether to use shadow or nominal prices. Almost inevitably, difficulties also are encountered in the determination of exchange rates and the valuation of capital, land and labour.

Various attempts have been made to evade some of these obstacles. Perhaps the most ingenious suggests that costs are revealed in final product prices. According to this argument, high product prices reflect high costs and low domestic costs reflect low production costs. The argument that high prices reflect high production costs is well

known justification for high prices. The corollary is that low domestic prices reflect low domestic costs and are indicative of international comparative advantage.

The equivalence of prices with costs is attractive because prices are generally more transparent than costs. However, this equivalence neglects the distortions arising from market power as well as from subsidies, quotas, taxes, tariffs and other institutional interventions in the market. To the extent that these interventions are themselves an object of analysis, they cannot be subsumed within final costs.

Land, Labour and Capital

Among the most intractable of the problems which arise when engaging in international comparisons of factor costs is the valuation of land. In many situations, the resale value or rent for land provides a good indication of the price or cost of land and may be deduced from market quotations. Two major difficulties nevertheless remain. First, many agricultural crops are intercropped or farmed in rotation. When valuing the costs of production of specific crops, it is necessary to establish a basis for sharing the value of the land between the different uses.

An added complication when valuing land is that land values can become the residual value. If the price of a crop increases but the cost structure of production remains unchanged, the value of land may simply rise. If this is the case, the costs of production will always tend to equal the selling price, with the price of land providing the equilibriating cushion. In order to get around the difficulties associated with this residual definition of land values, land may be valued in terms of its opportunity cost. Land values are then determined by the potential for alternative use.

The difficulties of evaluating capital stock and its depreciation are well known by accountants. International comparisons of these costs are particularly hazardous, although this is as much due to differences in the macroeconomic environment as to the variations which exist in accounting practices. Among these is the choice of the valuation of capital stock on a historical basis or a replacement cost basis. The historical cost of capital reflects interest rates and inflation, and in countries which have experienced hyperinflation may for certain periods of its recent history be negligible.

The accuracy of historical cost valuations in part depends on the choice between nominal and real interest rates. Nominal interest rates tend to offset inflation and to the extent which interest rates keep face with inflation may support the argument for comparing historical costs and applying nominal interest rates. However, real interest rates are a more accurate reflection of the real cost of capital and when used in conjunction with replacement cost (adjusted for depreciation) tends to better reflect the cost. Interest rates and inflation rates tend to move in the same direction, and real interest rates tend to be relatively stable. However, in many developing countries, and

especially those experiencing high inflation, there are times when real interest rate may well be negative. An alternative method of valuation is to use rental values, although this is not always possible.

The valuation of investment, and especially public investment in infrastructure, further complicates international comparisons of production costs. In order to allocate the costs of public investment to individual agricultural activities it is necessary to overcome major methodological and empirical obstacles. Yet, roads, water supplies, port facilities, electricity and other infrastructural investments play a vital role in determining the cost structure and competitiveness of agricultural producers. Investment in services is equally important, be it health, education, disease eradication or agricultural extension and improvement services. To the extent that such investment is attributable to the agricultural sector or benefits the agricultural sector it should be reflected in international analyses of factor costs and comparative advantage. (Bilateral or multilateral lending also raises the possibility of the costs of investment in one country being financed elsewhere.)

International comparisons of the costs of labour in developed countries are complicated by differing definitions of work practices, differing regulations and norms regarding the contributions of the employee, employer and the public sector to the wage costs and by differing length and definition of work time. Nevertheless, with the appropriate adjustments, reasonably accurate international comparisons - such as those undertaken by the International Labour Office (ILO) - are available on at least an annual basis. The ILO also provides annual data on developing country wages (including agricultural wages). However, comparative labour cost data for the developing countries is available only for the manufacturing sector and the scant agricultural sector data which is available needs to be heavily qualified. Measurement of costs is particularly difficult in situations where family labour contributes to production, where tenancy or other non-pecuniary arrangements exist, or when at least part of the agricultural labour force is migrant or engaged in informal or other activities.

These complications are only partly resolved when labour is valued according to the determination of shadow wages. In situations where no income alternatives exist, the shadow price of labour, which may be imputed as the marginal value or opportunity cost, may well be negligible. However, although the assessment of shadow wages may offer a more appropriate indicator of costs, it is not necessarily a short cut. In order to evaluate the shadow wage it is necessary to develop a clear understanding of employment practices and alternatives. Such analysis needs to incorporate changes in shadow wages over the crop or livestock cycle (for example, the shadow wage may be high during seasonal harvest peaks).

Joint Products

The question of joint production and joint products poses serious problems in the estimation of agricultural production costs. A high proportion of the total production costs for many agricultural commodities are not directly attributable to a single enterprise. Many fixed costs as well as variable costs for the use of land, machinery, labour and management are often not easily divisible by product. The identification of the product itself may cause difficulties, and one agricultural crop may be identifiable with different sub-products, for example sugar cane with raw sugar, molasses and bagasse. In addition, many crops are grown in rotation, which raises questions not only about the allocation of land, labour and capital values but also regarding the allocation of costs of soil enrichment or the erosion reducing impact of the rotational crops.

The fact that factors of production generally have many uses means that changes in the value of one application impact throughout the system, although to differing degrees. For this reason changes in the value of one crop affect the costs of production of other crops. Furthermore, this interdependency extends well beyond the agricultural sector, so that changes within the manufacturing or services sector lead to changes in factor costs in the agricultural sector.

Cost Studies

The diversity of production cost studies is evident from the sample of studies covered in this review. The range of methodologies and countries and crops offered undermines attempts to piece together the jigsaw of changing comparative advantage. The problem is aggravated further by the apparent absence of time series data of sufficient quality and length to enable an analysis of global or even national trends.

The existing studies tend to be associated with no more than a dozen institutions. Among the most widely known are those of the USDA and notably its annual "Costs of Production" studies of the US farm sector. The annual report assesses costs and returns on a per-acre basis under three sections of a farm budget: cash receipts, cash expenses, and economic costs. Since 1983, the budgets have been based on national weighted average estimates of all costs associated with the particular enterprise.

In addition to its national studies, the USDA has been associated with international cost comparisons. Such studies include the 1986 examination of the international competitiveness of US wheat and the comparative study undertaken by Cornell University on production costs for cereals in the European Community and the USA. The question of agricultural competitiveness is also the direct concern of the US International Trade Commission (ITC). The ITC has to date conducted studies which include comparative analysis of countries exporting oilseeds, citrus, meat, flowers and certain vegetables to the USA. The US Office of Technology Assessment (OTA) in 1986 also engaged in a major review of US competitiveness in Agricultural Trade. The OTA study provides

particularly valuable perspectives on technology influences on agricultural competitiveness. Significantly, after reviewing the difficulties associated with international cost comparisons, the OTA concludes that it is unable to provide an international comparison of production costs.

The FAO's "Economic Accounts for Agriculture" between 1961 and 1977 provided a useful data source for comparisons of production costs. It would appear that the FAO no longer publishes a detailed analysis of production costs outside of its annual fertiliser yearbook, which measures the application and cost of the principal chemical fertilisers.

The Farm Accountancy Data Network (FADN) has been established under EEC sponsorship to provide annual data on farm income, expenses and returns in each of the member states. The majority of EEC countries have not yet systematised their national cost data on an annual basis. Furthermore, for those who have, questions remain regarding the representative of the national data. Farmers are among the strongest critics, arguing that the national estimates tend to under-represent small producers and therefore underestimate the average production costs. Furthermore, national averages tend to mask regional differences as well as intra-regional differences, so that the national average may not provide an accurate reflection of the situation facing farmers either in particular regions or even nationally.

While farm cost data in OECD countries is far from complete, it compares very favourably with that of developing countries. Available data suggests that a comparison of costs in OECD countries is a feasible undertaking. International comparisons of production costs which include developing countries are much more problematic.

Among the groups currently examining the question of international comparisons of factor costs are two who share in common a methodological bias in favour of the engineering cost approach and a concern to compare developed and developing countries using a commodity specific approach.

Engineering Cost Studies

The engineering cost approach provides the framework for the international studies of production costs being undertaken at the Mediterranean Agronomic Institute (MAI) in Montpellier and at Landell Mills Commodities Studies (LMCS) in Oxford.

The Mediterranean Agronomic Institute, in the context of its convention with the French Ministries of Agriculture and the Planning Commission, has used engineering cost components to build a linear programming model designed to analyse international differences in production costs[2]. In its simplest form, the model examines one product and

assumes all prices are given. The model shows the efficiency of different technologies and provides perspectives on the choice of minimum cost technology. Rent is a residual within the model and is not itself included as a factor cost input

An interesting feature of the Montpellier model is its use of EPIC, the Erosion Productivity Impact Calculator devised by Texas A and M University in association with the USDA. EPIC provides a framework for associating different inputs and the intensity of their application with the output. Plant growth and biomass formation are specified according to genetic criteria which then interact with climatical, soil and other significant input factors. The model was devised to examine erosion and is being adapted by the Mediterranean Agronomic Institute to provide the coefficients required in a comprehensive engineering cost approach to comparing technological efficiency in production. To date, comparisons of the efficiency of production of maize, wheat, sunflower and soybean production have been made between different regions of France, Argentina and the United States.

The extent to which the EPIC model could be adapted to analyse factor costs and comparative advantage requires further investigation. Among the factors which need to be introduced are land values and shadow prices and differential exchange rates. The exclusion of land costs and of taxes and subsidies from the analysis means that the IAM studies provide an incomplete examination of competitiveness, although they do provide an indication of relative economic efficiency.

The engineering cost model developed by Landell Mills Commodities Studies is also based on a system of "technical blueprints". To date, LMCS has developed comprehensive international comparisons of production costs for sugar, rubber, oilseeds, cocoa and coffee. For each crop, the production process is divided into a number of distinct sub-processes, such as land preparation, fertiliser application, plant seeding, cultivation, harvesting, transport and so on. For each such sub-process, various options or technologies are distinguished. These typically include a range from labour intensive to capital intensive methods for performing the same task. For each commodity and country a particular combination of processes is chosen. Weighted averages of the different technologies are determined to provide a hybrid technology which represents the national average.

The accuracy of the production cost estimates derived from engineering cost models reflects the underlying cost data and technology assumptions. An advantage of the engineering cost approach is that, in general, costs assembled for the analysis of one crop are applicable to other applications, so that the extension of the analysis to additional crops requires the estimation of new technological coefficients and an extension, but not laborious redeterimination, of the cost data. A further advantage of the engineering cost approach is that it lends itself to sensitivity and time series analysis. It is a relatively simple matter within the model to change either the technical coefficients or the input prices, and to pose hypothetical questions regarding the application of new

technologies or changes in different input prices on production costs. Furthermore, because costs are determined on the basis of sub-processes, the analysis of costs may be segmented to provide international comparisons of discrete elements within the cost structure. In this way, it is possible to simply compare field costs, harvesting costs or any other sub-process or group of sub-processes defined in the cost model. A further advantage of the engineering cost approaches is that they lend themselves to linear programming and therefore could be used to determine optimum patterns of technological transformation. For example, the application of the engineering cost data to linear programming could determine the least cost technology. Such information has many uses, including the analysis of investment opportunities. However, the failure of the engineering cost approaches to adequately deal with issues associated with the valuation of land, labour and capital seriously erodes the credibility of these international cost comparisons. Comparisons of costs, including those using engineering cost methodologies, require as a foundation extensive comparable cost data. In the final analysis, it is the absence of these and the practically prohibitive data collection and measurement problems involved, which preclude a comprehensive analysis of relative costs embracing developing countries.

Revealed Comparative Advantage[3]

Balassa and others have suggested that in the absence of sufficient data on factor costs it may be possible to indicate revealed comparative advantage by examining the trade performance of individual countries. Only export data were used in his analysis. His relative export share measure of revealed comparative advantage, **BRC**, is defined as:

$$BRC_{a,m}^{i,w} = (XS_a^i / XS_m^i) / (XS_a^w / XS_m^w) \qquad (1)$$

where, **XS** refers to export supply, i to the home country, w to the world, a to any particular commodity and m to all commodities.

The assumption is that the commodity pattern of exports reflects relative costs as well as differences in non-price factors and that comparative advantage can be expected to determine the structure of exports. The higher the net exports within a particular commodity group, the greater the revealed comparative advantage. Balassa, however, restricted his analysis to manufactured goods on the grounds that distortions in primary product trade meant that this trade would not reflect comparative advantage.

Subsequent development of the notion of revealed comparative advantage has concentrated on the identification of the appropriate trade measures for analysis. Kunimoto introduced into the analysis a relation between actual and expected country exports for different commodities. Deviations of the actual from the expected export ratio

accordingly provide an indication of the difference between what a country actually trades and what it may be expected to trade. This distinction rests on fragile assumptions regarding a constant total level of trade, and also, as Bowen has pointed out, like Balassa's measure, requires that a country does not import and export the same commodity. Bowen thus developed an alternative index of revealed comparative advantage, which focuses on net trade. His "net trade intensity index", (TI), measures actual trade relative to the production that would exist in a world in which trade were determined according to comparative advantage. This is based, however, on the inappropriate assumption of homothetic and identical preferences, the result of which, as Ballance has pointed out, would be that trade would not occur.

Vollrath and Vo have attempted to advance the application of revealed comparative advantage through the development of a "revealed competitiveness" (RC) index. This incorporates imports as well as exports and includes intra-industry trade. The inclusion of intra-industry trade improves the relevance of the revealed comparative advantage approach by simultaneously ensuring that an important component of trade is included and that the unrealistic assumption that all countries have to export all commodities is lifted.

Using their revealed competitiveness index, Vollrath and Vo identified changing patterns of revealed agricultural competitiveness. This was based principally on assumptions regarding shifts in government policy. These were shown to substantially alter relative import shares.

Changes in government policies are also the focus of a number of studies undertaken in the 1980s to highlight the implications of agricultural trade liberalisation. While this work is generally viewed in the context of the Uruguay Round of the GATT, and has undoubtedly been stimulated by the current trade negotiations, it also is of relevance to discussions of revealed comparative advantage. To what extent, it may be asked, may models of agricultural trade liberalisation, which examine the implications of the removal of distortions, provide insights into comparative advantage?

Trade Liberalisation Simulations

In recent years a number of projections of agricultural trade which stretch to 1995 and beyond have been published. The FAO in its study "Agriculture: Toward 2000" assumes that distortions continue to influence trade in the year 2000. However, the International Institute of Applied Systems Analysis (IIASA), Tyers and Anderson, Burniaux, Valdes and Zietz, the USDA, the OECD and others have provided projections which assume the removal of many distortions[4]. It is worth considering whether these trade liberalisation studies offer a means to identify revealed trends in costs and comparative advantage.

The FAO projections do not explicitly incorporate a production function. The values are derived from the projection of domestic demand by country and commodity on the basis of GDP and population growth projections. Initial assumptions follow as to national self-sufficiency goals of developing countries. The implied tentative production "targets" are then evaluated (and modified as required) for their technical and economic feasibility. In parallel, assessments are made of possible production trends in each developed country to define possible net trade positions and a first estimate is made of the implied net trade positions. Further iterations, which take into account the resource and technological constraints in developing countries lead to the development of a world balance.

The FAO projections provide a valuable assessment of trends in production and trade over the period to the year 2000. However, production functions which embrace costs and technology are not specified. The question therefore arises whether it is possible to identify trends in comparative advantage through the projections. In part this depends on how one defines comparative advantage; if comparative advantage reflects costs (rather than costs plus government and other support) the projections may not be able to help us, for they implicitly assume the continuation of current support levels. In addition, the assumption that there will be a tendency towards self-sufficiency among the major developing country deficit countries may bias the FAO projections against trade based on comparative advantage.

Recently, the USDA has demonstrated its interest in the question of foreign support for agriculture by applying the notions of Producer Subsidy Equivalents (PSEs) and Consumer Subsidy Equivalents (CSEs), which were pioneered by the OECD, to an international comparison of government intervention in agriculture. The approach is conducted on the basis of prices and not production costs. The USDA studies, and subsequent extensions of the OECD study to include developing countries, do not reveal factor cost comparisons. Nor are these costs hidden within the data assembled for the calculation of PSEs and CSEs, for the starting point of the models is the comparison of final product prices.

The International Institute of Applied Systems Analysis (IIASA) study of agricultural trade liberalisation applies a general equilibrium approach to an examination of the removal of distortions between trade (border) prices and domestic prices. The model projects changes in prices over the period 1986 to 2000 with these changes reflecting the balance between demand and supply. The model includes the major variables affecting supply and demand and shows how the global structure of agricultural production changes to meet the changing structure of demand. Various permutations of liberalisation are explored by IIASA. For the purposes of examining revealed comparative advantage, the scenario in which all market economies liberalise is most relevant.

The IIASA study notes that when more countries remove distortions, the scope for exploiting comparative advantage increases, and global gains in efficiency should result.

However, in the absence of lump-sum transfers, an individual country may be worse off if the changes in world market prices substantially worsen its terms of trade. The model assumes that agricultural trade is fully liberalised in 1986 so that between that year and the year 2000 domestic prices in a country equal its trade prices. Changes in world prices are transmitted to domestic prices and the resulting impact on factor allocation and growth is specified in the model. The broad pattern is that when agricultural prices increase countries put more factors into agricultural production. However, global production levels have to be consistent with global demand, and because the changes in demand for agricultural products due to liberalisation are small, changes in total global production levels are modest. Nevertheless, the pattern of production across countries and groups of countries does change. The developing countries increase their production of all agricultural commodities, except coarse grain. The most significant increases over the period are in rice (3.1%), bovine and ovine meat (1.2%), protein feed (9.5%), other food (2.1%) and nonfood agriculture (2.5%). The significance of the last two groups should not be underestimated as these groups account for 60% of the value of agricultural output in developing countries.

As may be expected, trade liberalisation is associated with a substantial growth in the volume of trade. The developed market economies significantly increase their imports of meat and other food and in the case of rice change from being net exporters to net importers. At the country level, these changes are even more dramatic and many countries change the direction of trade for one or more commodity. These changes provide an indication of revealed comparative advantage.

The Rural Urban North South (RUNS) model developed by Jean Marc Burniaux, shares in common with the IIASA model a desire to capture general equilibrium effects. The model is more aggregative than the IIASA model in its regional specification (the world is divided into ten regions), but more detailed in its agricultural and commodity detail (fourteen agricultural sectors are represented).

The IIASA and RUNS general equilibrium models go beyond the partial equilibrium models in their concern to take into account inter-sectoral factor movements resulting from reallocative efficiency. However, like all the other trade liberalisation models, these models are based on elasticity estimates derived from historical production and consumption trends. None of the models reveal factor endowments or factor costs and even the most detailed provide only a schematic consideration of production functions (indicative production functions are derived for land, labour and capital using shadow prices) and no endogenous technical change.

Tyers and Anderson have developed a dynamic stochastic model of world food markets which they use to estimate the effects of liberalising agricultural policies in OECD countries. The model covers grain, livestock products and sugar (GLS) and provides projections over the period 1983 to 1995. It incorporates elements which are absent from the IIASA and RUNS models - most notably, a domestic market stabilisation component

of food policy - but in other respects is less developed than the IIASA model and is not a general equilibrium model (other tradeable goods and non-tradeables are excluded and exchange rates are exogenous). The model is similarly driven by elasticities and the constant production functions are not derived with reference to costs.

Recent adaptations to the Tyers and Anderson model and also the Valdes and Zietz model have included within the model framework the analysis of exchange rate and other macro-economic changes within the developing countries. These adapted partial equilibrium models, like the IIASA or RUNS model, with important caveats may be valuable as a "second best" tool in the analysis of trends in comparative advantage.

In addition to providing important insights into comparative advantage, the modeling of agricultural liberalisation emphasises the relationship between international and domestic interventions. The global general equilibrium models, and a number of the partial models, such as that of Valdes and Zietz, review the implications of different macroeconomic policies on production and trade. They highlight the extent to which macroeconomic policy influences relative costs and national, as well as international, resource allocation.

Domestic Resource Cost Analysis

Prior to the development in the 1980s of trade liberalisation models, and in particular, prior to the application of general equilibrium analysis to the examination of resource allocation, a number of research institutes sponsored the development of measures of revealed comparative advantage. The Food Research Institute analysis builds on the formula that a country has a comparative advantage in the production of a specific commodity if the social opportunity costs of producing an incremental unit of that commodity are less than its border price. The analysis is based on the measurement of net social opportunity costs and hence on the distinction between social and private profitability. Relative comparative advantage across countries is measured by ranking each countries' ratio of the domestic resource costs (DRC) per unit of foreign exchange earned or saved to the shadow price of foreign exchange.

Within countries, the DRC approach allows a comparison of the relative efficiencies of region of production or of alternative technologies. International comparisons of efficiency are derived from the ranking of the regions or techniques with the lowest DRC coefficients in each country. Although the DRC does not capture the effects of technical change, technological change influences the patterns of comparative advantage (and DRC coefficients) in the future.

An examination by the Food Research Institute of revealed comparative advantage in rice production concluded that, except for Thailand, the technologies surveyed were inefficient at prevailing prices, implying that subsidisation and/or the introduction of new technologies would be necessary to maintain existing production levels in the USA, Taiwan and the Philippines. The study also concluded that labour costs in the four countries surveyed were of similar importance in determining comparative advantage. This tends to support the contention that increases in per unit labour costs and decreases in labour usage have been largely offsetting throughout the process of technological change in the production of rice.

The conclusions of the Food Research Institute are derived from a comparative static analysis and a full consideration is not given to trends in labour use and labour cost. By contrast, the Resources for the Future examination of the Asian rice economy explicitly examines trends in labour use and productivity. The difficulties associated with measuring labour costs or returns to labour, and notably the difficulty of measuring the family labour input, are highlighted in the Resources for the Future study. The study concludes that although labour productivity has been steadily increasing throughout the Asian rice growing world this has only been associated with a sustained growth in real wages in East Asia (excluding China). The Resources for the Future study does not however attempt to conduct a comparative analysis of wages or other costs; the concern is simply with assessing trends within each country.

The DRC technique used in the Food Research Institute studies compares prevailing technologies within and across countries at a given point in time. The assumptions of constant cost technologies and zero elasticities of input substitution (fixed production coefficients) mean that the determination of comparative advantage is static. The DRC analysis provides useful insights in the understanding of existing differences in production patterns and technologies, but cannot capture the effects of technical change, and can only be used in a dynamic sense if production technologies and growth patterns do not alter input mixes and factor costs. This seriously undermines the use of DRCs to determine trends in comparative advantage.

The DRC approach to the measurement of revealed comparative advantage is conducted with reference to border or traded prices which in themselves may not reflect international competitive equilibrium prices. For example, in the case of rice, less than 5% of world production is traded and any major shift in production seriously impacts on the world price. The partial and static nature of the DRC technique limits its usefulness as an indicator of long term comparative advantage. In many applications it may provide an useful proxy for a factor costs analysis of comparative advantage, but in others offers no short cut to the exploration of comparative advantage. It would appear therefore, that international comparisons of factor costs remain a vital element in the understanding of changing comparative advantage in agriculture.

The attempt to identify patterns of trade with factor costs or factor endowments is, however, as we have illustrated above, fraught with difficulties. Indeed, we have shown that factor endowments and costs are not directly revealed in trade and that there is no simple theoretical or empirical identification of trends in factor costs with trends in trade.

PART THREE

COMPARATIVE ADVANTAGE AND DEVELOPING COUNTRY AGRICULTURE

Comparative Advantage and Economic Growth

To the extent that comparative advantage is a determinant of economic performance, it may be expected that it is revealed in economic growth and the share of agriculture in this growth. We have noted that tests of the theory of comparative advantage failed to demonstrate that countries export commodities which require relatively intensive use of their relatively abundant factors of production. Modifications to the standard Heckshcher-Ohlin-Samuelson model by Johnson and others to widen the definition of capital to include not only physical capital but also human capital and technological know-how, allows measurement of relative capital intensity in terms of relative value added per unit of labour time input. Balassa and Anderson and Garnaut have shown that with respect to manufacturing it is indeed the case that countries exports are more intensive in the use of capital (broadly defined) when the countries endowment of this capital is large relative to the number of workers.

Whereas Johnson and Balassa focused on manufacturing, Krueger and Anderson have extended the analysis to primary products. This modification separates out natural resources from the definition of capital. The analysis is thus of an economy with two tradable sectors, producing primary products and manufactures, and three factors of production: natural resources, which are specific to the primary sector, capital which is specific to the manufacturing sector, and labour which is used in both sectors and is mobile[5]. Comparative advantage between manufacturers and primary products is determined by the relative endowments of man-made capital and natural resources. Accordingly, as Anderson has empirically verified, with capital accumulation, a country gradually changes from being predominantly a primary producer to a producer of manufacturers. As Anderson has shown, the theory suggests that a poor country opening up to international trade will have large shares of production and employment in the primary sectors, particularly agriculture, but that these will decline with economic growth. Furthermore, the fact that capital is required in addition to natural resources and labour in primary production strengthens the conclusion that natural-resource-poor, densely populated countries will begin manufacturing at an earlier stage of capital availability per worker than resource-rich countries.

Empirical support for modified versions of the theory of comparative advantage is also evident in the work of Haley and Abbot. Their model has identified that relative agricultural prices, income and savings behaviour together with resource availability and allocation (including the level of capital accumulation) help account for flows of trade. Changes in the trade mix over time are attributed to changes in production and consumption behaviour, although differing initial conditions are also shown to be important, and are used to explain differing production responses.

Regressions conducted by Haley and Abbot yield a number of interesting results regarding trends in agricultural production and trade. They show that natural resource or raw land potential does not explain inter-country differences in agricultural production and that only improved land contributes to agricultural comparative advantage. Land development costs have a significant effect on the productivity of agricultural capital and underline the importance of past investments.

While the work of Krueger and Anderson emphasises the importance of inter-sectoral allocation, that of Abbot, underlines Mundlak's stress on investment as a determinant of comparative advantage. Their work emphasises the need to distinguish clearly between the widely accepted notions that agricultural trade may be explained in terms of absolute or natural comparative advantage and the more nuanced interpretations which focus on comparative advantage as a relativity and including widely defined notions of factor endowments. The scant evidence which exists - such as that provided by Chenery - suggests that "natural" comparative advantage is an inadequate explanation of world trade and cannot in itself explain the pattern of growth of agriculture in developing countries.

A key problem is that the notion of comparative advantage is essentially static and refers to the optimisation of resource allocation at a given time. It aims to identify the configuration of products that a country can produce given existing factor endowments and technologies and assuming free trade. The emphasis on national resource allocation may mean that a country can lose its competitiveness in some product relative to another country, and yet the production of that product may still be in accordance with the country's comparative advantage.

Conclusion

In order to second-guess comparative advantage, reference may be made to relative costs and competitive advantage. The discussion above has however shown that in practice the definition and measurement of factor costs is as difficult as that of factor endowments. Our review of some of the literature on the subject of factor costs reveals a number of clues regarding the difficulties and the potential insights offered by an analysis of factor costs. Clearly, theoretical, methodological and empirical obstacles remain in the way of an analysis of trends in factor costs. Further difficulties exist if we

are to relate these trends in costs to comparative advantage. Various attempts, such as those evident in evaluations of "revealed comparative advantage" attempt to circumvent these difficulties. These are severely compromised by the fact that trade, particularly in agriculture, is severely distorted by non-market interventions.

Government and other interventions limit the extent to which comparative advantage is allowed to dictate patterns of international agricultural trade. To the extent that the 1990s will be associated with international trade liberalisation and that this will be accompanied by domestic liberalisation and structural adjustment comparative advantage will play a greater role in production and trade. Trade liberalisation and the reduction of government support for agriculture may be expected to increase the significance of factor endowments and comparative advantage in an understanding of future trends in agricultural production and trade.

Developing countries are increasingly unable to afford distortions and appear most likely to engage in structural adjustments. For them, efficiency and cost can be expected to become more important. An awareness of the importance of comparative advantage is thus likely to become more important to both actual and potential developing country participants in agricultural trade.

It should be noted, however, that at a time when the notion of comparative advantage is one of the few concepts to have gained widespread acceptance among economists, economic theory appears to have reached an impasse on the subject. Despite the depth of analysis, the literature appears inconclusive on many key points. Perhaps not surprisingly, therefore, it appears to be of little direct relevance to policy makers. So, for example, Governor Park of the Korean Central Bank noted in 1987: "Don't listen to 'comparative advantage' advice. Whenever we wanted to do anything, the advocates of comparative advantage said: 'we don't have the comparative advantage'. In fact, we did everything we wanted but whatever we did, we did well"[6].

If, as the New Palgrave Dictionary of Economics states, the principle of comparative advantage is "the deepest and most beautiful result in all of economics"[7], economists have a task to extend this conviction to policy makers. The optimisation of international and national resource allocation requires both a recognition of the importance of factor endowments and of the role of human capital and appropriate macro-economic policies in economic growth[8]. This much, we can deduce from the principle of comparative advantage.

NOTES

1. G. Haberler in B. Ohlin *et.al.* (eds.) *The International Allocation of Economic Activity: Proceedings of a Nobel Symposium*, Holmes and Meier, New York, 1977, p.4.

2. See. G. Flichman, Economic Efficiency and Agricultural Production, OECD Development Centre, *Technical Paper*, (forthcoming), 1990.

3. This section draws on discussions with Thomas Vollrath and on T. Vollrath and D. Huu Vo, *Investigating the Nature of World Agricultural Competitiveness*, USDA, ERS, Washington D.C., 1989, pp. 2-4.

4. For a review of the different models, see I. Goldin and O. Knudsen (eds.), *Agricultural Trade Liberalisation: The Implications for Developing Countries*, OECD and World Bank, Paris and Washington, 1990.

5. This paragraph is based on Kym Anderson, *Changing Comparative Advantages in China*, OECD, Paris, 1990, pp.17-31

6. Cited in Y. Alagh, The NIEs and the Developing Asian and Pacific Region: A View from South Asia, *Asian Development Review*, Vol. 7, No. 2, 1989, pg. 116.

7. R. Findlay, "Comparative Advantage", in J. Eatwell , *et.al*. (eds.), *The New Palgrave: A Dictionary of Economics*, (MacMillan, 1987, London), Vol. 1, page 514.

8. Korea's attempt to develop sectors where it has no comparative advantage has been a costly mistake, and, if recent trade statistics are indicative, is now resulting in a considerable drag on economic growth.

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