GUIDELINES ON NATIONAL COMPARATIVE ADVANTAGE AND AGRICULTURAL TRADE

January 1995

APAP III
Methods and Guidelines
No. 4001

AGRICULTURAL POLICY ANALYSIS PROJECT, PHASE III

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ABSTRACT

These guidelines summarize the state of the art of comparative advantage analysis in developing countries. Chapter 1 summarizes the key ideas behind the measurement of international comparative advantage in non-mathematical terms. Chapter 2 presents the quantitative tools that follow from those concepts. Chapter 3 discusses conclusions for the application of these concepts and measurement tools. The body of the text has been written for development professionals with a limited background in economics; details of interest primarily to economists have been included in two appendixes, one on comparative advantage theory and another on the accuracy of alternative measures.

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EXECUTIVE SUMMARY

Large shocks in commodity prices, capital flows and exchange rates have put an end to the certainties of post-war trade relationships, and brought corresponding turmoil in economic thought about global competitiveness and the benefits of trade. From these challenges a strong new consensus has emerged around the classic principles of comparative advantage. More than ever, economists now agree that gains from trade are a key source of national wealth, and that faster economic growth can be achieved by pursuing activities with greater comparative advantage. This applies particularly to the agricultural sector, where attempts to "go against" comparative advantage have been both widespread and very costly. As a result, both low- and high-income countries have been moving towards more open agricultural trade, and commitments on continued market access have been accepted under the GATT.

Applying the theory of comparative advantage requires using a few fundamental principles to derive meaningful measurement tools. Many of the key principles are as old as economics itself, but have been strengthened by recent challenges. The most accurate measurement tools require large amounts of data and complex analyses; such models are typically used only by specialized researchers. For most policy-making applications, analyses must be done quickly with very limited information. Simpler measures are needed; in these guidelines a variety of such measures are compared, in terms of accuracy and significance.

The simplified measures of comparative advantage analyzed in these guidelines all rely on comparing the costs and benefits of alternative activities, at market prices and/or social opportunity costs. The possible measures include:

- *Indicators of policy effects*, such as the nominal protection coefficient (NPC) which compares market prices and opportunity costs for a particular product; the effective protection coefficient (EPC) which compares net value added or gross return to all domestic factors using market prices and using opportunity costs; and the producer subsidy equivalent (PSE), which compare net producer income levels at market prices and at opportunity costs, or

- *Indicators of comparative advantage*, which use only opportunity costs to assess an activity's level of net social profit (NSP) per acre or per ton, and unit-free proportional measures such as the domestic resource cost (DRC) or social cost-benefit (SCB) ratios.

Policy-effect measures have evolved over time to include increasing amounts of data, from Adam Smith's use of a measure like the NPC to analyze the costs of the British corn laws, through the use of EPCs in early GATT negotiations, to the use of the PSE and related measures in recent trade agreements. Comparative-advantage measures generally use similar data, in different formulas. Most recently, researchers have developed the Policy Analysis Matrix (PAM), a simple accounting framework from which all of these measures can be computed simultaneously.

By comparing the mathematical properties of alternative measures, we find that only one formula is fully consistent with maximizing national income: it is the social cost-benefit (SCB) ratio, corresponding to a particular form of the PSE known as the subsidy ratio to producers (SRP) . Applied analysts seeking an unbiased measure should generally use this SCB/SRP indicator, which uses the same data other indicators of comparative advantage, but in a more generally valid formula.

The choice of indicator is only one step in the measurement process. Obtaining relevant data on prices and quantities is also critical. The guiding principle here is that the data must reflect actual opportunities available in the economy: market prices and quantities are those that prevail under current conditions, while social opportunity costs are those that would prevail with economically optimal government policies. Unlike the choice of formula, no simple rules can guide the collection of data -- but a number of excellent textbooks summarize the state-of-the-art in this area.

The theory and measurement of comparative advantage shows clearly that there is ample scope for national governments to improve economic performance, by shifting to more cost-effective interventions. These include primarily steps to open international trade and provide more domestic public goods. Key public goods in agriculture include research and education to raise skill levels, health and sanitation to maintain productivity, justice and property rights to ensure labor mobility and efficient land use, market infrastructure and information to extend competition, and grades and standards to maintain product quality.

The provision of public goods to all citizens, if carried out in cost-effective manner, can reduce costs and deepen national comparative advantage. In contrast, attempts to intervene directly in trade can have only a cosmetic effect. More extensive use of economic analysis can make it easier for policy-makers to distinguish successful from unsuccessful policies, and thereby raise rates of economic growth throughout the world.

1. PRINCIPLES OF COMPARATIVE ADVANTAGE ANALYSIS

These guidelines have been written for USAID staff and other development practicioners, to provide a compact and accessible summary of comparative advantage analysis techniques in developing countries. The concepts of comparative advantage and competitiveness arise in many fields, but are critical for three key areas of work in international development:

- *Project design and evaluation*, including export-promotion and natural-resource management projects as well as more traditional projects for infrastructure and institutional development;

- *Policy analysis and reform*, including market liberalization and structural adjustment programs, at the commodity and sector levels; and

- *Food security and equity programs*, including both project and policy components, to expand market access and productivity for vulnerable groups.

In each of these three areas, competitiveness and comparative advantage can be used to evaluate the economic costs and benefits of some activity, project or policy reform. Although the terms "competitiveness" and "comparative advantage" are sometimes used almost interchangeably, in these guidelines their definitions are quite different (see section 1.2 below): *comparative advantage* will be used when costs and benefits are evaluated from the point of view of the economy as a whole, while *competitiveness* will be used when costs and benefits are evaluated from the point of view of the individual farmer, manufacturer, exporter or other decision-maker.

1.1 Why These Guidelines?

Rapid changes in world commodity prices, capital flows and exchange rates have led to a resurgence of research in international economics, and a bewildering array of new ideas. Among the many economic and political changes of recent years, four are particularly relevant to USAID staff and their colleagues in the area of agricultural trade:

First, among professional economists, the growth of "new" trade theory and concepts of "competitive advantage" have substantially changed the vocabulary used to understand the gains from trade. New analytical methods have been introduced, nudging aside older techniques. And as with other new technologies, the resulting broader array of more powerful policy-analysis tools can be helpful, but seemingly sophisticated policy prescriptions can turn out to be misleading. These guidelines are designed to provide an accessible overview of alternative methods, to inform the choice of an appropriate tool for any given task.

Second, in many developing countries, reduced trade barriers and structural adjustment programs have made the appropriate direction for future reforms less obvious. For most of the past decade, the broad direction of change was clear. But some countries may now have gone far enough towards liberalization and market-oriented reforms. Further policy prescriptions will have to be tailored more precisely, and there is a greater need for donors and governments to "fine-tune" their aid programs and national policies.

Third, in the global economic environment, trading rules and practices are in flux. Through NAFTA and the EU, North America and Europe seem to have become committed to regional as opposed to global trade patterns. On the other hand, completion of the Uruguay Round of GATT negotiations has laid a foundation for world-wide openness, holding out the prospect of even greater gains from trade. The tension between bilateral and multilateral agreements will remain an important issue for many years, as countries experiment with the new legal mechanisms needed to regulate more open trade.

BOX 1. STRUCTURE OF THE GUIDELINES

The guidelines are written for development professionals with a variety of backgrounds, to assist in guiding and carrying out research on economic comparative advantage and competitiveness. It is intended to be accessible at many levels: a quick reading of the main text will summarize the main points, while the boxes and appendix materials provide more depth and detail.

- Section 1 provides an introduction to the definition and uses of comparative advantage analysis and measurement. More detail is provided in appendix A, which reviews the major theories of comparative advantage and their empirical tests.
- Section 2 summarizes the menu of measurement techniques which follow from the comparative advantage concept, providing the formulas and implementation guidelines needed to put principles into practice. Appendix B provides a formal model with which to evaluate alternative measures.
- Section 3 concludes the guidelines with a discussion of the resources needed to implement comparative advantage measurement, and a summary of the implications of these guidelines for development strategy, given recent changes in the world economy such as GATT, NAFTA and the breakup of the former Soviet Union.

Fourth, beyond national economic statistics, social and environmental concerns have taken on a new urgency. Brutal inequities and environmental breakdown in many countries around the world are increasingly seen to affect not only those directly concerned, but also their neighbors and overseas partners. As trade and communication becomes more open, each region's problems become less and less isolated. Analysts are forced to take an increasingly broad view of competitiveness and comparative advantage. The methods surveyed in these guidelines permit a variety of new dimensions to be incorporated in comparative advantage analysis, in a consistent framework.

In responding to rapid change and continually-expanding responsibilities, the staff of aid agencies and government ministries may need to reassess their measurement methods. Our focus is on how to measure the economic value of agricultural production for trade. Such measurement is critical in part because not all activities are equally profitable in all countries: a new rice technology may take off in Indonesia but fail in the Philippines, while horticultural crops that thrive in Kenya may fail in Tanzania, and fruit processing that succeeds in Poland may fail in Bulgaria. In measuring these differences across countries and across industries, we will gain insight into both the gains and losses from past policies and investments, and the value of new investments and policy changes.

Expanding on Arnold Harberger's (1993) analogy of economics as medicine, our diagnostic insight will inevitably be most accurate for "typical" syndromes and conditions. Many real-life cases will present intermediate, hard-to-classify symptoms. And even in seemingly classic cases, there will always be exceptional countries which defy the usual outcome--exceptions which may be said to prove the rule. Furthermore, as in medicine the mechanisms and dynamics involved in any particular case are often not well understood. We may know in general terms where an economy is going, without knowing exactly how events will unfold.

1.2 What is Comparative Advantage? What Is Competitiveness?

Much confusion in economics is due simply to unclear definitions. Following the trade policy analysis tradition of Corden (1974) and others, we define comparative advantage to be an activity's marginal contribution to national income (or "social profits"), while competitiveness is its marginal contribution to the net income of its owner or manager ("private profits"). An activity that generates positive social profits is said to be "economically efficient", and to have some "comparative advantage" relative to other activities.

Under this definition, the *comparative advantage* of a country or region determines how a new project or policy change will affect the whole economy; it is therefore most useful for *evaluating* new projects and proposed policy reforms, in terms of their impact on average real incomes and economic growth. On the other hand, the *competitiveness* of an activity determines whether or not it can attract workers and other resources; it is therefore most useful for *predicting* whether or not new firms would engage in the activity. Clearly, the highest-possible level of real income and economic growth arises when competitiveness and comparative advantage are equalized, so that the most socially valuable activities attract the most resources. At any one point in time, however, we can expect substantial differences between comparative advantage and competitiveness, signalling important opportunities for new projects, policies and programs to raise productivity and well-being.

The value of defining competitiveness and comparative advantage in terms of profitability is its immediate policy implication: expanding socially profitable activities will raise national income, while expanding privately profitable ones may not. Profitability levels have an influence on market share and production levels, but activities can have large market shares and yet be unprofitable in terms of raising national income, because they benefit from government subsidies or other transfers from the rest of the economy.

If all markets were perfectly competitive, the marginal profitability of all activities would be equalized. Any differences in private profits would be eliminated by expansion or entry into profitable activities, and contraction or exit from unprofitable ones. Competitiveness and comparative advantage would thus be the same for all activities. Sustained differences in profitability across industries must be maintained by a market failure such as monopoly power, and/or an associated policy failure such as weak anti-trust rules which generate transfers among market participants. Market and policy failures are inter-related, as each one implies the other: a failure of the economic and political systems to interact in a cost-effective manner.

Since there are many possible market and policy failures, quantitative tools are needed to assess their relative importance across industries. These tools are the focus of Chapter 3 of these guidelines, drawing on both the project-appraisal literature (e.g. Gittinger 1982) which has traditionally been concerned with evaluating potential public-sector enterprises, and the policy-analysis tradition (e.g. Tsakok 1990) which has focused on existing private-sector activities. The two fields have converged on quite similar methods, and have a shared conceptual foundation. Both approaches focus on the divergences between market prices and opportunity costs caused by market and policy failures: market prices are what is actually paid, while opportunity costs are the prices that would have been achieved with more effective government policies. The difference between them is a tax, subsidy or other transfer, caused by a combination of government policy and market failure.

The divergences created by market and policy failures typically involve transfers from one group to another within the economy, and also inefficiencies or permanent losses to the economy as a whole. The transfers are typically much larger than the efficiency losses, and they may be an understandable political choice. But market and policy failures may also be historical accidents or unanticipated by-products of other policies. They may also be highly inequitable, flowing from poorer to richer members of society.

In practice, there is often ample scope for policy changes to improve efficiency while also improving equity; numerous examples of this type of change are presented in Byerlee (1989) for Ecuador, Masters (1994) for Zimbabwe, and other applications of comparative advantage analysis. Many areas of policy-making can be improved through the use of information generated by this type of analysis, including:

- The targeting of public investment programs, towards the provision of more cost-effective public goods such as research and education, sanitation and health, market infrastructure and information, justice and property rights, or grades and standards;

- The reform of trade and exchange rate policies, towards more open international competition and higher levels of national income and productivity; and

- The evolution of domestic taxation and market regulation, to help align private incentives with public interests, and reduce opportunities for corruption.

Comparative advantage analysis can be used not only to measure the gains from small changes (new investments or "marginal" reforms), but also to set the broad themes of a development strategy, such as an emphasis on liberalizing trade, expanding agricultural production, or raising savings rates. These "strategic" themes would be composed of many "tactical" policies and projects, which can all be guided by analysis of national comparative advantage. The real strength of the methods outlined in these guidelines is in permitting analysts to look at individual activities and sectors from the viewpoint of the whole economy, with a minimum amount of data and economic modeling. This is achieved by relying on the few fundamental concepts reviewed in the following chapter.

1.3 Theoretical Foundations of Comparative Advantage Measurement

Like any other type of quantitative research, the measurement of comparative advantage requires an underlying theory: theory is needed both to inform what should be measured, and to inform how the resulting numbers should be interpreted. The historical development of economic thought in this area is detailed in appendix A; some of the key elements are summarized in box 3 and the text below.

1.3.1 The Classical Political Economy of Trade and Comparative Advantage

BOX 2. MARKET FAILURES, POLICY FAILURES, AND PARETO OPTIMALITY

> Economists sometimes distinguish between *market failures* and *policy failures*. Both are failures to achieve *Pareto-optimal* economic conditions, i.e. the best possible outcome, in the sense that there is no other outcome to which all citizens would agree.
>
> Simple examples of market failure are caused by *barriers to entry*, for example in the case of existing telephone companies who can prevent new firms from using their networks, and *external costs or benefits*, such as pollution or sanitation. Many more subtle examples of market failure arise because of *asymmetric information*, when buyers know less than sellers about the products being sold; prominent examples include patients choosing their medical treatments, and buyers choosing used cars (Akerlof 1970).
>
> Since market failures are ubiquitous, achieving Pareto-optimality requires some level of tax-and-spend government activity to offset them. Policies needed include the enforcement of *laws and regulations* to make markets more competitive, and the direct provision of *public goods* not provided by the market, such as open-access roads, parks, and information services.
>
> Governments often intervene too much, or in the wrong places. Inappropriate policies may make market failures worse, or simply leave them uncorrected. Thus all observed market failures involve a simultaneous government failure, and vice-versa. Both are failures relative to an optimal set of policies that involves laissez-faire in some markets and intervention in others.

Much of contemporary international trade theory is rooted in the writings of classical economists, notably Adam Smith (1723-1790), David Ricardo (1772-1823), and John Stuart Mill (1806-1873). The central conclusion of these authors' work is that, although there are exceptions, almost all countries can reach their highest possible levels of income and economic growth by maintaining open international trade; domestic production and consumption should be guided by the prices at which foreigners are willing to trade. Rather than restricting trade, governments should focus on maintaining competitive national markets and investing in public goods such as research and education. The key elements of this classical trade theory include:

- *The extent of the market determines productivity growth.* Smith (1776) argued that access to larger markets permits faster productivity growth and higher income levels, primarily

BOX 3. FOUNDATIONS OF COMPARATIVE ADVANTAGE ANALYSIS

	Key Concept(s)	Mechanism(s)
Classical Political Economy		
Adam Smith	Market size/productivity	specialization, competition
David Ricardo	Comparative advantage	international trade
J.S. Mill	Infant industries	learning-by-doing
J.S. Mill	Politics of protection	income distribution
Neoclassical Models		
Ricardian	Technical efficiency	use of a single key resource
Heckscher-Ohlin	Factor-intensity	use of more than one resource
Ricardo-Viner	Specific factors	use of industry-specific inputs
H-O-Samuelson	Consumer demand	product preferences
Salter-Swan	Exchange rates	nontraded goods, inflation
Challenges to Comparative Advantage		
Prebisch/Singer	Import-substitution	external terms of trade
A.O. Hirschman	Development strategy	inter-industry linkages
New trade theorists	Strategic policy	rent-shifting, externalities
Michael Porter	Competitive advantage	factor creation, demand signaling

because it permits more specialization and competition. A continuing strong link between market access and productivity growth has been confirmed by recent research, notably Ades and Glaeser (1994).

- *Only comparative costs determine the pattern of trade.* Ricardo (1817) established that the pattern of trade which generates the highest-possible level of national income depends only on the cost of alternative goods compared to each other within the country. The lowest-cost or most profitable goods are said to have a "comparative advantage" relative to the others. The overall level of productivity, or "absolute advantage", determines the level of maximum possible income but not production patterns.

- *There exist "infant industries" whose comparative advantage is hidden.* John Stuart Mill (1848) noted that some activities will be profitable only if the government intervenes to protect them through a period of learning-by-doing. He argued that trade restrictions against current comparative advantage "will sometimes be the least inconvenient mode in which the nation can tax itself for the support of such an experiment" (Mill 1848, p. 922). It is clear, however, that there are often more cost-effective forms of support for learning-by-doing, such as state-subsidized research and education.

- *Trade restrictions tend to be both inefficient and inequitable.* In an autobiography published at the end of his life, John Stuart Mill (1873) argued that policies to restrict trade "against" comparative advantage generate transfers to a few specific beneficiaries, at the expense of all other market participants. Potential beneficiaries tend to use up resources to solicit protection, and only relatively wealthy groups tend to succeed. As a result, removing protection often helps the poor.

The classical arguments outlined above have been formalized and quantified by many contemporary economists, in a number of "neo"-classical models. These models have permitted the classical arguments for open trade to be tested empirically; such tests generally find strong evidence that countries with more open trade have had faster growth of national income (e.g. Dollar 1992).

1.3.2 Neoclassical Models of Comparative Advantage

Perhaps the greatest contribution of neoclassical models is to identify the sources of comparative advantage, or the reasons why one industry can profitably expand while others cannot. Without such explanations for the rise and fall of major industries, it will be thought that learning-by-doing is the only real source of comparative advantage, so that trade restrictions to "create" comparative advantage can often be successful. Neoclassical models have quantified five broad contributors to an industry's comparative advantage, each of which corresponds to a somewhat different type of model:

- *Technological efficiency* was the first determinant of comparative advantage to be identified, in David Ricardo (1817)'s original model. "Ricardian" models focus on the use of a resource such as labor, which can be shifted among industries but not across country borders. As a result, the efficiency with which that resource is used becomes an important source of comparative advantage. In Ricardo's own example, if English workers can choose between making either two cases of wine or one bolt of cloth, while Portuguese workers can make *three* cases or one bolt, then both can gain if Portugal exports wine to England in exchange for cloth. This pattern of specialization and trade is determined only by "comparative" efficiency between industries; "absolute" advantage, or the average amount of labor needed in each country, determines only each country's overall production and consumption level.

- *The factor-intensity of different industries* was highlighted by Eli Heckscher (1919) and Bertil Ohlin (1933). The resulting "Heckscher-Ohlin" models show that when countries have more than one distinct national resource, such as "capital" and "labor", an industry's comparative advantage can be determined by its resource demands relative to national endowments. For example, a wealthy country with relatively more capital would tend to specialize in capital-intensive goods, importing more labor-intensive goods from poor countries. For many years such "Heckscher-Ohlin" models were limited to two domestic resources and two traded goods, but such models are easily rejected in empirical tests: most famously, Wassily Leontief (1953) found that the U.S. was more capital-abundant than the rest of the world, and yet its imports tended to be capital-intensive. This "Leontief paradox" was readily resolved in subsequent years, as Jaroslav Vanek (1968) and others allowed the effects of additional resources such as natural resources and labor skills to be incorporated in "Heckscher-Ohlin-Vanek" models.

- *The use of industry-specific resources* was a third source of comparative advantage, added to the Ricardian model by Jacob Viner (1937) and others. Such "Ricardo-Viner" models account for resources such as farmland, which cannot be used in other industries. But many industry-specific inputs are the results of past investment, such as machinery and labor skills. In the long run these investments can shift across industries, so Ricardo-Viner models are suitable primarily for short-run analyses over the life of key capital goods.

- *Domestic demand* is a fourth contributor to each country's pattern of comparative advantage, added by Paul Samuelson (1962) and others. Sometimes known as "Heckscher-Ohlin-Samuelson" models, these analyses note that even if there are no differences across countries in technology, factor-intensity, and resource endowments, countries could find mutually-advantageous trade simply in exporting goods they do not like, while importing goods they prefer to consume.

- Finally, *exchange rates* became a fifth key determinant of comparative advantage with the work of W.E.G. Salter (1959), Trevor Swan (1960), and other Australian economists. Perhaps because of their remote geographical position, their "Salter-Swan" or "Australian" models emphasize the fact that not all goods which are consumed domestically can be traded internationally. Goods with high transport costs relative to their value will be "nontraded", so their prices will not be influenced by imports and exports. In this case, for a given level of domestic prices and inflation, a higher ("devalued") currency exchange rate leads to more goods being exported while fewer are imported.

From Ricardo to Salter-Swan, these classical and neoclassical models are all fundamentally compatible, and all yield the same conclusions as to the central determinants of comparative advantage. They suggest that the pattern of national comparative advantage can best be measured by comparing production costs with product value, where nontraded goods and national resources are valued at domestic opportunity costs while tradable goods are valued at opportunity costs in trade. These measurement rules form the basis of Chapter 2 of these guidelines. But neoclassical models are not the only possible theory of comparative advantage, and alternative theories might lead to somewhat different measurement methods. It is therefore essential that the key challenges to neoclassical comparative advantage be considered, before the neoclassical measures are adopted.

1.3.3 Challenges to Neoclassical Comparative Advantage

Neoclassical principles dominate contemporary economics, but they are commonly honored in the breach. Much of modern international economics consists of finding exceptions to the standard neoclassical prescription of free trade, and attempting to measure the potential gains from "creating" comparative advantage through government actions.

Challenges to comparative advantage have come in two broad waves: one focusing on developing countries starting around 1950, and another focusing on industrialized countries starting in the early 1980s. Both challenges have been associated with periods of rapid change in production and trade levels, and popular demands for government actions to support vulnerable industries. But a major difference is that most non-neoclassical theories for developing countries argued in favor of restricting imports to avoid "dependency" on others (Palma 1978), while the corresponding theories for industrial countries argue generally for subsidizing exports with "strategic policies" to capture market share (Krugman 1986).

For the developing countries, we can usefully distinguish two distinct arguments for restricting trade: import-substitution industrialization based on Prebisch/Singer models of the external terms of trade, and domestic development strategies based on Hirschman's model of internal linkages between sectors. Both approaches argue in favor of import restriction, but for very different reasons.

- *Import-substitution industrialization,* based on the research of Raoul Prebisch (1950), Hans Singer (1950) and others, suggests that governments can raise national income by turning towards self-sufficiency because of unfavorable external conditions. The "Singer-Prebisch" model focuses on developing countries' "terms of trade", or the prices received for exports relative to the prices paid for imports. Singer and Prebisch argued that: (1) there is a "secular" decline in the prices of developing countries' exports relative to their imports, so that current prices are misleading; and (2) global price and income elasticities are such that restricting trade would raise developing countries's incomes, by improving their terms of trade.

  In testing hypothesis (1), subsequent research has found little historical evidence for any clear trend in developing countries' terms of trade. On the other hand, tests of hypothesis (2) have shown clearly that some trade restriction can raise national income--although the appropriate level of restriction is far smaller than current interventions, and generally succeeds in raising national income only as long as the foreign countries hurt by these policies do not retaliate.

- *Development strategies* targeting specific industries has been supported principally by the work of Albert O. Hirschman (1958), using the principle that different industries have different "linkages" to the rest of the domestic economy. These could be "forward" linkages in providing inputs to other activities (e.g. a petroleum refinery which generates distillates for many possible uses), or "backward" linkages in demanding inputs from other industries (e.g. the refinery's need for pumps, motors, spare parts etc.). It was commonly argued that developing countries would benefit more from the linkages of import-substitution industries than those of export industries, so that these linkages justify trade restrictions and an inward-looking strategy. Unfortunately, many seemingly attractive linkages have turned out to be constraints, as developing countries' industrial capacity typically operates far below capacity due to insufficient product demand (a "forward constraint") or shortage of inputs (a "backward constraint").

In practice, neither external conditions nor domestic linkages have proven to be adequate grounds for "going against" comparative advantage in developing countries. As shown in empirical studies by Dollar (1992), Edwards (1993) and many others, countries with more restricted trade have generally developed more slowly than others. This historical experience, combined with the debt crisis of the early 1980s, led many developing countries to turn outward in the past decade. Encouraged by foreign aid donors and the IMF, a majority of countries in Latin America, Asia and Africa reduced their trade barriers and devalued their currencies in hopes of expanding exports and imports, to capture gains from trade and increase economic growth.

While developing countries were liberalizing, industrialized countries were experiencing a new wave of challenges to neoclassical theory and practice: "Is Free Trade Passé?" was the title of a prominent journal article of this period (Krugman 1987). The resulting "new trade theory", associated in part with a "new protectionism" practiced by industrial country governments during the 1970s and early 1980s, concerned export subsidies to promote emerging "high tech" industries such as computers and aircraft, as well as import restrictions to assist established industries such a clothing and cars (Salvatore 1993).

- The *strategic trade policies* identified by new trade theorists are applicable to any market with imperfect competition or nonmarket externalities. In this context, interventions can "shift" monopoly rents and externalities from one country to another. But as with earlier arguments for protection, imperfect competition and externalities can justify only relatively small trade interventions, and can generally raise national income only if other countries do not retaliate. By the mid-1990s, most prominent new trade theorists were arguing strongly for less intervention rather than more (e.g. Krugman 1993b). It was recognized that, as predicted by John Stuart Mill, trade interventions were primarily used to transfer resources to politically influential groups, at the expense of overall economic growth.

A second set of challenges to neoclassical comparative advantage in the 1980s came from the case-study approach practiced in business schools, rather than the formal hypothesis-testing approach of professional economists:

- *Competitive advantage* analysis, as practiced by Michael Porter (1990a, 1990b), consists of examining case studies of successful industries to identify why they are located in particular countries. Although Porter initially rejects formal economic theory, he comes to virtually all of the same conclusions as the new trade theorists: ultimately, he finds, industries are successful because of the fundamental economic conditions around them. Porter explicitly rejects trade intervention which, he writes, just "guarantees a market for inefficient companies" (Porter 1990a, p. 88). The policies needed to support Porterian competitive advantage turn out to be precisely the same as those needed to support neoclassical comparative advantage: the provision of education, research, and other public goods as well as the enforcement of anti-trust rules, disclosure and labeling requirements and safety regulations. These are all standard interventions needed to maintain competition in domestic markets; Porter calls them "factor creation" (in the case of public-goods provision) and "demand signaling" (in the case of labeling requirements and safety regulations).

In sum, the many challenges have substantially strengthened the neoclassical theory of comparative advantage, by extending it to a broader variety of conditions and circumstances. It is increasingly recognized that the potential gains from trade restrictions are far outweighed by the gains from open trade. Evidence of "created" comparative advantage may be found in specific countries, sectors and time periods, where vulnerable industries have grown after being nurtured by trade restrictions. But closer examination typically shows that the costs of supporting these industries exceeds the eventual payoff, especially in the long run when the returns to alternative investments are taken into account.

2. MEASUREMENT METHODS

The analyses presented in the previous chapter lead strongly to the conclusion that comparative advantage is best assessed by comparing current levels of domestic opportunity costs, relative to market prices in trade. This "comparative cost" theory originates in the classic work of David Ricardo (1817), but has been strengthened by neoclassical modeling as well as challenges from proponents of infant-industry protection, import-substitution industrialization, and strategic trade policy.

Empirical measurement of comparative costs raises a number of complex issues. Some can be resolved by appealing to economic theory, while others must be resolved on the basis of available data. Actually implementing full-scale neoclassical models requires very large amounts of information; at the very least, researchers must estimate supply and demand elasticities or resource constraints. Since acceptable estimates of these values are rarely available on short notice, fully specified neoclassical models are typically confined to academic research. The models do, however, provide strong guidance as to appropriate ways of measuring comparative advantage to support day-to-day policy choices.

In this chapter we review the principal measurement tools derived from neoclassical models, to provide users with concrete guidelines on where each technique is most appropriate. Our broad conclusion is that, for most purposes, comparative advantage analysis rests fundamentally on cost-benefit principles, and a social cost-benefit ratio provides the most appropriate measure. A formal derivation of this result is given in appendix B.

2.1 Models and Indicators

Many researchers have attempted to measure comparative advantage directly, using economic models to capture the interaction of national resources, production technology, product demand, and government interventions. Such models include econometric studies such as Leamer (1984), and programming studies such as those surveyed in Kendrick (1990).

Most models are custom-built to answer specific questions, and require a relatively large investment in data collection and analysis. As a result, they are appropriate primarily for academic research or high-stakes investment decisions and policy choices. Typical examples include the optimal location of large factories or the consequences of major policy reforms. In such cases, it is both desirable and feasible to invest heavily in predicting future interactions among countries and sectors. It is also generally appropriate to employ a specialist staff, as new developments in modeling methods are constantly being introduced.

The main alternatives to models are index-number indicators, designed to measure some change over time or comparison across industries. Like the Consumer Price Index measure of inflation, or the Gross National Product measure of total income, such indicators do not pretend to simulate the economy itself; they serve as thermometers or barometers, not weather forecasters. But while many different indicators have been proposed and used, not all are equally relevant to policy analysis and project appraisal.

One convenient classification of indicators would distinguish between measures of "competitiveness" and of "comparative advantage." In this context, "competitiveness" concerns the actual performance of a country or industry: it can be measured with only observed data. In contrast, "comparative advantage" concerns the underlying economic potential of an industry: it requires specifying one or more policy alternatives or counter-factual scenarios. In a sense, competitiveness concerns what *is*, whereas comparative advantage concerns what *could be*.

BOX 4. COMPARATIVE ADVANTAGE MODELING WITH GAMS AND GTAP

Recent innovations have helped make economic modeling increasingly accessible to nonspecialists. In the 1980s several modeling "languages" were developed, of which the World Bank's General Algebraic Modeling System (GAMS) is the most widely used. More recently, the data needed for trade modeling have been made more accessible through Purdue University's Global Trade Analysis Project (GTAP), supported by USDA. Through GTAP these data can readily be used for a wide range of comparative advantage models.

Although far more accessible than previous modeling approaches, both GAMS and GTAP require substantial training and experience to use productively. Training in both GAMS and GTAP is available to USAID staff and grantees through the Agricultural Policy Analysis Project, Phase III (APAP III), in short courses at Stanford and Purdue Universities. For information contact the USAID project officer for APAP III, David Schroder, at 703/875-4045.

Where the investment in modeling can be made, it can be well worthwhile. But there remain many circumstances under which policy analyses and project appraisals must be done quickly, without the data and research resources needed for explicit modeling--and it is under these conditions that the methods summarized in these guidelines are intended to be used.

2.2 Measures of Competitiveness

There are essentially three distinct approaches to measuring competitiveness: market share, relative prices, and physical productivity. Since the three are linked through market adjustments, they generally tell the same story: higher market share is achieved through greater productivity and/or lower prices. But this is not always the case, as was noted by Alexander Kaldor; McCorriston and Sheldon (1992) demonstrate the "Kaldor paradox" by showing that during the 1966-85 period, production costs, export prices, and market share all declined for the U.S. while they all rose for Japan. The paradox can easily be explained in terms of missing data, but it confirms the danger of relying exclusively on any one approach. Given the limited data available, it may be necessary to use any or all of these methods, so all three are reviewed here.

2.2.1 Market Share and "Revealed" Comparative Advantage

The difficulty of measuring comparative advantage itself led Bela Balassa (1965) to investigate trade patterns directly, without reference to underlying resources, productivity, or prices. He argued that "'revealed' comparative advantage can be indicated by the trade performance of individual countries... in the sense that the commodity pattern of trade reflects relative costs as well as differences in non-price factors", such as government policies. Early work in this approach was done by Balassa (1977, 1986), and more recent calculations for agriculture have been done at USDA by Vollrath (1989, 1991).

Many alternative measures of revealed comparative advantage (RCA) have been employed, but most are similar to Balassa's original formula: they compare each country's share of the world market in one good relative to its share of all goods.[1] Using such a measure, we might see that the U.S.'s market share in wheat exports is much larger than the U.S. share of all exports, and conclude that the U.S. has thereby "revealed" its comparative advantage in wheat. Equivalently, the same measure would show that wheat provides a larger share of U.S. exports than of global trade, pointing to an identical result.

As noted by Balassa and later practitioners, the problem with RCA analysis is that it says nothing about how the U.S. acquired its market share. Market share may well be maintained by costly export subsidies, so that a smaller market share would be more economically efficient. Or, perhaps large market share is driven by low costs, and an even larger market share might turn out to be efficient. Because of this confusion, RCA indicators themselves yield no specific policy implications. Despite their name, they measure competitiveness, rather than comparative advantage.

2.2.2 Price Comparisons, The Real Exchange Rate and Purchasing Power Parity

The second approach to measuring competitiveness is the international comparison of price levels. Doing so at a disaggregated, commodity-specific level requires very large amounts of data, as exemplified by the UN's International Comparisons Project (ICP) (Summers and Heston 1991) and the agricultural-sector value added measurements of Angus Maddison (Maddison and va Oostroom, 1993). But many analysts use international price comparisons to look at economy-wide "competitiveness", in the sense of a country's incentives to expand exports and reduce imports in general. Similar aggregate measures can be applied at a sectoral level.

Following the "Australian" model described in chapter 2.3, analysts may seek a measure of the internal real exchange rate (RER), in the sense of the relative price of tradables to nontradables:

$$RER = P_t/P_{nt}$$

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1. Denoting goods by subscript j and countries by subscript i, the measure would be:

$$RCA_{i,j} = \frac{\dfrac{x_{i,j}}{\Sigma_j\, x_{i,j}}}{\dfrac{\Sigma_i\, x_{i,j}}{\Sigma_{i,j}\, x_{i,j}}}$$

When this ratio rises (a "real depreciation"), exports and import substitutes have become more valuable relative to services and other goods. Thus, it can be expected that net exports will rise, and the economy may be said to have become more "competitive" in export production.

In practice, price indexes for nontradables are rarely available. To get around this problem, analysts typically construct a type of RER index relying on some foreign price index (P*) multiplied by the exchange rate (e) to approximate the prices of tradables, and some domestic price index (P) to approximate nontradables' prices (Edwards 1989):

$$RER' = eP^*/P$$

As suggested by Edwards (1989), such differential-inflation (RER') measures may be made more similar to the internal real exchange rate (RER) by measuring foreign prices (P*) with an index that consists mostly of tradable goods, and domestic prices (P) with an index that includes a larger share of nontradables. Thus analysts often use a wholesale price index for foreign prices, and a consumer price index or a GDP deflator for domestic prices. This reduces the biases in RER', but does not eliminate them.

Some analysts are not interested using inflation differences (RER') as an indicator of the real exchange rate (RER), but rather to make an international comparison of the purchasing power of alternative currencies, or their "purchasing power parity" (PPP). In this case, the basket of goods included in the foreign price index should be identical to the basket in the domestic price index. But the implications of a PPP index for competitiveness are ambiguous: when comparing the prices of nontradables, greater competitiveness would lead to higher prices (i.e. higher wages), but when comparing the prices of tradables, greater competitiveness would be associated with lower prices (i.e. lower costs). Thus, PPP indexes as such tell us nothing about competitiveness, unless we know the proportion of nontradables in the index--in which case better information would be provided by an RER index.

BOX 5. WHAT'S WRONG WITH INFLATION AS A MEASURE OF COMPETITIVENESS?

Although differential inflation (RER') is widely used as an approximate measure of economy-wide competitiveness (RER), it is often inaccurate. Masters (1991) identifies three fundamental weaknesses in international RER' indexes as measures of the internal RER: in essence, the RER' assumes that changes in the foreign prices and nominal exchange rate are directly passed through to the local prices of tradables; that foreign countries have no RER changes of their own; and that domestic nontradable prices move in proportion to the overall domestic price level. All three implicit assumptions generally lead RER' to overstate the degree of real depreciation that has taken place in most countries, thus overstating any gain in "competitiveness" over time.

2.2.3 Input-Output Performance and Total Factor Productivity

Given the empirical difficulty of collecting accurate price data, a popular alternative is to compare physical levels of inputs and outputs. Following Robert Solow (1954), productivity indexes have been considered a key measure of economic performance and competitiveness, particularly in terms of the residual productivity gain after increased input use has been accounted for. This "Solow residual" or total factor productivity (TFP) change can be measured at the firm, industry, sector or national level, and can readily be compared across countries and over time. Clearly the size of the Solow residual depends on how accurately inputs and outputs are measured. With perfect measurement that fully accounts for the quality and quantity of all inputs, TFP gain would be tautologically zero. But with broad measures of labor, capital and visible inputs, TFP gains typically account for between a third and a half of output growth. In contemporary research, TFP measures generally focus either on physical productivity itself as a determinant of economic performance (e.g. Bernard and Jones 1993), or on incorporating environmental and other costs into productivity measurement (Harrington, Jones and Winograd 1993). It is also widely used to measure the impact of research or other government policies on productivity (e.g. Evenson 1992).

2.3 Measures of Comparative Advantage and Policy Effects

The indicators of competitiveness discussed above are based entirely on observed data. To measure underlying comparative advantage, we will need some model of what would have happened under alternative policies. As suggested by our survey of methods in Chapter 2, we will generally follow the Australian model and the related theory of domestic divergences. This approach potentially calls for the construction of a detailed empirical model for each policy analysis or project appraisal, as discussed in section 2.1. But in practice we can use a general neoclassical trade model to derive relatively simple measures, and demonstrate which indicator will give the most accurate results relative to a more detailed model.

The central objective of each indicator, like its "parent" model, is to assess the economy-wide or social relative cost of a good, in distinction to its market-level or private cost, and to measure the divergence or policy effect between them. They can be divided into two sorts of indicators: those that explicitly compare social and private values, and those that use social values only. The former were developed primarily in the policy-analysis literature, while the latter originate primarily for project appraisal. But there is considerable overlap between the two types of measures, and we will see that the two analytical traditions have in fact converged to equivalent measures. In this review we will briefly summarize the various measures algebraically and graphically; in a mathematical appendix we derive all the measures from a formal model, which will allow us to state their properties more precisely and quantify the relationship between each indicator and the complete model.

2.3.1 The Nominal Protection Coefficient

The oldest measure of comparative advantage -- dating back to Adam Smith -- is the nominal protection coefficient (NPC): the observed market price (P) paid to producers of a given product, relative to that good's underlying economy-wide social opportunity cost (P*):

$$NPC = P/P^*$$

If this NPC is less than one, production incentives do not reflect full economic value, and the country will have some unexploited comparative advantage in expanding production. This could occur because of a market failure (i.e. the product generates positive externalities) or a government restriction (i.e. the product is more heavily taxed than others). Similarly, if the NPC exceeds one, the country has a comparative advantage in contracting production, so that other activities can expand.

A popular variant of the NPC is the nominal *rate* of protection (NRP), which is the NPC minus one. This would be positive for "protected" activities which are at a comparative disadvantage, and negative for "disprotected" activities which have some unexploited comparative advantage.

Since market failures and opportunity costs for nontradable goods are hard to measure, the NPC is used primarily with tradables--for which opportunity costs are generally the good's value in trade, measured as its "border price" or "trade parity". It is in this context that the NPV was developed, by Adam Smith in Book IV of his *Wealth of Nations*. He used it to compare the market price and social opportunity costs of wheat given the Corn Laws restricting wheat imports. For this type of research the NPC remains a dominant analytical tool, over two hundred years after its first use (e.g. Wiebelt et al., 1992).

Generally, P* is estimated by finding a relevant foreign price (P_f), multiplied by the exchange rate (e), plus or minus whatever marketing costs (m) are needed to make the foreign good equivalent to the domestic good. Where marketing costs are expressed in proportional terms, we have:

$$P^* = eP_f(1+m)$$

But with trade restrictions, producers receive this opportunity cost plus a tariff, or a "rent" to owners of scarce import quotas and licenses. Where these costs are proportional to price (*ad-valorem*), we have:

$$P = (1+t)P^*$$

Thus, in its simplest form, the NPC simply measures the level of ad-valorem tariff which would be equivalent to whatever combination of trade restrictions may be in place:

$$NPC = P/P^* = (1+t)P^*/P^* = (1+t)$$

Since many countries use a bewildering array of quotas, marketing orders, licensing procedures, and other rules to restrict imports and raise prices, such a "tariff-equivalent" measure can be very useful to compare protection levels across products and across countries.

Nominal protection coefficients may be measured at any point along the marketing chain, and are not affected by this as long as all marketing costs and policy effects are strictly proportional to price. Often however, there are fixed per-unit charges which make NPCs sensitive to location (farmgate, rural market, urban center), time (post-harvest, mid-year, pre-harvest), and processing level (unprocessed, partly processed, retail).

Variation in NPCs reflects underlying variation in comparative advantage within a country, across regions, times of year, or processing levels. In much of West Africa, for example, food production may have a strong comparative advantage--but only in inland regions, during the post-harvest period, and for relatively unprocessed goods. Because of the high cost of transport, storage and processing, it may be very costly to attempt year-round self-sufficiency in all regions for all types of products.

The circumstances under which NPCs are accurate measures of comparative advantage can be examined graphically, in standard economic models: these are discussed in the mathematical appendix, using diagrams of the production possibilities frontier (PPF) and supply/demand curves. That analysis shows that while nominal protection is very useful for taking account of market and policy failures in *product* markets, it cannot take account of divergences in *input* markets. For that purpose, a broader measure is needed.

BOX 6. NOMINAL PROTECTION FOR CROPS AND FERTILIZER IN ZIMBABWE

An example of the value of nominal protection analysis is given by recent research in Zimbabwe, where through the 1980s quantitative controls and market regulations often masked the degree of taxes and subsidies imposed by the government.

For crops, nominal protection is difficult to measure because government marketing boards typically controlled both domestic markets and international trade. But much trade did take place; by comparing trade values with prices received by farmers, Masters (1994) shows that after taking account of marketing and processing costs, farmers were lightly taxed on most crops. Crop NPCs ranged between 0.96 and 0.69. These NPCs do not take account of the reduction in marketing costs that might occur in a more competitive market; they are simply transfers to consumers and others, holding marketing costs constant.

On the inputs side, measuring nominal protection can be even more complex. The local market for nitrogenous fertilizer, for example, is protected by a total ban on imports. Only Ammonium Nitrate (AN) is produced, whereas international trade typically involved urea. In this case an NPC was estimated by finding the lowest-cost source of urea and finding its AN-equivalent value. The main steps in this calculation can be summarized as follows:

	162	US$/mt	Bagged urea	(fob Europe)
+	37		Ocean freight to port	(Beira)
	199			
÷	.45	US$/Z$	Nominal exchange rate (year ave.)	
	442	Z$/mt	Landed trade parity	
+	42		Rail freight	(Beira-Harare)
	484		Inland trade parity	
x	.75		AN/urea conversion ratio	(34.5% ÷ 46%)
=	363	Z$/mt	AN-equivalent trade parity	

Data sources for this calculation included the IMF *International Financial Statistics* (for bagged urea), the FAO *Food Outlook* (for ocean freight), and railway file data (for rail freight). The domestic price of locally-produced AN is Z$415, for an NPC of 415/363 = 1.14.

2.3.2 The Effective Protection Coefficient

The first attempt to take account of multiple distortions in a single indicator is the effective protection coefficient (EPC), developed by Barber (1955) and popularized by Johnson (1965b), Corden (1966) and others. Working in the context of on-going GATT negotiations, they sought primarily to take account of the interaction among different tariffs in determining the incidence of protection. As argued most forcefully by Balassa and Schydlowski (1968, 1972), the EPC could also serve as an indicator of the underlying pattern of comparative advantage, much like the NPC in a two-good model.

The EPC was developed by simply extending the NPC concept to include restrictions on trade in inputs: it is the tariff-equivalent incidence of policy on value added (v), defined as revenue (P_xQ_x) minus the sum of all input costs ($\Sigma_i P_i Q_i$).

$$EPC = v/v^* = (P_xQ_x - \Sigma_i p_i q_i)/(P_x^*Q_x^* - \Sigma_i P_i^*Q_i^*)$$

whereas

$$NPC = P_x/P_x^*$$

The EPC is clearly analogous to the NPC, except that value added determines returns to fixed factors (labor, capital, land), whereas price determines only gross revenue (i.e. returns to fixed factors plus cost of variable inputs). As a result, when comparing products with very different levels of input use, EPC and NPC rankings may differ even if only one distortion is present--and the two measures are very likely to differ if the degree of protection imposed on their inputs are very different. In either case, the EPC will be a more accurate indicator of protection and comparative advantage, in the sense that it provides a more accurate ranking of quantity and welfare changes induced by distortions. This improved measurement is achieved primarily by collecting a larger number of opportunity costs (P^* and P_i^*'s), each of which is measured much as it is for the NPC.

BOX 7. EFFECTIVE PROTECTION FOR MAIZE IN ZIMBABWE

The value of effective protection analysis can be illustrated by comparing maize (corn) production in large-scale and smallholder production systems. Masters (1994) shows that, on similar types of land, the tariff-equivalent nominal protection coefficients are about the same for outputs (the NPCs on maize are 0.91 and 0.92 respectively) but their use of inputs is quite different. Moving to the EPC to take account of trade policy (including the implicit value of foreign exchange licenses) reveals EPCs of 0.53 for large-scale maize and 0.59 for smallholder maize. Both are heavily taxed, but the EPC suggests that trade policy penalizes large-scale producers somewhat more than smallholders.

The major empirical hurdle in measuring EPCs is the need to determine the appropriate quantities of each input. With a complete model of how input use might adjust to price changes, we could determine the exact Q_i and Q_i^* coefficients at both market prices and social opportunity costs. But if such a model were available, we could use it directly instead of an indicator. Thus EPCs are almost always implemented with the input and output coefficients fixed at their observed levels (Q_x, Q_i). The inaccuracies this causes have been extensively explored by Ethier (1972); in brief, since adjustments in input use would serve to reduce the efficiency cost of the policy, the use of fixed coefficients generally introduces a slight overstatement of the degree of protection, and the difference between market-level competitiveness and economy-wide comparative advantage.

For agricultural products, EPCs are typically not very different from NPCs, particularly in low-income countries. This is because relatively few purchased inputs are used, so that a relatively large proportion of revenue is paid to primary factors (land and labor). In this sense agriculture is a very high value-added activity. Other sectors tend to require more tradable inputs, so nominal and effective protection rankings are more likely to differ.

2.3.3 The Producer Subsidy Equivalent

In the early 1970s it became clear that agricultural trade was heavily distorted by many policies other than trade restrictions. Industrialized countries had developed a range of deficiency payments, farm credit programs and other domestic interventions to support their declining farm sectors, and these interventions were not subject to GATT negotiations. They were not even well-measured: to include them in an EPC measure would be impossible, since the denominator would approach zero and occasionally become negative, making the ratio very hard to interpret.

In studies for the FAO, Josling (1973) solved this measurement problem by proposing the "subsidy equivalent" concept: "the level of producer subsidy that would be necessary to replace the array of actual farm policies employed in a particular country in order to leave farm income unchanged. It can be thought of as the 'cash' value of policy transfers occasioned by price and nonprice policies" (Josling and Tangermann 1989, p. 346). Most broadly, including policy effects on all inputs (P_i) and factors (P_j), this "total" PSE would be:

$$\text{Total PSE} = Q_x(P_x-P_x^*) - \Sigma_i Q_i(P_i-P_i^*) - \Sigma_j Q_j(P_j-P_j^*)$$

Since this measure is a sum, denominated in national currency and referring to some specific activity, it cannot be used to compare across different activities or countries. For this purpose, Josling suggested using a "percentage" PSE measured as a proportion of market revenue:

$$\text{Percentage PSE} = \text{Total PSE}/P_xQ_x$$

The percentage PSE is very easy to interpret and explain, since it is expressed as a proportion of actual farm revenue rather than some counterfactual economic opportunity cost. This simplicity has no doubt contributed to the PSE's great popularity in the 1980s, when the USDA (1988), OECD (1991) and others launched large-scale projects to estimate PSEs, and their results came to be considered authoritative in the press (e.g. Carr 1992). This work was driven largely by the need to bring agriculture into trade negotiations: PSEs were used heavily to guide GATT negotiators, and the earlier Canada-U.S. Trade Agreement explicitly used PSEs as a test of compliance.

Percentage PSEs are attractive measures, but the use of market prices in the denominator makes the results sensitive to the "mix" of policies between product- and input-market interventions. For example, a country could lower its percentage PSE by switching from an input subsidy to a output price support, even if this does not change its total PSE. For this reason, Masters (1993) argues that the rankings produced by true "tariff-equivalent" measures using opportunity costs (P_x*) in the denominator will be more accurate, in the sense that they will provide rankings that correspond more closely with the changes in quantities produced. A tariff-equivalent measure analogous to the PSE had been proposed in a different context by Monke and Pearson (1989), who called it the Subsidy Ratio to Producers (SRP), while a similar measure was introduced by the OECD (1993) as the Nominal Assistance Coefficient (NAC):

BOX 8. THE PSE IN ZIMBABWE

The value of moving from EPCs to a broader measure such as PSEs is clear in the case of Zimbabwean maize production. Masters (1994) shows that large-scale producers receive large implicit subsidies in their use of land and capital, which partly offsets the level of taxation indicated by the EPC (see previous box). Smallholders receive very little factor-market subsidy, so their PSEs are lower than those of large-scale maize producers. After netting out all policies, percentage PSEs for maize are -51% on smallholder farms, and -44% on large-scale farms. Taking account of *all* policies reverses the relative ranking found with the EPC.

$$SRP = NAC = \text{Total PSE}/P_x{*}Q_x$$

All three types of tariff-equivalent measures listed above (NPC, EPC, and PSE/SRP) are designed primarily for analyzing policy effects, but serve equally well to measure comparative advantage: "protected" activities have some comparative disadvantage, and vice-versa. This fundamental similarity between policy and comparative advantage measurement has led the policy-analysis and project-appraisal literatures to converge on exactly the same indicators. This can best be seen by examining each cost-benefit measure in turn, using the same notation as the policy measures.

2.3.4 Net Social Profits

The most fundamental cost-benefit measure is the net social profit (NSP) from some project or activity: it corresponds to the total PSE, but includes social opportunity costs only:

$$NSP = Q_xP_x{*} - \Sigma_iQ_iP_i{*} - \Sigma_jQ_jP_j{*}$$

Such a measure is known to be the most accurate indicator of comparative advantage (e.g. Gittinger 1982), but like the total PSE it is denominated in currency units--so only similar activities, such as alternative projects competing for a given fixed resource, can be compared. For agricultural production, resources are typically fixed only in the aggregate. To any individual crop, the supply of land, labor and capital may be quite elastic at some known price or opportunity cost. Thus the activity can expand at roughly constant returns to scale, and a unit-free ratio indicator is called for.

BOX 9. THE NSP IN ZIMBABWE

> Again comparing large-scale and smallholder maize production in Zimbabwe, NSP results show clearly that the large-scale farms' higher level of input use pays off in terms of greater social profits per hectare: the NSP level for large-scale farms is Z$486/ha and only Z$425 for smallholders under similar agroecological conditions (Masters 1994). This suggests that, despite the greater degree of taxation of smallholders as shown by the PSE, large-scale farmers have maintained a higher degree of economic efficiency.

Some analysts (e.g. Tweeten 1986, Nelson and Panggabean 1991) have proposed the NSP per hectare as an appropriate ratio, and others have used NSP per unit of labor. But the choice of denominator can have a major influence on activity rankings: the NSP per hectare favors land-saving activities with high levels of input use (and output) per hectare, and the NSP per unit of labor favors labor-saving activities. These biases may be attractive if labor- and land-saving is desired, but following Harberger (1971), any such preference should be reflected in the opportunity costs of land and labor rather than the formula used, if only to make the weighting scheme clear.

2.3.5 The Domestic Resource Cost

Perhaps the most popular ratio form of the NSP is the domestic resource cost (DRC), which uses exactly the same data in a different formula:

$$DRC = \Sigma_j Q_j P_j^* \;/\; (Q_x P_x^* + \Sigma_i Q_i P_i^*)$$

BOX 10. THE DRC IN ZIMBABWE

> The need for using a ratio indicator like the DRC is made clear in the case of Zimbabwe, where the NSP results presented in the previous box are reversed by DRC measurement. Using the DRC, maize production is shown to be more economically efficient on smallholder farms than in large-scale production: the smallholders' maize DRC is 0.53, while the large-scale farmers' DRC is 0.63, despite similar agroecological areas (Masters 1994). This result occurs because smallholders are far more frugal in their use of all inputs; large-scale farmers obtain higher yields, but at the expense of much higher costs. The result is a higher NSP per hectare, but a lower rate of profit relative to other inputs.

The DRC ratio was first proposed independently by Michael Bruno (1967, 1972) as a cost-benefit indicator, and by Anne Krueger (1966, 1972) as a policy-analysis measure. They both converged on the DRC because they sought a measure for use where the opportunity costs of individual tradable goods (P_x^* and the P_i^*'s) was known only in foreign currency, while the opportunity cost of domestic factors (P_j^*'s) was known only in domestic currency. By separating the two types of opportunity costs, the DRC was the only ratio which would allow alternative activities to be ranked without knowing the shadow exchange rate between the two currencies.

Since the shadow exchange rate was still necessary to determine the absolute cut-off between comparative advantage and disadvantage (or protection and disprotection), analysts soon began to estimate it at the same time as they did DRC studies. Analysts also began to multiply the DRC ratio by that estimated shadow exchange rate to obtain a unit-free ratio. Doing so does not affect activity rankings, but it ensures that the cut-off between efficient and inefficient activities always equals 1, and the DRCs can be compared across countries as well as across activities within a country. This absolute measure was soon widely adopted for agriculture-sector studies (e.g. Pearson and Meyer 1974), and remains the dominant measure of comparative advantage in numerous World Bank and USAID sector studies (e.g. World Bank 1991), as well as studies done for the FAO (Appleyard 1987), CIMMYT (Morris 1990), IFPRI (Gonzalez et al. 1993), and many others.

Like the NSP-per-hectare and NSP-per-labor-unit measures, the choice of denominator in the DRC can be a source of bias in activity rankings. In particular, by placing factor costs in the numerator and tradable inputs in the denominator, the DRC formula makes it possible for an activity to appear more efficient by replacing some nontradable factors with an equivalent value of tradable inputs. This substitution might be thought desirable by analysts who favor high-input activities, but it might also be thought undesirable by those who favor increased demand for local land and labor. Again following Harberger (1971), relative valuation should not be buried in the measurement method, but should be made explicit through shadow pricing. In this case, the relative value of tradables and nontradables should be reflected in the shadow exchange rate between them.

To eliminate the hidden bias in the DRC, analysts should simply add up all costs in the numerator, and all benefits in the denominator. Such a social cost-benefit ratio (SCB) eliminates any discrimination between tradable and nontradable costs. In the mathematical appendix we show that the SCB formula is the only ratio which accurately replicates the activity rankings of a complete Australian-type model of trade; in this sense it is the best possible measure for replicable farming activities, just as the NSP is the best possible measures for irreplicable projects whose scale is fixed.

2.3.6 A Unified Measure of Trade Policy and Comparative Advantage

The SCB uses exactly the same data as the NSP and DRC, in a somewhat different formula:

$$SCB = (\Sigma_j Q_j P_j^* + \Sigma_i Q_i P_i^*) \; / \; Q_x P_x^*$$

Where all costs have been measured precisely so that the activity yields zero profits at market prices (i.e. $Q_x P_x^* - \Sigma_j Q_j P_j^* - \Sigma_i Q_i P_i^* = 0$), the SCB can readily be shown to be give exactly the same rankings as the SRP:

$$SCB = SRP + 1$$

Thus the SCB/SRP measure unifies the policy-analysis and cost-benefit traditions of measuring comparative advantage, into a single indicator that can be used equally well for both purposes. It is the exact analogue to the NPC, for use in settings with multiple distortions, among both tradable and nontradable goods. In serves as an exact tariff-equivalent aggregate measure of support to measure the combined effect of many types of policies and other distortions on competitiveness, and also serves as an exact measure of comparative advantage taking account of those distortions.

Like the NPC, the absolute value of the SCB has little real meaning; the measure's only value is in ranking multiple activities. And also like the NPC, its accuracy depends entirely on the underlying data used. This is the real challenge of comparative advantage analysis: finding appropriate border prices for tradable goods, appropriate domestic opportunity costs for nontradables, and an appropriate real exchange rate between tradables and nontradables. For this there is no simple formula. Common procedures for the agricultural sector are discussed at length in Gittinger (1982), Monke and Pearson (1989) and Tsakok (1990), while more theoretical treatments are given in any cost-benefit analysis text (e.g. Mishan 1982).

BOX 11. THE SCB IN ZIMBABWE

The value of moving to the SCB measure is made clear in the Zimbabwe case when comparing whole-farm profitability. The DRC measure suggests that large-scale commercial farms are somewhat more economically efficient than smallholders on a whole-farm basis, with a DRC of 0.54 instead of 0.60 on similar high-potential land (Masters 1994). But the large-scale farms make much more intensive use of fertilizer and other tradable inputs to achieve their results, while smallholders farms make more intensive use of labor. This difference accounts for *all* of the apparent difference in DRC levels: using the preferable SCB ratio, the economic efficiency of the two types of farms is found to be virtually identical (both have SCBs of 0.67). Even more dramatic changes in efficiency rankings are found with data from other countries, notably Kenya, as shown by Masters and Winter-Nelson (1995).

Although the appropriate formula for measuring comparative advantage remains the SCB/SRP, the data and results will depend very much on the context of the analysis. In particular, as emphasized by Schmid (1989) among others, the appropriate shadow price for any given item sometimes depends as much on political concerns as it does on economic conditions. An analyst must make as realistic an estimate as possible, based on what he or she knows about the likely evolution of the economy.

For example, an analyst who knows that certain import quotas will definitely remain in place should treat those products as nontradable, because domestic demand and supply changes will not lead to changes in imports. On the other hand, an analyst who knows that those seemingly inflexible quotas are in fact adjusted periodically to maintain roughly constant tariff-equivalence should treat the quota-restricted good as tradable, since marginal quantities are procured or sold on foreign markets. This is essentially a restatement of the 1960s debate between proponents of Little and Mirrlees's (1969) OECD-sponsored *Manual of Industrial Project Analysis in Developing Countries*, and Dasgupta, Marglin and Sen's (1972) UNIDO-sponsored *Guidelines for Project Evaluations*: Little and Mirrlees advocated the use of prices which reflect a fully Pareto-optimal set of policies, while Dasgupta, Marglin and Sen argued for second-best prices which reflect the limited influence of each decision-maker within government. Economics provides no formal resolution to this debate, since the appropriate method depends entirely on the potential influence of the policy analysis being performed. What economics does provide is the general principle that, to measure comparative advantage, shadow prices should be combined in a formula like that of the SCB above, and that each shadow price should reflect actual opportunity costs.

2.3.7 The Policy Analysis Matrix (PAM)

The use of the SCB/SRP measure allows very different activities to be compared, across sectors and across countries. But relying on a single number can hide all of its determinants. To make the sources of an activity's comparative advantage fully explicit, in the 1980s Pearson devised the Policy Analysis Matrix (PAM). The PAM is, in essence, a formal way to present all of the data needed to calculate PSEs, NSPs, DRCs, and the SCB or SRP. It is typically organized as follows (Monke and Pearson 1989):

TABLE 1. THE POLICY ANALYSIS MATRIX

	BENEFITS	COSTS		
	Gross Revenue	Tradable Inputs	Domestic Factors	Net Profit
Budget at Market Prices	$A=\Sigma_x P_x Q_x$	$B=\Sigma_i P_i Q_i$	$C=\Sigma_j P_j Q_j$	D
Budget at Social Opportunity Costs	$E=\Sigma_x P_x^* Q_x$	$F=\Sigma_i P_i^* Q_i$	$G=\Sigma_j P_j^* Q_j$	H
Divergences	I	J	K	L

Matrix entries A, B, and C are the sum of products of market prices (P) and quantities (Q) representing all of an activity's outputs (with subscript x), tradable inputs (subscript i) and nontradable domestic factor inputs (subscript j). Entries E, F, and G use the same quantities but are valued at social opportunity costs or shadow prices (P^*). The bottom row is the difference between the other two rows; the last column is benefits minus costs. Thus the PAM is a double-entry accounting system of identities, with no behavioral equations. The behavioral content of the PAM is embodied in the shadow prices used, and in the interpretation of the matrix.

TABLE 2. COMMON INDICATORS OF COMPARATIVE ADVANTAGE

Project appraisal measures	Policy analysis measures
NSP = E-F-G	NPC = A/E
DRC = G/(E-F)	EPC = (A-B)/(E-F)
SCB = (F+G)/E	PSE = L/A
	SRP = L/E

Formulating all the indicators in this way shows their fundamental similarities and differences, and allows the determinants of comparative advantage to be explicitly traced to specific elements of the PAM. In part for this reason, the PAM has become an enduringly popular way to present policy-analysis and project-appraisal data (e.g. Byerlee 1989, Nelson and Panggabean 1991, Masters 1994).

The PAM approach is not fundamentally different from the analyses behind each of the individual indicators, but it does permit their data and results to be presented with far greater clarity and elegance than is possible when working only with one or two specific formulas. For comparison with the list in Table 2 above, Box 12 provides a full list of the formulas presented earlier in this chapter. The formulas correspond directly to the data and structure of the PAM, but are somewhat harder to present and interpret.

BOX 12. FORMULAS FOR THE STANDARD MEASURES

Nominal Protection

$NPC = P/P^*$

Effective Protection

$EPC = v/v^*$

$= (P_x Q_x - \Sigma_i P_i Q_i)/(P_x^* Q_x^* - \Sigma_i P_i^* Q_i^*)$

$= (P_x - \Sigma_i \alpha_i P_i)/(P_x^* - \Sigma_i \alpha_i P_i^*)$

Producer Subsidy Equivalent

Total PSE

$= Q_x(P_x - P_x^*) - \Sigma_i Q_i(P_i - P_i^*) - \Sigma_j Q_j(P_j - P_j^*)$

Per-Unit PSE

$=$ Total PSE / Q_x

Percentage PSE

$=$ Total PSE / $P_x Q_x$

$=$ Per-Unit PSE / $\alpha_x P_x$

Subsidy Ratio to Producers

SRP = Tot.PSE/$P_x^* Q_x$

$=$ Per-Unit PSE / $\alpha_x P_x^*$

Net Social Profit

$NSP = Q_x P_x^* - \Sigma_i Q_i P_i^* - \Sigma_j Q_j P_j^*$

Domestic Resource Cost

$DRC = \Sigma_j Q_j P_j^* / (Q_x P_x^* - \Sigma_i Q_i P_i^*)$

Social Cost-Benefit Ratio

$SCB = (\Sigma_j Q_j P_j^* + \Sigma_i Q_i P_i^*) / Q_x P_x^*$

2.4 Implementation Issues in Comparative Advantage Analysis

These guidelines focus on the principles needed to guide comparative advantage analysis; these principles are useful for all development professionals who encounter the concepts of competitiveness and comparative advantage in their daily work. The implementation of comparative advantage analysis, however, is typically done by full-time economists. Everyone can use the ideas and formulas discussed in these guidelines, but actually measuring quantities and prices requires substantially more background in data collection and analysis.

The economics background needed for accurate measurement is usually acquired through formal training and experience; key concepts are summarized in standard texts, of which the most prominent sources include Scandizzo and Bruce (1980), Gittinger (1982), Timmer, Falcon and Pearson (1983), Monke and Pearson (1989), Tsakok (1990), Ellis (1992), and Tweeten (1992). Data collection and fieldwork techniques are discussed in Casley and Lurie (1987) and Devereux and Hoddinott (1993). The guidelines are not intended to substitute for these or other texts, training and experience. There is so much variation across cases that no "cookbook" approach can be adequate. Nonetheless it may be useful to note a few of the major hurdles commonly encountered in measuring quantities and prices, to ensure that these empirical issues are given adequate consideration in designing and interpreting comparative advantage analyses.

2.4.1 What Is to Be Measured? Marginal Versus Average Observations

The first critical hurdle is simply to define the activities being compared, to determine which quantities and prices should be measured. Some activities are essentially indivisible, and must be analyzed as a single well-defined entity. In the agricultural sector, this includes most irrigation and processing projects. In contrast, many farm activities are highly divisible, and can easily be reduced or expanded. Most crop production is of this type, as farmers can generally move resources such as land, labor and inputs between crops. If farmers can change area planted easily, expansion can occur at roughly constant returns to scale. It then suffices to select some representative sample of "typical" production units, since average observations and marginal values will be the same.

For agricultural production as a whole, or for crops which use specialized inputs, expansion cannot occur easily. In this case, the costs of expansion do not involve simply replicating existing activities, but bringing in other less productive or more costly types of land, labor and other inputs. Since data on these marginal values are rarely available, however, analysts must typically use observed averages to indicate marginal performance. This implicitly assumes constant returns to scale, which understates the cost of expansion and hence overstates the degree of comparative advantage. Depending on the circumstances, it may therefore be important for users of comparative advantage studies to question the use of observed averages, and look for some indication of marginal costs and marginal comparative advantage.

2.4.2 Estimating Quantities and Input/Output Budgets

For most agricultural applications, analysts are interested in comparing farm-level production options. Perhaps the best source on farm budgeting remains Brown (1979). Although farm-oriented analysts are most concerned with obtaining reliable estimates of how much seed, fertilizer, manure, irrigation water, animal and mechanical traction, family and hired labor, and other farm-level inputs may be used, it is also necessary to do a substantial amount of research on off-farm inputs. Since the opportunity costs of tradable goods are defined by trade opportunities, it is necessary to include all of the transport, processing and marketing inputs needed to reach foreign markets. Perhaps the most common error in agricultural comparative advantage analyses is to omit or understate these off-farm inputs. The off-farm component of product values is extremely high, averaging from 20 to 50 percent in many African and Asian countries (Ahmed and Rustagi 1987). Analysts may wish to construct separate budgets for on- and off-farm inputs (as in Monke and Pearson 1989), or combine them in a consolidated statement (as in Masters 1994).

Both on- and off-farm costs often include substantial amounts of nontraded intermediate inputs, such as transport or electricity or irrigation services. Intermediates may have to be decomposed into tradable and nontradable components, which was a major source of debate in the 1960s: proponents of the "Corden method" argued that intermediates were really nontradables and should be classed as domestic factors, while proponents of the "Balassa method" argued that they were really embodied tradables and should be put with traded inputs. In fact, both authors argued that wherever possible, nontradable intermediate inputs should be "decomposed" into their tradable and nontradable components, to capture the incidence of trade policy on the cost of the input. A complete decomposition would require input-output coefficients for all traded inputs into the nontraded service, plus market prices and opportunity costs for those "indirect" inputs. However, complete decomposition can be a Pandora's box as each intermediate input requires some other intermediate, requiring further decomposition. In practice analysts must stop somewhere; Monke and Pearson (1989) suggest that a useful rule of thumb is to not decompose anything that accounts for less than 5% of production costs. And if no other information is available, it is generally better to guess at the decomposition than not to decompose. A good starting point for many services would be that half of costs are tradable and the other half are nontradable capital and labor.

2.4.3 Estimating Prices and Opportunity Costs

Two sets of values are needed for each budget item: market prices and opportunity costs. Since prices can vary substantially across transactions it is important to be careful and consistent. Averaging may be needed to smooth out random fluctuations, but simple averages are not usually very meaningful. Careful research may be needed to determine which prices are actually relevant for production and policy decisions. Key issues include product quality, packaging and volume, as well as the season and location in which sales or purchases occur. For example, given high internal transport costs, locally-produced food may be competitive with imported foods for consumption in remote rural areas, but not in more accessible urban areas: this was the major conclusion of the classic study on rice in West Africa (Pearson et al., 1981).

For market prices, one critical question is whether crops are being purchased or sold by farmers. Farmers are often net buyers of food crops, so that their farm production decisions are made with reference to farmgate *purchase* prices. These are often far higher than sales prices. Understating farmers' valuation of food crops can lead to major errors in evaluating the comparative advantage of cash crops, as documented by Jayne (1994).

For the opportunity costs of traded crops and inputs, a key choice is between using foreign price observations--suitably corrected for international marketing costs--and using local observations of import or export prices. When trade does not actually occur, it is obviously necessary to find foreign-market prices. For standard-grade commodities such as wheat, corn and rice, prices for the most commonly-traded varieties (e.g. hard red winter wheat, 5% broken rice, yellow corn) at major ports (e.g. Rotterdam, Bangkok, U.S. Gulf Ports) are published on a regular basis in the FAO's *Monthly Bulletin of Statistics* and other sources. If similar grades are used locally, it may be necessary only to correct for transport and marketing costs; if grades differ, consumer preferences will influence the appropriate quality premium or discount to be applied.

When trade does occur, products must typically pass through some formal data collection process at the national level, so that average unit values or specific price quotations can be obtained from government sources. These may be in unpublished records of customs officials, a central bank, or government statistics offices. They may be distorted by traders' desire to avoid taxes or transfer currencies, but are often more accurate than foreign price quotes because they take account of subtle differences in quality, timing and direction of sales. In Southern Africa, for example, standard grades of grain can often be exported in a substantial regional market, at prices far from those of Europe or the United States; in this context a country may have a comparative advantage in exports to its neighbors, but not overseas (see Masters 1994 for the example of Zimbabwe).

The opportunity costs of nontradable goods and services are among the most difficult prices to estimate. Land values must often be imputed from a very small number of observed rentals or sales, or inferred from whole-farm profits. Capital costs are often highly distorted by inflation and other factors, and sometimes must be estimated from urban borrowing rates, plus transaction costs and loss factors associated with on-lending to farmers. Values for farm labor, in particular, are rarely known with much confidence. The hourly return to family workers may be far different from the wages paid to hired workers, because of differences in skills and motivation. It is often necessary to impute returns to family labor from whole-farm profits along with land. If there is no independent estimate of land and labor values, their returns cannot be separated. Most commonly, land values are observed separately and only labor returns are imputed from whole-farm profits. This implicitly assumes that hourly returns are equalized across all tasks. This is rarely the case, as production decisions are often determined by the returns to peak-season or high-skill tasks, while farmers' off-season or low-skill labor tasks have little influence. For this reason, studies typically find that skill-intensive crops like cotton, and crops with severe peak labor requirements like peanuts, generate above-average returns compared to corn or wheat. In fact, however, they use inputs with above-average costs, and may have little unexploited comparative advantage for expansion.

3. COMPARATIVE ADVANTAGE ANALYSIS IN PRACTICE

No simple rules can guide a researcher over the many hurdles associated with estimating quantities and prices. But the concepts and formulas discussed in these guidelines can be used to inform how those data are analyzed and interpreted. In essence, the guidelines indicate that comparative advantage analysis is no different from cost-benefit analysis in general. To evaluate farm activities, a simple cost-benefit (SCB) ratio is most appropriate. To evaluate discrete projects, a net social profit (NSP) or net present value (NPV) measure is best. In either case, all costs and benefits should be evaluated at social opportunity costs, to net out the effects of policies that distort observed competitiveness away from Pareto-optimal prices. Opportunity costs may be found either in border prices or in the domestic economy, and the overall shadow exchange rate will involve both.

The convergence of comparative advantage measurement with cost-benefit calculations is in some sense a return to the ideas of Adam Smith, who argued that international and domestic markets were fundamentally similar. But their similarity has been increasing over time, as rising incomes and falling transaction costs permit ever-greater economic integration. Many goods and services which were nontradable only a few years ago are now routinely traded, from fresh fruits and vegetables via refrigerated air freight to data entry and publications services via electronic communication. There is already not much difference between U.S.-Canada trade and transactions between, say, New York and New Jersey. Virtually all countries are growing closer to their neighbors and overseas partners.

3.1 Economic Integration and Unilateral, Regional or Multilateral Reforms

The progress of integration is by no means smooth, as legal rules to enforce contracts, prevent monopolies, and otherwise police the operation of a market economy need to be substantially rewritten. This is difficult enough in the case of unilateral liberalization efforts, such as those of Mexico before NAFTA. The design of appropriate regulations in regional agreements is even harder, as witnessed by the widespread frustration in Europe with the rule-making of the European Union bureaucracy in Brussels. But hardest of all is the design of "global" regulatory systems, such as those of the GATT.

An example of the complexity of regulating international trade is the difficulty of extending domestic antitrust rules, which help prevent firms from temporarily selling below cost to eliminate smaller rivals. International dumping needs to be regulated in a similar way, but there is now great tension between unilateral antidumping measures (e.g. U.S. actions taken under the Section 301 and Super-301 provisions of U.S. trade law) and a broader multilateral approach (e.g. any country's actions taken under Article VI of the GATT). Unilateral legislation permits a great deal of unjustified protection to pass for anti-dumping measures, but this is difficult to avoid without a more credible multilateral enforcement mechanism--which in turn requires a legal framework acceptable to all parties.

Another example of the need for new regulatory mechanisms is the extension of national inspections of food plants, which help ensure that accurate information about product quality is passed on to consumers. What sort of analogous sanitary and phytosanitary controls are appropriate to products shipped across national borders? How can Americans gain confidence in Mexican meat packing standards, and vice-versa? What happens when a third party might enter?

In these and other cases, the basic mode of analysis remains a simple cost-benefit framework, but an enormous amount of detailed information is needed to make informed judgements. The adoption of standard procedures through the GATT's new World Trade Organization (GATT 1993) will be an important step in making trade rules more transparent, but specialist knowledge will remain necessary to calculate comparative advantage in specific sectors.

3.2 Data and Analysis Needs for Measuring Comparative Advantage

As these guidelines have indicated, no country can afford to take its pattern of comparative advantage for granted. Decision-makers in national governments and international agencies must be aware of what factors determine that pattern, and be able to measure whether a particular program or project is consistent with national circumstances.

Data collection and analysis to support comparative advantage measurement can be organized in many different ways. Traditional LDC efforts to establish a single planning ministry to do such measurements and guide resource allocation in all sectors have not generally been successful. One fundamental reason for this is that central-planning staff are never as familiar with each individual activity as the staff of the line ministries responsible for industry, mining, tourism, health, etc.

For agriculture in particular, successful assessment of comparative advantage requires day-to-day access to the entire production and marketing chain, from input suppliers to farmers, processors, and traders. Important price and nonprice factors change continually, and successful analysts generally have numerous personal contacts within the sector to help them keep up to date and aware of hidden constraints and trade-offs. On the other hand, several important components of comparative advantage analysis must be done on an economy-wide basis. It is therefore appropriate to consider carefully how comparative advantage analysis can best be carried out, and by whom.

Commodity-specific comparative advantage is based on a large amount of sector-specific information. As such it is probably best analyzed by sector specialists, in a policy-analysis or planning unit located within each line ministry. USAID experience in Morocco and many other countries points clearly to the potential for specialist research to provide timely, accurate analyses (Wilcock and Salinger 1994). Since the policy influence of sector specialists may be blocked by generalists in more powerful posts, some delegation of authority may be necessary for information to flow freely.

The size and structure of sectoral policy-analysis units obviously depends on the size and structure of the entire government as well as the complexity of the question; in agriculture, it is generally appropriate to have one or more specialists concerned with inputs supply, irrigation, crop production, livestock production, farm finance, product marketing, processing, and international trade. Some specialty areas may be handled by agencies with specific responsibilities such as an agricultural credit facility, but all are inter-related--and data from each area is needed to assess the relative costs and benefits of any new programs or projects, as well as to monitor the on-going effects of established policies.

One task that cannot be accomplished by sector specialists is macroeconomic coordination. The Pandora's Box of "coordination" is often argued to include anything the coordinators want to control. But our analysis points to a few broad areas of government responsibility that are specifically macroeconomic in nature and are associated with key influences on commodity-specific comparative advantage. Monitoring and measuring these macroeconomic forces is best done in the ministries with an economy-wide mandate, such as finance, planning, trade, labor and the central bank. These analyses do require input from the sectoral ministries, and the sectoral analyses certainly require macroeconomic input, so extensive communication among analysts is critical to each analyst's success.

Macroeconomic aspects of comparative advantage are often thought to begin with the big-government vs. small-government question, state control vs. free markets, and nationalization vs. privatization. But for the analysis of comparative advantage, the overall share of activity in government hands is much less important than how government activity is financed. Whether a particular activity is in the "public" or "private" sector has little macroeconomic importance; what determines its success or failure is primarily a microeconomic or institutional question. In the U.S., for example, health care is a largely "private-sector" activity while retirement savings is largely public (through the social security system). In most other industrial countries, it's the other way around. Which system is used has little influence on macroeconomic performance, although it does have a big influence on the share of the economy in public hands.

The public-sector question which most influences macroeconomic performance is the share of expenditure that is paid for immediately in taxes (fiscal policy), or postponed by issuing new credit or public debt (monetary policy). Some governments have greater difficulty raising revenue and mobilizing local savings than others, and therefore tend to postpone payment through a budget deficit and foreign borrowing with a corresponding trade deficit. The hallmark of these "twin deficits" is RER appreciation and a loss of current competitiveness in the production of all tradable goods, as well as a narrowing of the range of goods in which one has comparative advantage (see, for example, Dornbusch, Fisher and Samuelson 1977). This situation applied to most developing countries in the 1970s, and to the U.S. in the 1980s.

Running twin deficits and losing current competitiveness is not necessary bad policy: if the underlying pattern of government expenditure and taxation is sound, the twin deficits are fully supportable by future growth in taxes and exports without changes in macroeconomic policy. On the other hand, if the government deficit and foreign borrowing is consumed rather than invested and does not lead to future productivity growth, then reversing the twin deficits will inevitably require a substantial real exchange rate depreciation to reverse the trade deficit, higher real interest rates to raise savings and investment, and perhaps also lower real wage rates to increase employment. Thus, the key question for macroeconomic management and the measurement of comparative advantage is the appropriate levels of these shadow prices: analysts must assess whether current exchange rates, interest rates and wage rates are really sustainable, and if not what their "equilibrium" level might be. As argued most eloquently by Harberger (1971), it is essential that all official policy analyses and project appraisals use common values for these economy-wide resources; as such they should be accepted at the highest levels of government, and supported by the latest information from all policy analysts.

3.3 Conclusions for Development Strategy

The recent evolution of comparative advantage analysis, reviewed in these guidelines, abounds with ironies. One is the outcome of the "new" trade theory and strategic trade literature, which sought initially to discredit neoclassical theory and promote nationalistic policy, and has led instead to a even deeper understanding of the benefits of open trade (e.g. Krugman 1993b). Another irony--which may yet evolve into a tragedy--is the rise of protectionist pressures against evolving comparative advantage in the U.S. and Europe during the 1980s, just as the low-income countries were looking to capture greater gains from trade (Whalley et al. 1989). Both reversals suggest that comparative advantage analysis is a sort of race, between the common good and those looking for ways to declare themselves exceptions.

Modern trade and growth theory finds many opportunities for government interventions to increase national welfare and growth, but interventions in international trade are rarely appropriate. Optimal interventions to provide public goods, offset externalities and reduce market power are almost always targeted at the home market, on the behavior of the country's own residents. To quote Krugman: "while markets are without question imperfect, the appropriate fix for their imperfections rarely involves trade policy per se. What is wrong with markets is usually a *domestic* distortion." (Krugman 1993, p. 364).

The need for domestic policy reforms rather than trade interventions has a clear intuitive reason: international trade consists principally of fully-specified contracts for known goods and services. Relatively little market power can sustainably be exercised in such contracts, and they have relatively few external costs and benefits. Market power and externalities are more important in actual production or consumption, for which there is little distinction between products that do or don't enter international trade.

Recent advances in trade theory provide even stronger evidence that national resource endowments -- broadly defined to include all classes of human, institutional and infrastructural capital -- still provide the fundamental basis for comparative advantage, and that comparative advantage can best be measured through relative costs. Economic growth is maximized by the pursuit of the lowest-cost, highest-return activities, for which a broadly defined cost-benefit ratio remains the most useful measurement tool.

APPENDIX A

COMPARATIVE ADVANTAGE: THEORY AND CHALLENGES

Modern concepts underlying the measurement of competitiveness and comparative advantage have been formed through a long history of debates between protectionists and free traders. To understand many of today's ideas, it is helpful to see them in that historical context. Here we will first review some of the fundamental arguments of the theory of comparative advantage and the gains from trade (sections A.1 - A.3), and then the major recent challenges to that theory (sections A.4 - A.7)

THE THEORY OF COMPARATIVE ADVANTAGE

A.1 Classical Economics and Ricardian Comparative Advantage

Modern economics began in the late eighteenth century, while modern theories of international trade were not formulated until fifty years later. Adam Smith argued for free international trade in his *Wealth of Nations* (1776), but he used the same reasons as when arguing for laissez-faire in the domestic economy. The argument which later became most important in trade theory is the notion that government interventions can inhibit productivity by limiting the extent of the market. Much new research has shown close links between productivity growth and access to larger markets, as larger markets permit both more competition and more specialization (see section A.5 below).

Much of Smith's argument is directed against the British "corn laws", which limited wheat imports from Europe. This hurt British commerce and industry, but kept land values high--and was therefore supported by the landowning aristocracy.

Despite the arguments of Smith and other liberals, the corn laws were maintained from 1660 until 1846. The protracted debate leading up to their repeal spurred the development of many important concepts in modern economics--including David Ricardo's principle of comparative advantage (1817).

The Ricardian theory of trade begins from the observation that some domestic resources (e.g. labor) may be mobile within a country, but not across countries. Only certain goods can be readily shipped long distances. Thus the key question for trade theory is how the international exchange of goods affects the value of immobile national resources, and vice-versa.

Ricardo's contribution was to argue not only that national resources are most valuable under free trade, but that the optimal pattern of trade was determined only by international differences in the *comparative costs* of some goods relative to other goods. The average or *absolute cost* level for all goods in each country determines each country's level of income and wealth, but not the appropriate pattern of trade.

The distinction between comparative and absolute advantage has been called the "deepest and most beautiful result in all of economics" (Findlay 1987, p. 514), perhaps because it is not at all obvious. Even after almost two centuries it is still counter-intuitive to many observers.

Perhaps the central unlearned lesson of Ricardian comparative advantage is that one country cannot benefit from imitating another country's pattern of trade: if rich countries export high-tech goods, it does not follow that exporting high-tech goods will make you rich. This message is lost on many otherwise sensible people, who argue that countries should strive to export only "value-added" goods, or "high-skill" goods, or goods which appear to have other desirable properties when produced in other countries: as shown by Ricardo, these desirable properties are a function of the country, not of the activity itself.

BOX 13. DOMESTIC MARKETS AND INTERNATIONAL TRADE

Adam Smith saw few differences between domestic markets and international trade. Their similarity still needs to be emphasized, if only to counter the common fear and distrust of foreigners which makes international trade suspect, even when it is overwhelmingly advantageous.

To make this point, Paul Krugman (1993a, p. 24) cites a memorable parable:

> An entrepreneur starts a new business that uses secret technology to convert U.S. wheat, lumber and so on into cheap high-quality consumer goods. The entrepreneur is hailed as an industrial hero; although some of his competitors are hurt, everyone accepts that occasional dislocations are the price of a free-market economy. But then an investigative reporter discovers that what he is really doing is shipping the wheat and lumber to Asia and using the proceeds to buy manufactured goods--whereupon he is denounced as a fraud who is destroying American jobs.

Krugman concludes that "the point, of course, is that international trade is an economic activity like any other and indeed usefully be thought of as a kind of production process that transforms exports into imports."

Ricardo's theory implies that following comparative advantage will not produce equal gains for all countries, nor will it benefit all groups within a country. There are groups who gain from restricting trade, or from trading "against" comparative advantage. But at the national level, the classical Ricardian principle argues that trade to exploit comparative advantage will give each country access to the greatest possible quantity of goods for present consumption or investment, thereby yielding the highest possible level of national income and economic growth. Comparative advantage is thus both a positive theory, used to predict the pattern of trade in the absence of trade restrictions, and a normative theory, used to prescribe the policies needed to obtain economically optimal outcomes.

After Ricardo, the contributions of a third nineteenth-century founder of modern economics, John Stuart Mill, should be mentioned. Among Mill's most enduring principles is the argument that trade protection is typically imposed to help the more powerful (and wealthier) members of a society, at the expense of the less powerful (and poorer); such income transfers are both inequitable and inefficient. This theory has been rediscovered in contemporary economics through the concept of rent seeking, a term coined by Anne Krueger (1974), as well as empirical studies of the relationship between trade protection, income inequality, and growth performance.

As economics developed from political philosophy into a modern social science, the classical principles of Smith, Ricardo and Mill have been restated in mathematical terms, more amenable to empirical application, hypothesis testing and peer review. The resulting profusion of stylized models, each assuming knowledge of previous models and addressing only some specific issue, is rarely as vivid or accessible as the anecdotes and metaphors of political philosophy. In these guidelines we will attempt to summarize their main implications in general terms, being aware that, as with any summary, much of the detail and richness of the original is being lost.

A.2 Neoclassical Comparative Advantage and the Gains From Trade

The formal model implicit in Ricardo's writing has a single country-specific factor which is mobile between uses (e.g., labor), and a single production technique for each good in each country (represented by a fixed number of labor hours per unit of output). Since this model implies fixed relative prices and extremes of specialization, it is often dismissed as unrealistic.

Among the first "neo"-classical innovations was to relax Ricardo's assumption of fixed resource costs for each good. As suggested by Ricardo himself and later formalized by Jacob Viner (1937) among others, this is typically done by specifying some industry-specific resource such as land for agriculture. In such specific-factor "Ricardo-Viner" models, additional labor applied to the fixed resource yields diminishing marginal returns, so that relative resource costs (and hence prices) vary with the level of production.

The presence of diminishing returns is one defining feature of neoclassical economic models. It helps explain why small changes in resource availability generally lead to small changes in relative prices, and why specialization is rarely complete: even city-states like Hong Kong have some agricultural production. Stark classical models, in contrast, typically imply dramatic jumps from one extreme to another. The presence of diminishing returns also allows each country to choose their production technique (e.g. the amount of labor to use in an activity) from a common base of technological knowledge. In this way, labor productivity is explained as a function of the availability of complementary resources, rather than some special information available only in one country.

Another key neoclassical innovation has been the introduction of consumer demand as a source of comparative advantage. In Ricardo-Viner models with demand, there can be mutually advantageous trade even among otherwise identical countries, due only to international differences in consumption (e.g. Abbott and Thompson 1987).

Ricardo-Viner models remain widely used by trade theorists (e.g. Dixit and Norman 1980, pp. 38-43). But by using sector-specific factors to represent national production possibilities, any country can be described as being relatively well-endowed with whatever resource is needed for what it produces: an abundance of vineyards, or factories, or fishing boats. Since many of these resources are the product of deliberate investment, Ricardo-Viner models are typically used primarily for short-run analyses. In the longer run, capital and other resources can be shifted between sectors, while still being specific to a country.

Relaxing the Ricardo-Viner assumption of only one mobile factor forms the foundation of modern neoclassical trade theory. With multiple mobile factors, it is no longer necessary to identify industry-specific factors. Now comparative advantage can be driven by a country's proportional endowment of a smaller number of basic factors, relative to how intensively each factor is used in different industries. This factor-intensity theory of trade is due principally to Eli Heckscher (1919) and Bertil Ohlin (1933).

In the simplest possible Heckscher-Ohlin model, there may be two mobile factors (e.g. labor and capital), each of which can be used in two activities (e.g. agriculture and manufacturing), in two countries (e.g. the U.S. versus the rest-of-the-world). If manufacturing is relatively more capital-intensive than agriculture, and the U.S. starts with more capital per worker, then the Heckscher-Ohlin (HO) theory predicts that the U.S. will export manufactures. No factor specific to agriculture or manufacturing is needed to explain the growth of these industries.

The Heckscher-Ohlin (HO) model is most easily understood with only two factors, two industries, and two countries, but this simple form of the model can be readily rejected in empirical tests. The most famous such test is that of Leontief (1953), who found U.S. imports to be more capital-intensive than U.S. exports, despite a relative abundance of capital in the U.S. This "Leontief paradox" has been widely interpreted as a rejection of the HO theory itself, and sometimes of the entire concept of comparative advantage. But in fact the paradox can be readily explained as a simple specification error: adding data on some other factors (such as labor skills or natural resources) could easily resolve the paradox. Leontief hypothesized that U.S. products were relatively skill-intensive, but formal extensions of the HO theory to many goods and factors were not well developed at that time. It was not until later that Jaroslav Vanek (1968), Wilfred Ethier (1974) and others derived testable implications of the HO theory in more than two dimensions, permitting more realistic empirical tests of the factor-intensity theory of trade.

The empirical tests of Leamer (1984) and many others have demonstrated conclusively that national trade patterns are in fact largely driven by relative resource endowments, and not government policy or corporate management. Attempts to "go against" comparative advantage may succeed for short periods of time or for a few firms, but in the long run and for the economy as a whole trade patterns do appear to be determined by the Ricardian comparative cost principle. The normative implication of this evidence is that, since "created" comparative advantage tends not to be long-lasting, government attempts to do so are unlikely to generate sustained profits. Indeed, the high cost of trade restrictions for economic growth has been demonstrated directly in numerous studies, among the most notable of which are Dollar (1992) and Edwards (1993).

The historical record reinforces the view that economic growth is greatest under more open trade regimes. But this does not imply that complete laissez-faire is optimal, or that there is nothing governments can do to influence trade patterns. Among the most appropriate theories of trade policy for LDCs comes from Australia, where the impact on trade of exchange rates and domestic market policies has been highlighted.

BOX 14. TESTING THE THEORY OF COMPARATIVE ADVANTAGE

In a comprehensive empirical study of Heckscher-Ohlin-Vanek (HOV) theory, Leamer (1984) uses 11 distinct resources to account for net trade in 10 composite goods, across 58 countries, for two time periods. He finds strong support for HOV theory, but notes that different factors may be important for different industries at different times, so no one set of factors are the definitive "source" of international comparative advantage. For LDCs, Leamer's study supports the concept of a "ladder" of comparative advantage as capital accumulation in some countries allowed them to export an increasing array of manufactured products over time.

Leamer also found that some aspects of international trade could not be explained by his data on factor endowments. In particular, he finds a number of nonlinearities and "jumps" which could be due to increasing returns to scale, as well as unexplained "clustering" within product categories which could be due to externalities and market power. But these effects could also be explained within HOV theory by the presence of additional unmeasured factors. To evaluate the influence of factor endowments relative to alternative explanations, the influence of scale economies, externalities and market power would have to be formulated into testable hypotheses--which was not generally done until the mid-1980s, in the "new" trade theory discussed in section 2.4 below.

A.3 The Australian "Dependent Economy" Model and the Real Exchange Rate

Through the 1950s, most trade theory concerned the problems of large countries, principally the U.S. and the European powers. Since they accounted for large shares of world trade, their actions had a major influence on foreign prices. As a result, trade theory appropriately focused on the international terms of trade, while the absolute level of prices and international exchange rates received little notice.

The modern theory of exchange rates was developed after the second world war, as a by-product of studying the problems of former colonies and other economically "small" countries. Much of this work was done by Australians, who focused on their small size and lack of influence on foreign prices as a key difference between them and their former colonial rulers. Salter (1959) first labeled this a "dependent" economy, and along with Swan (1960), Corden (1960) and others developed the modern theory of structural adjustment. The founding notion of this "Australian" model is the idea that, since they have but a small share of world trade, changes in exports or imports are primarily influenced by domestic forces rather than foreign demand or supply. As a result, national policies can significantly influence the trade balance, whether or not external events are favorable.

The Salter-Swan model begins by assuming that the foreign-currency prices of imports and exports are fixed in a large world market. As a result, these goods--and their close substitutes, which may be "importable" and "exportable" even if not actually traded--can be aggregated into a single category. The domestic prices of all such "tradables" will rise and fall together with the national exchange rate at which foreign prices are converted into domestic currency. In contrast, the prices of "nontradables" such as construction or other services will

BOX 15. THE MANY "TERMS OF TRADE"

> The "terms of trade" usually refers to the relative prices of imports and exports; "falling" terms of trade usually means that the prices of imports are rising relative to exports.
>
> In contrast, the "real exchange rate" concept refers to the *internal* terms of trade, or relative prices within a country. Here the contrast is generally between *tradable* goods which can profitably be exported or imported, and *nontradables* which cannot.
>
> A third relative-price concept used in trade theory is the "purchasing power parity" of different currencies, measured as the overall price level in one currency relative to another. Since the 1920s it has been sometimes argued that exchange rates adjust to equalize overall price levels in different countries, but this theory has been extremely controversial (Officer 1976 and Frankel 1978).

rise and fall with domestic supply and demand alone. Nontradables will influence tradables' prices through the cost of local transport and marketing, taxes and tariffs, but their exchange rate serves as a key relative price, raising or lowering the value of all exportables and importables, relative to all nontradable good and domestic factors.

The internal relative price of tradables in terms of nontradables, called the "real" exchange rate in the Australian model, is influenced by the nominal exchange rate (which changes the prices of all tradables), but also domestic monetary and fiscal policy (which changes the demand and supply of domestic factors). Through these two mechanisms, the Australian model showed how the national balance of payments could be influenced by government actions, irrespective of foreign economic conditions or the policies of other governments. As such it has had enormous influence, not only in developing countries but throughout the world: for example, it is largely the Salter-Swan model which underlies the current U.S. argument that Japan and Germany could reduce their trade surpluses through monetary and fiscal expansion. The model predicts that this will raise the prices of their nontradables relative to tradables in those countries, thereby reducing their exports and increasing their imports. It is also the Australian model which underlies the broad lines of most World Bank/IMF-sponsored structural adjustment programs, using a combination of monetary and fiscal restraint and nominal devaluation to reduce a trade deficit.

A sort of corollary to the Australian model is the theory of "domestic divergences" or "domestic distortions," associated primarily with the work of Johnson (1965a), Bhagwati (1971), and Corden (1974). The central argument of the domestic-distortions view is that markets are often inefficient, leading to many opportunities for government actions to accelerate growth--but that these are almost always domestic in nature, so that trade interventions are not called for. Instead, government is called upon to invest in national public goods (such as transport infrastructure, health services and education), as well as market institutions (such as a justice system for enforcing implicit contracts and a banking system to control credit). In this view, international trade is subject to far fewer distortions than domestic institutions and factor markets, because trade consists mostly of commodities and other products with well-known characteristics.

The Australian model of trade and the associated theory of domestic distortions remain at the core of neoclassical trade theory; as such they are the foundation for the measurement methods presented in Chapter 3, and of the formal model presented in the mathematical appendix. In the remainder of this section we will focus on the principal challenges to this "standard" view, to assess their value in practical applications.

CHALLENGING COMPARATIVE ADVANTAGE: STRATEGIES FOR INDUSTRIALIZATION

A.4 The Latin-American *dependencia* Model and Import-Substitution

For many years, the main alternative to the Australian model was another southern-hemisphere view of international trade, the "*dependencia*" model developed for Latin America. In the Latin view "dependency" was seen as an undesirable reliance on foreign suppliers and customers, which could be avoided through greater levels of self-sufficiency. This is quite a different meaning of the term than in the Australian dependent-economy model, in which being economically small is seen to be an advantage in world markets, because it allows exports and imports to expand without encountering foreign demand and supply constraints. Latin American theorists, facing similar world market conditions but with a very different historical experience, saw foreign constraints as one of the key restrictions on their growth. As a result they advised their governments to ignore current comparative advantage and turn inward, using taxes and restrictions on trade to raise revenue and create domestic import-substitution industries.

Until recently, European and North American development theorists often took the Latin view, which was widespread throughout Africa and Asia as well. Professional economists were influenced towards this perspective in part by the attractive theoretical framework of growth models in the Harrod-Domar tradition (Harrod 1939, Domar 1946), and the related development models of Rosenstein-Rodan (1943), Mahalanobis (1953), Lewis (1954), Hirschman (1958) and others. These models generally ignored the gains from trade altogether, focusing instead on the process of capital accumulation in a closed economy. Even for open economies, the early growth theory such as Chenery's "two-gap" model (Chenery and Bruno 1962, Chenery and Strout 1966) focused on using foreign markets to obtain capital inflows, rather than to exploit comparative advantage and thereby obtain gains from trade.

A fundamental mistrust of international trade in LDCs was also influenced by the dismal record of colonial trade and investment arrangements, dominated by state-sanctioned monopolies (see, for example, Rodney 1972). It was also no doubt influenced by the traumatic experience of world price collapse in the great depression of the 1930s. Both of these experiences suggest that apparently profitable trading opportunities are in fact associated with foreign control, uncertainty, and limited economic growth--so that current comparative advantage is no guide to growth prospects.

A third factor behind post-war "trade pessimism" in developing countries was the trade theory work of Hans Singer (1950) and Raul Prebisch (1950). The Singer-Prebisch trade theory starts with the view that poor countries are poor in part because the international terms of trade have tended to turn against them, so that trade has been used to extract capital from LDCs.

Some dependency theorists expanded this view into a complete explanation of "unequal exchange," "dependent development" or the "development of underdevelopment," such as Arrighi, Emmanuel (1972), Samir Amin (1977), and Immanuel Wallerstein (1979. Many dependency theorists sought primarily to explain historical events in the Marxist tradition (Palma 1978), and to argue for a "new international economic order" governing industrialized countries (Bhagwati 1977). Singer and Prebisch were among the few who sought to formulate testable hypotheses in the tradition of mainstream economics, and to make policy recommendations that could be implemented by LDCs themselves.

The Singer-Prebisch model focuses on the causes of adverse movements in the terms of trade, and the way in which these reduce or eliminate any perceived comparative advantage based on current resource endowments, technology and institutions. Terms-of-trade movements in the Singer-Prebisch model include both "secular" trends over time, and "endogenous" shifts in response to increased LDC exports or imports. Both were seen to call for a strategy of trade restriction and inward-looking import substitution, and were highly persuasive arguments in their day. Even now the Singer-Prebisch model is influential in some circles, and should be taken into account even if it is no longer dominant.

A.4.1 Secular Declines in the Terms of Trade

In the Singer-Prebisch model, LDCs' terms of trade inevitably decline over time, because world demand for the primary products which they export rises less fast than world demand for the manufactured products of industrial countries. As a result, the prices of their imports (manufactures) rise relative to their exports (primary products). One Singer-Prebisch explanation for this trend was rising world income, because the income elasticities of demand are higher for manufactures than for primary products. Another explanation was that new manufactures were increasingly close substitutes for primary products (i.e., polyester for cotton, plastics for wood and metal).

Singer, Prebisch and many other researchers found many empirical examples of seriously adverse movements in LDCs' terms of trade. Such problems continue to plague many countries. But the theory's predictive value has proven to be limited, principally because it omits the influence of supply constraints on the prices of primary products: in particular, if some primary products require resources that are renewable but fixed in supply (like cropland, forests or fish), or are exhaustible (like oil and coal), then their prices can easily rise faster than those of manufactures.

Which set of prices will rise faster in the future is far from certain. Historically, the terms of trade between manufactures and primary products have gone through long swings, from periods of resource-scarcity with high primary product prices (such as the 1940s and 1970s) to periods of resource-abundance with low primary product prices (such as the 1930s and 1980s). Furthermore the prices of some commodities have often fluctuated independently of other primary products. Thus the prediction that LDC terms of trade inevitably fall over time seems at best simplistic, and at worse misleading. In any event it mainly justifies careful forecasting of expected export and import prices; it is not an argument for trade restrictions, unless the government makes better forecasts than private traders. In no case is it really an argument against resource-based comparative advantage in general.

A.4.2 Export-Induced Movements in the Terms of Trade

The Singer-Prebisch prediction that increased trade will worsen LDCs' terms of trade refers primarily to exports, but also applies to LDCs' imports. In both cases it implies that some government restriction of trade is appropriate.

The view that increasing LDC exports would cause their prices to fall implies that the foreign price elasticity of demand for those products is low; this is typically ascribed to an inelastic demand for all primary products. The view that increased LDC imports would cause their prices to rise implies that the foreign price elasticity of supply is low; this is usually ascribed to monopoly power in among manufacturers in industrialized countries, who perceive a low elasticity of demand in LDCs and exploit it by restricting output.

Both predictions of the Singer-Prebisch theory could well be valid, particularly for LDCs which have significant shares of world exports, and do call for governments to restrict trade against comparative advantage. But the "optimal" tariff or export tax tends to be small: it is equal to $1/\epsilon$, where ϵ is the rest-of-world elasticity of export supply or import demand (Corden 1974), and ϵ is generally a large number that rises over time (e.g. 5-10 in the short run, 10-20 in the long run). Thus it might be possible to justify temporary tariffs as high as 20% and permanent ones as high as 10%, but only if no retaliation is expected. If foreigners notice this tariff and apply counter-tariffs, the optimal tariff falls to zero--as discussed in section A.5.4 below.

A.4.3 Infant Industries and Domestic Linkages

In addition to the negative aspects of foreign trade highlighted by the Singer-Prebisch model, "trade pessimists" have also emphasized the positive benefits of restricting trade, to "go against" comparative advantage and expand import-substitution industries in place of export-oriented ones. The benefits of import substitution can be summarized in terms of the classical theory of infant industries, whose most famous proponent in U.S. history was Alexander Hamilton (1791), and the theory of forward and backward linkages associated with Albert Hirschman (1977, 1986).

Like the export pessimism of the Singer-Prebisch model, optimism about import-substitution has strong psychological foundations--principally in the simple fact that virtually all major industries of the U.S., Europe, Japan and elsewhere have themselves enjoyed periods of protection. This fact alone can be very persuasive, although on reflection the existence of protection does not prove it was beneficial. Without import-substitution an even better outcome might have been achieved. Some theory would be needed for history to justify a future policy action. In practice, the fundamental economic rationales for import substitution can be divided into sector-specific "infant industry" arguments, and inter-sectoral externalities such as Hirschman's "linkages".

Infant industry arguments are very old. They start with the simple idea that it is more difficult to start an industry than to continue an established one. It is argued that this prevents local start-ups from successfully competing against imports, but that if protected during "infancy", they would yield handsome profits for many years. Indeed, this concept may have been the first theory of comparative advantage, which John Stuart Mill (1848) summarizes in the argument that "The superiority of one country over another in a branch of production often arises only from having begun it sooner." (quoted in Corden 1974, p. 248).

John Stuart Mill accepted this argument, but cautioned that the future gains from profitability may not outweigh the present costs of start-up. Bastable (1921) later added that future gains must outweigh present costs *plus interest*, at whatever rate of profit would have been earned in alternative investments. This Mill-Bastable test remains the principal criterion by which the desirability of establishing infant industries is judged; it is precisely the net present value (NPV) measure used to evaluate other new projects (Gittinger, 1982).

Recent refinements of the Mill-Bastable test (summarized most succinctly in Corden 1974, pp. 248-279) have served primarily to improve the measurement of present costs and future benefits, and thereby define the Mill-Bastable test more precisely. Better definition has served to raise the hurdle; when all costs and benefits are taken into account, the conditions under which infant-industry protection actually produces net social gains are very limited. In essence, what is needed is that the industry generate a large flow of benefits to other industries, which the government cannot subsidize directly.

Because it is so difficult to satisfy the Mill-Bastable test and justify infant-industry protection, protectionists have turned to other arguments for justification. Perhaps the most successful of these is the idea of inter-sectoral linkages, promoted by Hirschman (1977, 1986) among others. Hirschman argued, in essence, that not all industries convey the same benefits to the rest of the economy, so that each industry's "backward" linkages (in demanding the output of other sectors) and "forward" linkages (in supplying goods to other industries) should be taken into account when evaluating comparative advantage.

Taking account of linkages is often an argument against trade, because linkages are thought to be weak for exports but strong for import-substitutes. Most LDC exports are primary commodities that demand few skills or capital, and supply few inputs to other industries. In contrast, import-substitutes are manufactures requiring substantial amounts of skilled labor and capital, and supplying inputs to other industries as well as consumer goods. As a result, using trade restrictions to accelerate the switch from primary commodities to manufactures can be seen to lead to a "big push" towards upgrading skills and capital, through "balanced growth" in many complementary activities.

As with infant industries, the degree to which linkages are a valid argument against comparative advantage hinges on some market failure. Net gains from expanding one sector will be reaped only if there are social gains from its linkages. With backward linkages, the sector to be supported must pay its input suppliers more than their social costs; for forward linkages, the sector must sell its output for less than its social value. There are undoubtedly many sources of such intersectoral externalities, but it is the externalities rather than the linkages themselves which would justify protection.

When looking at the value of external gains only, and not the whole linkage concept, it is not at all clear that these are greater for import-substitutes than for exports. It is also not clear that when intersectoral externalities are known, import protection would be the appropriate policy. In general, traditional comparative advantage would still be relevant, so that free trade with some domestic intervention would be the most appropriate policy action.

By the early 1980s, both the infant-industry and sectoral-linkages arguments for protection had lost much of their previous force in the developing world. Protected infant industries were failing to grow up, and import-substitution policies were failing to reduce dependence on foreigners. Protection was seen merely to shift the composition of trade and reduce its volume, without improving either growth or equity. Along with the debt crisis and increasingly policy-based aid, this experience helped persuade many LDC governments to dismantle their trade restrictions and begin to follow the prescriptions of the Australian model. Although the rhetoric of self-sufficiency remains strong, more and more LDCs in fact are seeking to capture gains from trade through market liberalization, devaluation and fiscal restraint. Whether these reforms are sustained in any one country depends in part on politics (including whether freer trade can be made intuitively appealing), and in part on economic performance (including whether each country's trading partners are receptive to increased trade).

BOX 16. INFANT INDUSTRIES

It is sometimes argued that the main problem with "infant industries" is that they often don't grow up. But even if an infant industry is eventually weaned from trade protection, that protection may still have been costly to the economy as a whole. For infant-industry protection to raise national welfare, it is necessary for the protected industry to demonstrate three key attributes adapted from Corden (1974):

- increasing returns with capital market failure;
- external benefits with government failure; and
- no foreign retaliation.

To pass the first hurdle, the industry must show increasing returns to scale. This is relatively common, but the industry must also show that private capital markets are unable to provide the funds needed to reach the optimal size. This usually requires that the benefits of increasing returns will be reaped by other firms, through "positive externalities" such as the training of workers who may then be hired away by others.

To pass the second hurdle, firms must show that the "external" benefits they provide are "internal" to the country, and so cannot be borrowed from abroad. Perhaps the most important example of this sort of externality is agricultural research and extension, which generates knowledge that is of value only in a specific location. But the firm must also show that the government is unwilling or unable to supply these national public goods directly, since direct provision is generally more cost-effective than protecting an entire industry.

The final hurdle requires that foreign governments do not attempt to retaliate with similar infant-industry protection. If they do retaliate, both sides' profits will be eroded. But since infant-industry protection derives its value (if any) at the expense of foreigners, any successful infant-industry protection merely invites retaliation in kind.

A.5 "New" Trade Theory and Strategic Trade Policy

Ironically, just as LDC governments turned towards neoclassical economics, a revival of interest in non-neoclassical trade theory arose in the U.S. and Europe. This work was driven in part by sudden increases in imports into the U.S., challenging the profitability of several prominent industries. As American producers of automobiles, semiconductors, aircraft and other highly visible products lost market share to Asian and European exporters, economists and journalists jostled to explain the change and prescribe an appropriate policy response.

The trade models developed in the 1980s produced dramatic advances in economic theory and policy analysis, based primarily on a few stylized cases: in particular, competition between Boeing and the European Airbus in the aircraft industry led to new theories of international trade with oligopolies, while competition between U.S. and Japanese firms in the semiconductor industry led to new theories of trade with external gains from learning new technologies.

The imperfect-competition story was pioneered in a series of papers by Barbara Spencer and James Brander (Spencer and Brander 1983, Brander and Spencer 1985), while the technology-learning story was pioneered by the work at U.C. Berkeley led in part by Laura d'Andrea Tyson (e.g. Borrus, Tyson and Zysman 1986). In both cases the novelty was to clarify the exact conditions under which a country could gain by trade intervention: the Boeing vs. Airbus story was used to argue that countries could capture economic rents in oligopolistic industries by using government subsidies to deter foreigners' entry, while the semiconductor story was used to argue that countries could gain dynamic learning externalities by using subsidies to expand high-tech activities.

BOX 17. EXPLAINING TRADE DEFICITS

Although many observers sought to blame individuals or groups for the growing U.S. trade deficit in the 1980s, it turns out that a ready explanation could be given by a standard combination of macroeconomics and comparative advantage. In essence, macroeconomic conditions determined the size of the trade deficit, while comparative advantage determined its composition.

The growing size of the trade deficit was caused by the combination of government deficits, low private savings, and low money supply growth. Together these factors led to high real interest rates and capital inflows from abroad, which Americans quickly spent on increased imports.

The composition of the trade deficit was largely determined by those countries which were in a position to supply the US demand for imports, due to their high savings rates and low domestic demand. These countries were Japan and Germany, whose comparative advantage was in automobiles, semiconductors and other relatively high-tech goods, plus the East Asian NICs, with a comparative advantage in light manufactures.

Imperfect competition and externalities were consolidated into a positive theory of trade with the first Helpman and Krugman textbook (1985); their policy implications were consolidated by a similar treatment in Helpman and Krugman (1989). For the nonspecialist, useful introductions include the volume of survey papers edited by Krugman (1986) and a more recent journal article by Helpman (1990). During the 1980s this body of work came to be known as "new" trade theory, as it investigates various exceptions to the "old" neoclassical approach.

One unifying theme of the new trade literature is the role of increasing returns, at the firm level (in the case of imperfect competition), in a whole economy (in the case of externalities), and over time (in the case of dynamic learning effects). The possibility of increasing returns implies that comparative advantage is not entirely determined by resource endowments, but can be created by targeting "strategic" sectors.

As the strategic trade policy literature developed, two results became clear: first, that the new theory was in fact a formalization and restatement of some well-known results of "old" trade theory, in terms that are more amenable to empirical application; and second, that these applications have generated overwhelming empirical evidence in favor of resource-based comparative advantage and free trade (Baldwin, 1992). In summarizing their work, Helpman and Krugman (1989) wrote that "the principal effect of the new models on practical policy discussion has been to reinforce arguments in favor of trade liberalization" (p. 178-9). By the early 1990s, a consensus had emerged among the new trade theorists that, while imperfect competition and externalities have undoubtedly played a significant role in the rise and fall of specific industries, they do not explain much about economy-wide comparative advantage, and can rarely be exploited for large gains by government trade interventions. To quote Krugman again, "A few years ago it was common for advocates of aggressive trade policy like Bruce Scott (1985) to dismiss economists on the grounds that their theories neglected 'dynamic' aspects. We can now answer, truthfully, that we have looked pretty thoroughly into those dynamic aspects and found their policy implications to be limited." (Krugman 1993b, p. 366.)

Perhaps the clearest list of findings from the new trade theory is given by Elhanan Helpman (1990), who ends a survey of the topic by concluding that "(a) the information needed for successful policy design is not available; (b) the policy recommendations are very sensitive to this information; and (c) the 'calibration' studies indicate that good policies improve welfare only slightly; free trade remains a good rule of thumb--the more so given retaliation, the competitive pressure of a world trading system, and the political economy of protection" (p. 213). This list captures numerous key results of the new trade theory, which can readily be summarized following Helpman's own sequence.

A.5.1 Information Needs for Trade Intervention

Perhaps the most fundamental reason why "successful" (i.e. welfare-improving) trade restrictions cannot be implemented is that the data needed to design them are not available. The new trade theory has identified two underlying sources of "created" comparative advantage which might potentially be exploited by strategic trade policy: externalities and market power. Both phenomena can sometimes be measured *ex-post* in historical studies, but their very nature makes them almost impossible to predict and use for policy purposes.

Externalities can rarely be successfully measured for the same reason that they are external to firms: no one knows how much they are worth. As measurement methods improve, some externalities may become measurable, but then they are no longer necessarily externalities: they could be controlled or traded directly. Thus measurability makes trade restrictions undesirable, in the sense that another policy is preferable. Trade restrictions remain optimal only on the basis of something unmeasurable, and therefore of little practical use to policy-makers.

Market power is hard to measure for somewhat different reasons: its value depends on competitors' retaliation (or "reaction functions"), which can rarely be successfully predicted. Again there is a fundamental reason for this: it is in each competitor's interest to remain unpredictable. The classic case in which strategic trade policy can help a country exercise market power is using subsidies to deter foreigners' entry into a lucrative market (e.g. Brander and Spencer 1985). But to do so successfully in the long run requires expending the profits (or economic rents) from that market in carrying out the deterrence. No one has an interest in doing so, so predictable strategic actions tend to be unsustainable.

BOX 18. THE POLICY IMPLICATIONS OF MEASURING EXTERNALITIES

The policy implications of measuring externalities can be illustrated by two archetypical cases: environmental pollution (a negative externality) and worker training (a positive externality).

The cost of environmental pollution is an increasingly common argument for trade restriction, on the grounds that governments are unable to restrict pollution directly. But designing the optimal trade restriction requires measuring pollution levels--and once these become known, it becomes possible to enforce pollution controls directly. Once pollution is measurable it also becomes possible to assign property rights over unpolluted resources, thus forcing polluters to buy "pollution rights" in a competitive market.

Another example of the policy implications of measuring externalities is provided by the case of workers' learning-by-doing. It is often argued that, since workers can take on-the-job skills to other employers, such skills are a positive externality which must be subsidized by consumers through trade protection. But this argument is undercut by the history of labor training: traditionally on-the-job skills were "bought" by workers from employers through apprenticeship contracts, which are still common in some countries. More recently, transferable skills have been provided at lower cost through formal education. In both cases, any predictable gains from on-the-job training have already been reaped. A far more important determinant of labor skills is the general education level of potential employees.

A.5.2 The Need for Data to Design Optimal Policy

The trade theory literature identifies two fundamental reasons why optimal policies are highly sensitive to the information which, as discussed above, is unknown and often unknowable.

First, both "old" and "new" trade theory acknowledge that many activities generate some externalities, and many markets have some degree of imperfect competition. Thus the design of optimal interventions depends on relative levels of externalities and market power. Using "new" trade theory to show that one sector is "strategic" is no guide to policy; it must be shown to be more strategic than others.

Second, both "old" and "new" trade theory suggest that the costs of policy are highly nonlinear. In the "old" theory of competitive markets, the welfare costs of a tariff or quota rise with the square of the tariff rate. In the "new" theory, the relationship can be even more dramatic (e.g. Romer 1994), often with key "switchpoints" between gains and losses. For both reasons, the formulation of strategic trade policy is extremely data-intensive, which makes it almost impossible for it to be successfully practiced.

A.5.3 The Gains From Optimal Policy

When governments do pursue "created" comparative advantage, what can be gained? Does the upside potential outweigh the downside risk? Again, trade theory gives us a clear answer: upside gains are bounded by the value of the externalities or rents generated by an activity, which are typically small relative to the costs of the activity. If this were not the case, commensurate resources would be deployed to measure and capture them. Thus the potential gains cannot be much larger than the costs of pursuing them. But the "small" size of the potential gain is most dramatic in contrast with the potential losses from policy, which Helpman attributes to "retaliation, the competitive pressure of a free trading world system, and the political economy of protection." Each of these forces will now be addressed in turn.

A.5.4 The Potential for Retaliation

All "strategic" trade actions involve profiting at another country's expense. As such they invite retaliation, which can easily lead to losses far larger than any potential gain and makes predatory behavior unprofitable.

Perhaps the most general model for analyzing such situations is the "prisoner's dilemma", first articulated in its modern form by Tucker (1950), with trade policy applications reviewed by Brander (1986) and Richardson (1986) among others. These cases generally consider two or more countries, each of which has the choice of intervening or not intervening in trade. Strategic policy becomes possible under imperfect competition, where the profits of one manufacturer depend critically on whether others decide to enter the market. This makes it potentially attractive for one government to intervene (or threaten to intervene) just enough to deter foreign competitors from entering. But if another country retaliates with similar interventions, both sides lose.

The prisoner's dilemma, of course, need not end in lose-lose conflict. If there are ways to signal cooperative intentions and/or to penalize selfish behavior, cooperative outcomes can become predominant. Perhaps the simplest signalling/penalty mechanism arises from repetitions of same game: after experimenting with various actions, each participant can learn what works for them. One of the strongest results of the prisoner's dilemma literature is that, with an indefinite number of repetitions of a given scenario, each side's optimal strategy is generally a "tit-for-tat" approach: to act cooperatively unless others act selfishly first, and then to retaliate with a single selfish act (Axelrod 1984). The reasons why the tit-for-tat strategy is successful are very simple: acting selfishly any *more* often than the others simply elicits even more selfish behavior in them, while acting selfishly *less* often makes one an easy target, again eliciting selfish strategies in others. As the game is repeated, all participants can discover for themselves the value of cooperation. Ultimately, everyone knows it is possible to act selfishly, but it is in no one's interest to do so: the mere possibility of retaliation reduces the need for anyone to retaliate in practice.

BOX 19. THE PRISONER'S DILEMMA

> The name of the "prisoner's dilemma" refers to the case of two or more people on trial for a given crime. When each prisoner's penalty depends on whether the others have confessed, a dilemma may arise: it may be best for all to "cooperate" on a common confession, in which case each receives a light penalty, but each individual may have a selfish interest in "defecting" from the others and pleading innocent, once the others have confessed. The result can be that no one confesses, in which case all receive the heaviest sentence.
>
> The prisoner's dilemma concept is easiest to analyze with only two participants, but can have any number of players. With a very large number of participants, the dilemma is sometimes known as the "tragedy of the commons" (Hardin 1968). In Hardin's example, each user of a common pasture is tempted to add one more animal, until the grazing potential of the pasture is exhausted. No one will restrict their own herd size unless they can be sure other users will also exercise restraint. With an infinite (or very large) number of participants, the problem becomes one of a neoclassical externality in a competitive situation, with neoclassical remedies.

A.5.5 The Competitive Pressure of Open World Trade

A counterpart of the high cost of retaliation is the potential gain from cooperating in a free-trade strategy. When many countries have signaled their intention to maintain free trade and have agreed on a system of sanctions against those who seek selfish exceptions--through the GATT, for example--participation in that system becomes extremely attractive. Many of these gains are identified in "old" trade theory (e.g. Samuelson 1962), in the context of competitive markets. But even greater gains have been identified in the context of externalities and imperfect competition. In both cases, expanding the market allows costs to be reduced and benefits to be expanded. Hertel (1991) has called this the "procompetitive" effect of trade.

The procompetitive effects of open trade are important in the case of externalities, because they are spread over a larger community. For example, countries with more open trade are known to have faster rates of productivity growth, perhaps because they are better able to borrow and adapt new ideas from others (e.g. Barro 1991, Edwards 1993). In the case of imperfect competition, more open trade expands the size of the market, which allows export-oriented firms to capture economies of scale, while putting competitive pressure on import-substitution industries that would otherwise have market power. Perhaps the most famous detailed case study of this issue is that of Harris and Cox (1984), who find that such mechanisms could give Canada much larger gains from the Canada-U.S. Trade Agreement than would be expected under traditional trade theory.

A.5.6 The Political Economy of Protection

A final but crucial result of the new trade theory is the importance of rent-seeking in determining the costs of intervention. The "old" trade theory with competitive markets suggested that the welfare cost of a tariff or quota was just the foregone gains from trade. These "efficiency costs" are relatively small, compared with the total value of the welfare transfers to and from specific groups caused by trade restrictions.

With imperfect competition, the new trade theory suggests that more than just production efficiency is at stake: the possibility of obtaining protection will attract people to spend resources on influencing policy, possibly up to the point where the entire expected gain is diverted to rent-seeking. This possibility was first brought into the trade policy literature by Krueger (1974) under the term "rent-seeking", and subsequently formalized under the banner of "neoclassical political economy" (Collander 1984). This research shows clearly that firm government policies against intervention can discourage rent-seeking activity, and thereby make more resources available for other uses.

A.6 New Growth Theory and Endogenous Technical Change

Empirical tests of the trade theory consistently show the dominant role of resource endowments in determining trade patterns. But this "cold and mechanical" world, in which "neither Henry Ford nor Vladimir Lenin plays a role" (Leamer 1984, p. xvi), is less convincing in explaining economic growth over time.

The assumption of diminishing returns underlying neoclassical trade theory implies that rich countries will grow more slowly than poor ones, and that global economic growth rates will "converge" and eventually fall to zero as resources are exhausted. This view appears to be contradicted by the poor performance of many low-income countries, and the lack of any apparent slowdown in global growth. Such observations could be evidence of increasing returns, which enables national growth rates to diverge (as one country captures economies of scale in strategic activities), and enables growth to be self-sustaining (as new resources such as knowledge are "created" by private and government activity).

The growth implications of new trade theory became a field of its own in the 1980s, and was consolidated in a textbook by Grossman and Helpman (1991). Empirical tests show that government policies are indeed important in determining economic performance over time (e.g. Barro 1991, Edwards 1993). But this evidence consistently shows that growth is enhanced by more open trade policies, as the gains from specialization according to resource-based comparative advantage outweigh any gains from trying to "create" comparative advantage in other sectors.

The gains from following comparative advantage are strong even at the lowest levels of income, where open trade can lead to extremes of specialization, and at the highest levels of income, where economies become increasingly oriented to services and other nontradables (Ades and Glaeser 1994). In both cases, open trade appears to accelerate growth primarily by increasing the extent of the market, thus allowing greater specialization and economies of scale without increases in market power. This market development permits more efficient use of all of society's resources, as they change over time.

Each country's changing resource base includes not only aggregate levels of land, labor and capital, but also fine distinctions in the quality of each of these factors, and institutional resources such as contract enforcement and other regulations needed for competitive markets. These resources are often most cost-effective to produce in the public sector; providing such public goods is therefore a key mechanism by which governments can strengthen a country's competitiveness without the high cost of trade restrictions.

In sum, the dynamic new growth theory, like the comparative-static new trade theory, provides convincing evidence that deviations from the assumptions of "old" trade theory do not justify trade restrictions in pursuit of "created" comparative advantage. Instead, they point to ways in which increasing returns magnify the benefits of free trade and the appropriate provision of domestic public goods, thus permitting far larger gains from trade than are suggested by traditional theory.

A.7 Competitive Advantage and Corporate Strategy

At the same time as Krugman and his colleagues were developing the new trade theory in economics, Michael Porter and others were addressing similar issues in business-school terms. These languages often appear mutually contradictory--or mutually incomprehensible--but their differences and similarities bear some examination.

Porter begins his *Harvard Business Review* article on "The Competitive Advantage of Nations" with the provocative statement "National prosperity is created, not inherited. It does not grow out of a country's natural endowments, its labor pool, its interest rates or its currency's values, as classical economics insists" (1990a, p. 73). He structures much of his writing as an argument against economic theory, arguing that "we need a new perspective and new tools--an approach to competitiveness that grows directly out of an analysis of internationally successful industries, without regard to traditional ideology or current intellectual fashion. We need to know, very simply, what works and why." (1990a, p. 74).

Much of the conflict between the economics and business-school approaches can be traced to a difference of perspective: business school research originates in the point of view of an individual firm, whereas economics research studies entire economies. In the 1980s many observers saw U.S. trade performance as analogous to the rise and decline of individual U.S. companies, believing there to be a "head to head" contest between the U.S. and other countries for global market share (Thurow 1992). In this view it appears appropriate for the U.S. government to help those companies which are battling foreign competitors. But such a perspective overlooks the interests of other industries and of consumers in general, who in fact would be hurt by such assistance.

One key difference between countries and companies is that nations are populated by consumers, who benefit from imports and are hurt by exports. In Paul Krugman's memorable terms, "the need to export is a burden that a country must bear because its import suppliers are crass enough to demand payment" (1993a, p. 24). Another key difference is that the resources employed by any one firm have alternative uses--so that devoting resources to any one industry reduces production elsewhere. Again in Krugman's terms, "the government cannot favor one industry except at the expense of others" (1993a, p. 26). Thus the "competitive advantage" argument boils down to *which* groups will be favored, with the most visible or politically influential producers typically being supported, against the broad mass of consumers and other producers.

Avinash Dixit, a prominent new trade theorist who favors free trade, argues that the competitive-advantage argument in favor of intervention echoes the principles of nineteenth century mercantilists, for whom national welfare and the profits of prominent trading houses were one and the same thing. Dixit argues that an enduring obligation of economists is "to ask whether the policies of the new mercantilists serve the general interest, or whether John Stuart Mill's verdict on the old mercantilists-- 'when they say country, read aristocracy, and you will never be far from the truth'--still holds" (Dixit 1986, p. 283, citing Mill 1873).

Michael Porter's work on competitive advantage, although often using the language of mercantilism, actually converges on the basic principles of economic comparative advantage: the engine of growth is increased productivity, and open trade is needed to help raise productivity and increase competition. Unlike the mercantilists, he specifically rules out trade restrictions and export subsidies which, he writes, simply "guarantees a market for inefficient companies." (Porter 1990a, p. 88).

Porter's list of desirable government policies focuses on investment in education, infrastructure and research (which Porter calls "factor creation"); enforcement of grades and standards for product performance, safety, and environmental impact (which Porter describes as signalling key "consumer and social demands"); anti-trust regulations to promote competition, and tax preferences for investment over consumption (Porter 1990a, pp. 86-88). This is virtually identical to the archetypical list of public goods from any economics textbook; Porter omits some key policies such as patent law and contract enforcement which are common failings of LDC governments, but includes nothing that most contemporary academic economists would not agree is appropriate policy--and nothing that can be said to advocate going "against" comparative advantage, or attempting to "create" competitiveness in industries for which one has no comparative advantage.

Porterian competitiveness, like the "new" trade theory, sets out to investigate the exceptions to resource-based comparative advantage, and finds it to be remarkably robust--producing policy conclusions that would be unsurprising to Smith, Ricardo, Mill and the other classical founders of modern neoclassical economics. But the new work in business schools and trade theory provides far broader ground for these policy conclusions than was previously available. Only a decade ago, Edward Leamer could write, correctly, that "the present state of economic theory does not allow us to articulate fully and precisely even simple alternative models of trade" (1984, p. 45). By the early 1990s there were literally dozens of testable propositions in the new trade theory, as well as extensive work in the business-school tradition exemplified by Michael Porter. While many controversies remain, the broad thrust of this work is to reinforce the fundamental concepts of comparative advantage: that public policy should focus on public goods and leave trade unrestricted, while international trade guided by comparative costs is a key mechanism for increasing productivity and raising living standards around the world.

APPENDIX B

TESTING THE ACCURACY OF ALTERNATIVE MEASURES

In this appendix, the relationship between various comparative-advantage indicators and economy-wide social welfare is derived in a fully-specified economic model. We begin with a graphical exposition of the relationship between comparative advantage and the tariff-equivalent incidence of policies and market failures, in the market for any given product. Then, we use a broader model to show that, when aggregating the effects of divergences in inputs as well as outputs, only the social cost-benefit ratio provides activity rankings that correspond to maximizing social welfare. Other methods, most notably the domestic resource cost (DRC) ratio, provide consistently biased rankings.

B.1 Graphical Analysis of Tariff-Equivalent Measures

Our analysis can begin with the need for tariff-equivalent measures, to determine the monetary value of taxes, quantitative restrictions and market regulations imposed on a given product. A fundamental principle of comparative advantage measurement is that activities which are more heavily "taxed", or which generate larger transfers to the rest of the economy, have a greater underlying comparative advantage.

The circumstances under which the nominal protection coefficient (NPC) is an accurate measure of comparative advantage can be examined graphically, in familiar diagrams. Figure 1 presents the standard neoclassical general-equilibrium model of an economy that can produce and consume two different goods, both of which can also be traded internationally.

The diagram captures many of the standard assumptions of neoclassical economics: the "production possibilities frontier" (PPF) is bowed out to reflect diminishing marginal returns in production, while the "indifference curve" (IC) is bowed in to reflect diminishing marginal rates of substitution in consumption. The position and shape of the PPF are determined by the resources and technology available for production; the shape of the IC is determined by consumers' preferences, but its position is (as we shall see) "endogenous" to the economy: higher ICs, with production and consumption of both goods, would be preferable--but the highest-possible IC depends on economic conditions and government policies.

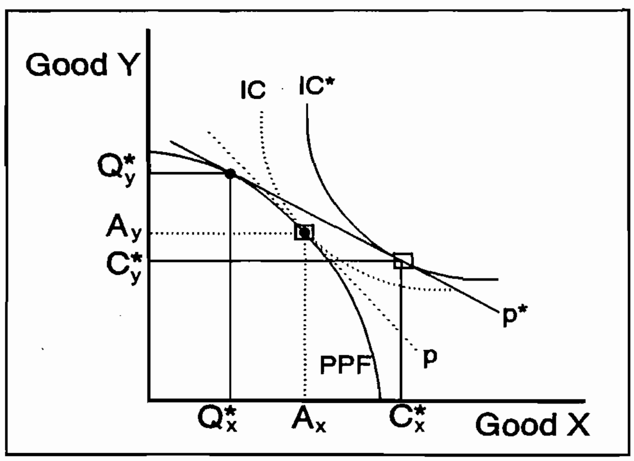

Figure 1. Comparative Advantage in a General Equilibrium Model

If no trade is possible, there is a single "autarky" level of production and consumption of the two goods, Ax and Ay, which is optimal in the sense that it allows consumers to reach their highest-possible indifference curve. This autarky equilibrium point (Ax, Ay) is associated with tangency of the PPF and the IC at some specific slope, or relative price ratio (p = Px/Py). Samuelson (1962) used such a diagram to show that, if a trading partner is found to exchange X for Y at a ratio that is lower than p, or Y for X at a ratio higher than p, then doing always allows the economy to reach a higher level of consumption--as long as the neoclassical assumptions which determine the shapes of the PPF and the IC continue to hold.

In Figure 1, the foreign price ratio (p^*=Px*/Py*) is shown lower (flatter) than p; in this case the country has a comparative advantage in Y, so that exporting Y and importing X allows more of both goods to be consumed. The highest-possible level of consumption (along IC*) requires moving along the PPF, increasing production of Y (from Ay to Qy*) and cutting back on X (from Ax to Qx*). Changing the production mix is always necessary to capture gains from trade, as long as the PPF is concave (i.e. there are diminishing returns in production). In this particular diagram, the shift from IC to IC* also implies changing consumption patterns, reducing consumption of Y (from Ay to Cy*) and increasing consumption of X (from Ax to Cx*)--but consumption adjustments depend on how the ICs shift (i.e. the two goods' income elasticities of demand) relative to their curvature (i.e. their compensated price elasticity of substitution).

Figure 1 demonstrates clearly that the exploitation of comparative advantage requires adjustment; there are no gains from trade for countries that are not responsive to foreign market conditions. Figure 1 also shows that in a hypothetical economy with only two goods, any unexploited comparative advantage can indeed be measured by the NPC as long as the neoclassical assumptions hold.[2] As long as the PPF is concave and the ICs are convex, the NPC does provide a consistent ordinal "ranking" of protection levels, although the cardinal "level" of protection conferred by a given NPC depends strongly on the shapes of the PPF and the ICs.[3]

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[2]. To demonstrate this, note that in the extreme case of a complete ban on trade, the observed domestic market price would be p while the observed foreign price ratio would be p^*. Expressing prices in terms of good Y (which might be, for example, a composite of all tradable goods other than X), $p > p^*$ which implies Px > Px* and NPC > 1. In this sense good X would be "protected", and the country's consumers would be better off if less of it were produced. The NPC measure is equally valid for intermediate levels of protection. Higher NPCs unambiguously correspond to higher levels of protection, in the sense of a higher level of production of X, a lower level of production of Y, and a lower indifference curve.

[3]. In cases where the neoclassical assumptions are violated, the NPC might or might not remain an accurate measure relative to the complete model. For example, if the producers of X could exercise market power in the domestic economy, the observed domestic price ratio would be above p--and conceivably even above p^*--so the NPC would give a completely wrong result. Similarly, if production of X yielded a positive externality, the observed domestic price ratio would be below p, leading to an error in the opposite direction. These are the precisely

For real-life economies with more than two goods, Figure 1 is not a very useful model. Most analysts prefer to work with a model like that of Figure 2, which tells much the same story as Figure 1 but focuses entirely on the market for good X only. If good X represents a small part of the whole economy, Figure 2 is generally drawn as a *ceteris paribus* "partial-equilibrium" model, holding constant the price and production level of all other goods. But if good X represents a large part of the total economy, it could also be as a *mutatis mutandis* "general-equilibrium" model like Figure 1, with changes in X occurring in part through changes in good Y or other goods. In either case, Figure 2 captures the main assumptions of neoclassical models through an upward-sloping supply curve which represents diminishing marginal returns in production, and a downward-sloping demand curve which represents diminishing marginal rates of substitution.[4] In this model, the position of the indifference curve is represented by "economic surplus", or the area between the supply and demand curves.

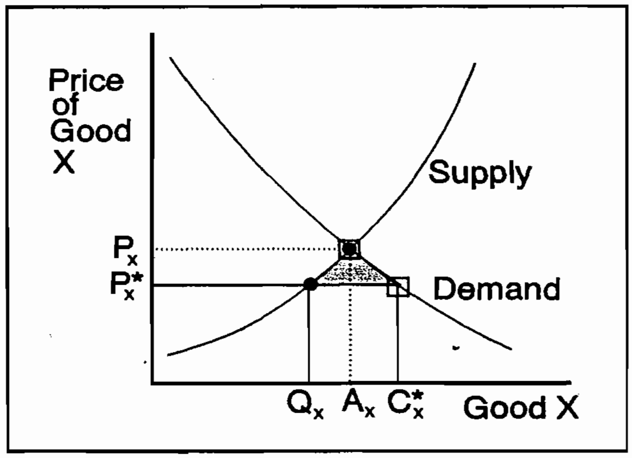

Figure 2. Comparative Advantage in a Partial-Equilibrium Model

If no trade is possible, the autarky equilibrium price (Ax) and quantity (Ax) is that which maximizes total economic surplus, corresponding to the highest-possible indifference curve in a general-equilibrium model. If trade is possible at any price other than Px, adjusting to that price unambiguously raises total economic surplus. But using this diagram instead of Figure 1 permits us to distinguish among participants in the market for good X. Each participant's economic surplus is the area between their own supply or demand curve and the price line. In the example shown, the foreign price (Px*) is smaller than the autarky price (Px), as it was in Figure 1. Adjusting to this price by increasing consumption (to Cx*) and reducing production (to Qx*) reduces producer surplus but raises consumer surplus even more; the net gain from trade is the shaded area, expressed in terms of money units.

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the sorts of cases that have been extensively investigated in the new trade theory, discussed in Section 2.5 above.

4. Since the demand curve is also influenced by income, even with neoclassical assumptions there could exist "Giffen" goods with upward sloping demand curves. This is very rare: the classic example is potatoes among the very poor of Ireland in the 19th century. For an item's demand curve to slope upward, it must be a highly "inferior" good (so that higher incomes reduce the absolute level of consumption) which accounts for a large share of expenditure but has few substitutes. Upward sloping demand curves could also arise in non-neoclassical situations, as when consumers cannot observe a good's quality, and therefore use its price as a signal of value.

As with Figure 1, this model shows that the extent of trade restriction caused by some policy or market failure can indeed be measured by the NPC (Px/Px*), but again only in an ordinal sense: a higher NPC implies greater adjustment in quantities and greater change in economic surplus, but increasing the NPC from 1.0 to 1.1 and then from 1.1 to 1.2 may have very different economic impacts. And as before, this general result is a function only of the slopes of supply and demand, so that any argument "against" comparative advantage must assume the contrary.

B.2 Model Structure and Notation

To add up the impacts of many different market and policy failures, it is necessary to move beyond the two-dimensional world of Figures 1 and 2, into the measures of effective protection and the many other indicators presented in Chapter 3 of the text. But that discussion emphasizes that it is important to maintain the tariff-equivalent concept, and that measures such as the producer subsidy equivalent (PSE) or the domestic resource cost (DRC) ratio which are not tariff-equivalents will produce biased measures. The discussion concludes that the broadest possible tariff-equivalent measure is the "subsidy ratio to producers" (SRP), which is very similar measure to the "social cost-benefit" (SCB) ratio. On those grounds the SRP/SCB is proposed as a "unified" measure of policy effects and comparative advantage. In this appendix we test the accuracy of alternative measures more formally, relative to a general model of economic welfare.

We begin by specifying a general accounting framework to describe an economy and measure welfare. In this framework, we classify all goods in one of three categories: exports or imports, whose prices are denominated in foreign currency, or nontraded goods, whose prices are denominated in local currency. This structure follows the "Australian model" approach of Salter, Swan, Corden and others, and is widely used in trade policy analysis. In our notation, imports and nontraded goods will be treated as inputs into the production of exports, so that the quantity of import goods used in production has a positive sign, as does the quantity of export goods produced. But for this paper, all quantities can be negative as well as positive, and we do not need to restrict the number of goods in each category. Thus any particular item (e.g. rice, fuel oil, or skilled labor) could be included in all three categories and can be produced or consumed, so the model's structure permits complete generality.

The notation labels exports, imports and nontraded goods by subscripts e, i and n respectively, and the total number of goods in each category is E, I and N respectively. The individual goods within the sets of exports, imports and nontraded goods are denoted by superscripts k, m and p respectively. The decision-makers, who may be in the private or public sector, choose levels of quantities consumed (denoted c) and produced or used in production (q) for all three types of goods, and levels of exports (x) and imports (m) for traded goods. Prices (p) for all traded goods are, for the purposes of evaluating alternative comparative advantage indicators, considered predetermined. The decision-maker is a "price-taker", which is a conventional assumption in project appraisal corresponding to the case of "small" projects which do not alter national or international prices.

In this notation the full set of quantities *consumed* of all goods is:

$$\{c_e^k,\ c_i^m,\ c_n^p\},\quad where\ k\in\{1,...,E\},\ m\in\{1,...,I\},\ \ and\ \ p\in\{1,...,N\}$$

and the corresponding vector notation is:

$$c_e = [c_e^1\ ...\ c_e^E],\quad c_i = [c_i^1\ ...\ c_i^I],\quad c_n = [c_n^1\ ...\ c_n^N].$$

A similar notation applies for production and input use (q), exports (x) and imports (m).

Using this accounting framework, the policy maker's economy-wide optimization problem is to ensure that quantities of all goods maximize social welfare, or "utility" (U) -- however that may be defined -- subject to two fundamental resource balances:

Maximize $\quad U(c_e,\ c_i,\ c_n)$

Subject to (1) $\quad p_e \cdot x_e - p_i \cdot m_i + T = 0$

(2) $\quad c_n + q_n - w_n \leq 0$

Since the form and parameters of the policy maker's economy-wide social welfare function (U) are not known (and may be changing rapidly over time), we need to look to general properties of the optimum of *any* function to provide a benchmark against which to assess the accuracy of alternative measures. These optimality conditions depend on the constraints as much as on (U) itself; to maintain the greatest possible degree of generality, we use the lightest possible restrictions needed to maintain accounting consistency, or a balance between each good's use and availability. A standard result of Australian-type trade models is that only two fundamental constraints are needed:

Equation (1) specifies "external balance", or balance-of-payments accounting, where
p_e, x_e are the vectors of export prices and quantities respectively;
p_i, m_i are the vectors of import prices and quantities respectively; and
T is the total financial transfer (capital flows, foreign aid, remittances, changes in reserves etc.), which permits an imbalance between exports and imports. In this single-period model, T is predetermined by past policies and conditions.

Equation (2) specifies "internal balance", or domestic market clearing, where
c_n is the vector of consumption of nontraded goods;
q_n is the vector of use in production of nontraded goods; and
w_n is the vector of endowments of nontraded goods, which again is predetermined by past policies and conditions, since this model includes only one time period.

To reduce the number of choice variables, we can impose two additional market-clearing conditions:

(3) $x_e = q_e - c_e$, exports equal production minus local consumption; and

(4) $m_i = q_i + c_i$, imports equal use in production plus local consumption;

and use these to rewrite the balance-of-payments constraint (1) as follows:

(1') $p_e \cdot (q_e - c_e) - p_i \cdot (q_i + c_i) + T = 0$

To reduce choice variables even further, we can impose a production possibilities frontier to reflect what is technically possible to produce:

(5) $q_e = f(q_i, q_n)$, production of export goods is a function of the use of import and nontraded goods in production,

and use equation (5) to rewrite the first constraint (1') in terms of input choices only:

(1") $p_e \cdot f(q_i, q_n) - p_e \cdot c_e - p_i \cdot q_i - p_i \cdot c_i + T = 0$

Thus the problem simplifies to the choice of consumption and input levels so as to maximize the following Langrangian expression, following the Kuhn-Tucker conditions for constrained optimization:

$$\mathcal{L} = U(c_e, c_i, c_n) - \lambda[p_e \cdot f(q_i, q_n) - p_e \cdot c_e - p_i \cdot q_i - p_i \cdot c_i + T] + p_n[c_n + q_n - w]$$

In this formulation the Lagrangian multipliers, reflecting the shadow prices of limiting resources, correspond to the value of foreign exchange (λ) which relaxes the balance-of-payments constraint, and the vector of values corresponding to each nontradable good (p_n). Assuming that both the utility function (U) and the production function (f) obey standard restrictions (e.g. the functions are smooth and convex, or twice-differentiable with all first derivatives nonnegative and all second derivatives nonpositive), the general conditions for maximizing social welfare can be written as:

(i) $$\frac{\partial \mathcal{L}}{\partial c_e^k} = u_e^k + \lambda p_e^k = 0 \ , \quad \forall \ k = 1, \ldots , E$$

(ii) $$\frac{\partial \mathcal{L}}{\partial c_i^m} = u_i^m + \lambda p_i^m = 0 \ , \quad \forall \ m = 1, \ldots , I$$

(iii) $$\frac{\partial \mathcal{L}}{\partial c_n^p} = u_n^p + p_n^p = 0 \ , \quad \forall \ p = 1, \ldots, N$$

(iv) $$\frac{\partial \mathcal{L}}{\partial q_i^m} = -\lambda \ p_e \cdot \frac{\partial f}{\partial q_i^m} + \lambda p_i^m = 0 \ , \quad \forall \ m = 1, \ldots, I$$

(v) $$\frac{\partial \mathcal{L}}{\partial q_n^p} = -\lambda \ p_e \cdot \frac{\partial f}{\partial q_n^p} + p_n^p = 0 \ , \quad \forall \ p = 1, \ldots, N$$

The first three optimality conditions specify that each good's marginal utility in consumption equals its local-currency relative price, and the last two optimality conditions specify the same thing for each input's marginal value product. Note that the Lagrange multiplier associated with the balance-of-payments constraint remains associated with all traded goods' prices to convert them into local currency. This is the shadow price of foreign exchange, or the increase in welfare (measured in domestic currency) which would be permitted by an additional unit of foreign currency.

For production decisions, the relevant optimality conditions are (iv) and (v); combining them, we obtain the familiar rule that inputs' relative marginal value products should equal their relative prices:

(vi) $$\frac{\partial f / \partial q_i^m}{\partial f / \partial q_n^p} = \frac{\partial q_n^p}{\partial q_i^m} = \frac{\lambda p_i^m}{p_n^p}$$

Equation (vi) determines the relative intensity with which any two inputs are used, and corresponds to the use of an isoquant to show that optimal input intensity requires tangency between the isoquant and the lowest possible isocost (or relative price) line.

B.3 Using the Model to Assess Alternative Indicators

By comparing the performance of alternative indicators relative to the optimality condition given in equations (iv), (v) and (vi) above, we can determine whether the indicators are consistent with maximizing social welfare. The indicators are used to rank two or more alternative production activities, each of which uses some observed level of inputs (q_i, q_n) to produce an observed level of outputs (q_e). The indicator formula allows these quantities and their associated prices (p_i, p_n, p_e, λ) to be added up and compared across activities.

If all markets were fully competitive, the first theorem of welfare economics would hold and all observed activities would be at social-welfare optimizing levels. In this case the net gain from expansion would be equal across activities, and there would be little interest in activity rankings. But in real-life markets, socially desirable activities may be undertaken at insufficient levels to maximize welfare, while less desirable activities are sustained. Following the "theory of domestic divergences" of Corden, Bhagwati and others, these discrepancies between market outcomes and economic efficiency are associated with divergences between market prices and social opportunity costs, caused by some market failures and economically inefficient policies.

To the extent that analysts can measure social opportunity costs, we can use these "shadow prices" along with input and output quantities to assess whether an activity is "socially profitable" (i.e. adds to national welfare), and whether it is *more* socially profitable than some other activity. The question addressed in this paper is whether the DRC or alternative indicators provide such rankings accurately, relative to the benchmark provided by equations (iv), (v) and (vi) above. The paper is concerned exclusively with the *formulas* for each indicator, rather than the price and quantity *data* that may be used. We assume that the analyst has chosen the best-available data for all necessary prices and quantities, so that no better data are available.[5]

The three comparative advantage indicators to be evaluated here are net social profits (NSP), which is the preferred project-appraisal criterion; the domestic resource cost (DRC) ratio, which is the standard unit-free measure used in policy analysis; and the social cost-benefit (SCB) ratio, which is the alternative proposed in Masters and Winter-Nelson (1994). Other indicators could also be evaluated using this same framework.

Beginning with the NSP measure, we wish to know whether, out of any sample of two or more activities, the activity with the highest level of NSP also satisfies the optimality condition in equation (vi). We can proceed by identifying the first-order conditions associated with choosing the maximum-NSP activity. Defining NSP in domestic-currency terms, the unconstrained optimization problem is to choose the activity whose set of input uses (q_i, q_n) will:

Maximize $NSP = R - T - D = \lambda p_e \cdot f(q_i, q_n) - \lambda p_i \cdot q_i - p_n \cdot q_n$,

where *R*, *T* and *D* denote revenue, tradable input costs, and nontradable domestic factor costs respectively. The first-order conditions associated with the maximum-NSP activity would be:

[5]. Monke and Pearson (1989) discuss various rules of thumb for shadow pricing. In general, quantities of outputs and inputs (q_e, q_i, q_n) are estimated with sample surveys or expert opinion; shadow prices for tradables (p_i,p_e) are border prices in foreign currency; shadow prices for nontradables (p_n) are estimated market-clearing rates in domestic currency; and the shadow exchange rate (λ) between currencies is estimated using trade elasticities and/or various real exchange rate indexes.

(a) $$\frac{\partial NSP}{\partial q_i^m} = \lambda p_e \cdot \frac{\partial f}{\partial q_i^m} - \lambda p_i^m = 0 \; , \quad \forall \; m = 1, \ldots, I$$

(b) $$\frac{\partial NSP}{\partial q_n^p} = \lambda p_e \cdot \frac{\partial f}{\partial q_n^p} - \lambda p_n^p = 0 \; , \quad \forall \; p = 1, \ldots, N$$

As before, combining the two optimality conditions yields the familiar ratio:

(c) $$\frac{\partial f / \partial q_i^m}{\partial f / \partial q_n^p} = \frac{\partial q_n^p}{\partial q_i^m} = \frac{\lambda p_i^m}{p_n^p}$$

The equality of (c) and (vi) demonstrates that choosing the highest-NSP activity leads to selecting activities with the same input intensity as when maximizing social welfare. But NSPs cannot be used to determine output levels or the optimal size of an activity, since larger activities always lead to larger NSPs. Thus NSPs are only useful for comparing mutually exclusive activities, whose size is predetermined by some fixed factor such as a specific construction site. For cases in which enterprise size may vary, we need to use a unit-free ratio such as the DRC or SCB. These will permit us to compare activities with very different levels of output along a normalized scale.

To test whether the DRC is consistent with welfare-maximization, we proceed as we did for the NSP. In the case of the DRC, we wish to identify that activity whose input levels (q_i, q_n) will:

Minimize $$DRC = \frac{D}{R - T} = \frac{p_n \cdot q_n}{\lambda p_e \cdot f(q_i, q_n) - \lambda p_i \cdot q_i}$$

The associated optimization conditions are:

(a') $$\frac{\partial DRC}{\partial q_i^m} = \frac{-p_n \cdot q_n \lambda p_e \cdot \frac{\partial f}{\partial q_i^m} + p_n \cdot q_n \lambda p_i^m}{(R - T)^2}, \quad \forall \; m = 1, \ldots, I$$

(b') $$\frac{\partial DRC}{\partial q_n^p} = \frac{p_n^p \lambda p_e \cdot f(q_i, q_n) - p_n^p \lambda p_i \cdot q_i - p_n \cdot q_n \lambda p_m^p \frac{\partial f}{\partial q_m^p}}{(R - T)^2}, \quad \forall \; p = 1, \ldots, N$$

Combining the two equations yields:

(c')

$$\frac{\partial f/\partial q_i^m}{\partial f/\partial q_n^p} = \left(\frac{p_n \cdot q_n}{\lambda p_e \cdot f(q_i, q_n) - \lambda p_i \cdot q_i}\right)\left(\frac{\lambda p_i^m}{p_n^p}\right) = DRC\frac{\lambda p_i^m}{p_n^p}$$

Since (c') is not generally equivalent to (c), the DRC does not generally identify the same optimal activity as the NSP. In particular, for profitable activities DRCs are below unity, so the optimal activity's ratio of inputs' marginal products may be lower than their price ratio. This corresponds to a higher level of tradable input use than is consistent with global optimization. From any given sample of two or more activities, the one identified as optimal by the DRC may not in fact maximize welfare; it may use too much tradable inputs and too little nontradable factors.

We can readily demonstrate that this same bias is not present in the SCB, which does replicate the same optimality condition for relative input use as global optimization. When following the SCB, we are choosing the activity whose input levels (q_i, q_n) which will minimize:

$$SCB = \frac{(T + D)}{R} = \frac{\lambda p_i \cdot q_i + p_n \cdot q_n}{\lambda p_e \cdot f(q_i, q_n)}$$

For which the optimality conditions are:

(a")

$$\frac{\partial SCB}{\partial q_i^m} = \frac{\lambda p_i^m R - \lambda p_e \frac{\partial f}{\partial q_i^m}(T + D)}{R^2}, \quad \forall\, m = 1, \dots, I$$

(b")

$$\frac{\partial SCB}{\partial q_n^p} = \frac{p_n^p R - \lambda p_e \frac{\partial f}{\partial q_n^p}(T + D)}{R^2}, \quad \forall\, p = 1, \dots, N$$

which produce (c"), the same relative-price condition as (c') and (vi) above:

(c")

$$\frac{\partial f/\partial q_i^m}{\partial f/\partial q_n^p} = \frac{\partial q_n^p}{\partial q_i^m} = \frac{\lambda p_i^m}{p_n^p}$$

Clearly, the SCB is the only unit-free ratio to reproduce exactly the general optimality rankings indicated by equation (vi); since the only assumptions underlying (vi) are the general properties of neoclassical utility and production functions, the SCB is unambiguously preferable to the DRC for the purpose of ranking alternative activities under these broad conditions.

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