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THE POLICY ANALYSIS MATRIX IN AGRICULTURAL DEVELOPMENT

SECTION I. THE PRACTICE OF AGRICULTURAL POLICY ANALYSIS

How might those concerned with agricultural policy, as analysts or policy-makers, conveniently approach the issues and organize their research agendas? In particular, where does the policy analysis matrix fit into the process of thinking about and measuring the effects of agricultural policies? The purpose of this concluding chapter is to suggest answers to these two questions by summarizing the arguments already presented. Two sections review the analytical approach to policy analysis. The first describes policies as instruments to achieve particular objectives. The second identifies when government intervention can help an agricultural sector to run more efficiently and how an analyst can approach the problem of measuring the effectiveness of agricultural price policies. The scope of analysis is broadened in the third section to include macroeconomic policies, especially exchange rates, and linkages between those policies and agricultural price policies. The fourth section reintroduces the PAM approach as a way to implement this analytical process and as an empirical method for measuring the effects of policy. A good complement to the PAM approach, the construction of price policy graphs, is discussed briefly in the fifth section. A final section then returns explicitly to the use of budgets as a way to estimate PAMs and contrasts the strengths and limitations of this method with the use of estimated elasticities to measure efficiency, policy, and welfare effects.

Framework for Agricultural Policy Analysis

Governments are assumed to have broad objectives that they are trying to further through interventions in the agricultural sector. The three most common objectives are efficiency (the allocation of resources to effect maximal national output), income distribution (the allocation of the benefits of agricultural production to preferred groups or regions), and food security (the short-run stability of food prices at levels affordable to consumers, reflecting the adequacy of food supplies, and the long-run guarantee of adequate human nutrition). Government actions that can further all three objectives are likely to be taken. Typically, however, the promotion of one objective conflicts with one or both of the others. In that situation, policy-makers must trade off gains in one area with losses in the others. For example, small losses in efficiency might be tolerated if the action were believed to result in significant improvements in income distribution or food security. Policy-makers make these tradeoffs explicitly or implicitly by forming value judgments about the worth of different objectives.

The need to make tradeoffs arises because of constraints in the economic system. Three categories of constraints limit the ability of policy-makers to realize all that they would like from their agricultural sectors. Production is limited by supply constraints—the input requirements of production technologies (for farming and processing) and the costs and availability of inputs. The value of the commodities produced is constrained in part by the characteristics of domestic demand-levels and growth rates of populations and incomes, changes in tastes and preferences, and willingness to substitute various agricultural commodities. Domestic supply and demand constraints are moderated by world prices for agricultural outputs and inputs. Because world prices, the third constraint, determine the domestic prices of internationally tradable commodities when no policies intervene, price policies either increase, decrease, or stabilize domestic prices relative to the underlying world prices. For each agricultural system, therefore, the three categories of constraints can be depicted by a drawing of a supply curve, a demand curve, and the relevant world price line for the outputs (the cif import price for goods that are partly imported or the fob export price for exported commodities).
Policies are the instruments of action that governments employ to effect change. Three principal categories of policies are used to bring about change in agriculture. The first is agricultural price policy. Two main types of price policy instruments can be used to alter prices of agricultural outputs or inputs. Quotas, tariffs, or subsidies on imports and quotas, taxes, or subsidies on exports directly decrease or increase amounts traded internationally and thus raise or lower domestic prices; these policies apply only to volumes traded internationally, not to domestic production. Domestic taxes or subsidies, in contrast, create transfers between the government treasury and domestic producers or consumers. Some cause a divergence between domestic and world prices; others do not.

The second category of policies is nationwide in coverage. Macro-economic policy includes the central government's decisions to tax and spend (fiscal policy), to control the supply of money (monetary policy), and to impose macro price policies affecting the foreign-exchange rate (exchange-rate policy) and the domestic factors (wage, interest, and land rental rates). With the exception of land market policy, these decisions typically are not taken because of their impact on the agricultural sector. But macro policy effects, however unintended they might be, can more than offset the desired incentives of agricultural price policy.

In addition to price and macro policies, governments influence their agricultural sectors through public investment policy. Government budgetary resources can be invested in agriculture to increase productivity and reduce costs. The most common investments are in agricultural research to develop new technologies, in infrastructure (roads, irrigation, ports, marketing facilities), in specific agricultural projects to increase productive capacity and demonstrate new technologies, and in education and training of agriculturists to upgrade the human capital in the sector.

**Effectiveness of Price Policies**

The next step is to examine how the objectives-constraints-policies framework can be made operational. The analytical approach views policy-makers as enacting policies (price, macro, or investment) to further objectives (efficiency, distribution, or food security) in the face of economic constraints (supply, demand, and world prices). The main services policy analysis can provide to policy-makers are to distinguish whether a policy is likely to improve the efficient operation of the economy and thus raise the level of national income, to measure the expected magnitude of the efficiency gains or losses, and to quantify, when possible, the direction and extent of the policy's likely effects on the distributional and food security objectives. Even when the nonefficiency effects are difficult to measure, economic analysis can provide a reasonable estimate of the efficiency costs associated with the promotion of nonefficiency objectives.

The ways in which agricultural price policy can lead to efficient gains are limited to offsetting market failures, assisting agricultural infant industries, and stabilizing domestic prices. In developing economies, the most prevalent market failures usually are found in the factor markets, particularly for capital and occasionally for labor. These market failures are caused by insufficient development of institutions (such as financial intermediaries) and communication networks (so that information on jobs is not widespread). A second type of market failure is the existence of monopolies or monopsonies, where only one or a few (cooperating) sellers or buyers have the ability to manipulate market prices to their own advantage. Externalities (costs for which the person responsible cannot be charged or benefits that cannot be appropriated by the enterprise creating them) are a third source of market failures. Public goods are the principal source of externalities in developing countries. A public good is inadequately provided because not all of those benefiting from it can be charged for their use of it; governments thus invest in public infrastructure (roads, ports, large irrigation works), which would otherwise be inadequately supplied by private individuals.
The two other rationales for efficient intervention may also be viewed as responses to special kinds of market failures. One is to assist agricultural infant industries by correcting for dynamic market failures. The essence of the infant industry argument is that, over time, the existence of market failures (usually in the capital market or because of information bottlenecks) will cause insufficient investment and technical change and thus not permit the economy to benefit from dynamic learning effects. The presence of efficient operations in the future is not enough to justify policy that offsets the market failures; the efficiency cost to society of the inefficient use of resources in the early years must be compensated by larger efficiency gains in the later years.

The third rationale is to stabilize domestic agricultural prices (relative to unstable world prices) when insurance markets are absent. Governments perceive benefits from reducing price risks for producers, fending off consumer pressures, averting hunger if food crop prices rise, and avoiding adjustment costs for producers and consumers. Price stabilization requires public intervention in international trade and domestic marketing (transport and storage). If a public agency manages a buffer stock, the benefits from price stability may justify producer prices that are lower than average world prices and consumer prices that are higher than world prices. This margin should cover the costs of buffer stock management.

The circumstances for efficient intervention—offsetting of domestic market failures, assistance to infant industries, and stabilization of domestic prices—are potentially widespread. Analysts of efficient policy intervention look for the sources of market failure and assess the present and future benefits and costs of such policies. Even efficient intervention typically has costs as well as gains.

The analyst of nonefficiency objectives begins by measuring constraints and then considers the effects of policy on objectives. If full information is available on a single commodity, the analyst can summarize the supply constraints into a supply schedule and the demand constraints into a demand schedule and can draw a standard price-quantity diagram that will portray the situation before the policy is enacted.

If a policy to raise the price of a commodity—for example, a tariff on competing imports—is put into place, the analyst examines the hypothetical effects of the restrictive trade policy on government objectives. The tariff (tax on imports) raises the domestic price to producers and consumers and influences the quantities produced, consumed, and traded internationally. Facing a higher price, producers will increase output (because they can cover higher costs of production), consumers will cut back consumption (and shift to cheaper substitutes), and the country's demand for imports of the commodity will decline on both accounts. The impact on efficiency will be negative—producers will overproduce and consumers will underconsume relative to the world price—unless the higher domestic price serves to offset a market failure. The trade policy will redistribute income, causing transfers from consumers (who will consume less at the higher price) to producers (who will grow more at the higher price) and to the government treasury (which will receive the tariff revenue on remaining imports); the effect on distribution will depend on how well off the producers and consumers are without and with the policy. The influence of the policy on food security depends on the relative stability of the additional domestic output versus the imports it replaces.

This simplified example shows how a price policy can be analyzed in order to identify its effects on government objectives. In actual price policy analysis, the process is more complicated. The first step in choosing among policies is to investigate the feasibility of the policy instrument. The imposition of a tariff on imports of a commodity can be done readily if rampant smuggling can be prevented, whereas the distribution of subsidy payments to millions of small-scale farmers might not be feasible. The next step is to measure the administrative costs of implementing the feasible instruments—for example, the costs of hiring additional customs agents. Such costs should be added to any efficiency losses of the policy or subtracted from any gains. In this way, the analyst can incorporate policy feasibility and administrative costs.
Linkages between Macroeconomic and Agricultural Price Policies

The objectives-constraints-policies framework applies to macroeconomic policy as well as to price policy. Common macroeconomic objectives include rapid economic growth, a desirable distribution of national income, reasonably low unemployment, and moderate or low inflation. In addition to facing the sectoral constraints of supply, demand, and world prices, macronconomic planners are also confronted by a need to maintain an approximate balance in the national fiscal accounts (government revenues and expenditures) and in the foreign-exchange accounts (export earnings and foreign capital inflows versus import expenditures and foreign capital outflows). The macroeconomic policies available to further these objectives in light of such constraints include fiscal and monetary policies, budgetary policies, and macro price policies influencing the foreign-exchange rate, interest rate, wage rate, and land rental rate.

The direct effects of macroeconomic policy on agricultural systems are felt through the macro price policies, especially exchange-rate policy. Fiscal and monetary policies influence agricultural systems indirectly by the interest and exchange rates. Budgetary policy-decisions on allocating both the recurrent and the capital budgets of the national government-also have indirect effects on systems, because budgetary choices influence agricultural price policy (through the availability of recurrent funds for subsidies) and public investment policy for agriculture. The three kinds of macro price policies affecting factor prices can be important in individual factor markets, although little can be said about them in general.

Some useful general lessons can be drawn from the relationships among fiscal and monetary policy, inflation, and the exchange rate and those between the exchange rate and price policies. Inflation is caused principally by macroeconomic policy-decisions to run fiscal deficits financed by expansionary monetary policy-abetted by inflation abroad that causes the prices of imports and exports to rise. If the government chooses to have a fixed-exchange-rate regime, the exchange rate will be changed only through discrete policy decisions, not because of market forces. When governments create inflation and then choose not to depreciate the nominal value of their currencies (by changing the exchange rate so that more units of domestic currency are required for each unit of foreign currency), profits are squeezed in agricultural systems that produce tradable commodities. The real exchange rate becomes overvalued when the rate of depreciation is less than the rate of inflation. Overvaluation of the real exchange rate imposes an implicit tax on producers of tradables (by keeping the domestic currency prices of their outputs artificially low), forces farmers growing tradable food crops to pay implicit food subsidies that benefit consumers, and permits artificially cheap imported inputs. A policy creating inflation with fixed nominal exchange rates squeezes agricultural profits, transfers the burden of subsidizing food from the government treasury to farmers, and makes projects based on tradable inputs appear to be more profitable than they would be if the exchange rate were set appropriately.

This state of affairs can be corrected if a government chooses to change the exchange rate. Devaluations are often difficult actions to take politically, because their short-run effects usually benefit rural inhabitants who have limited political power and harm powerful urban interest groups. Some form of foreign-exchange rationing is inevitable when the real exchange rate is overvalued, and this rationing is most often achieved by quantitative restrictions on imports that compete with domestically produced manufactures. Politically powerful urban manufacturers and their employees then shift from being supporters of devaluation to being vocal opponents of it. The prices of their products are protected from the taxing effects of overvaluation by the import quota, and the overvalued exchange rate permits them to obtain tradable inputs at artificially low prices.

The Policy Analysis Matrix

A central theme of this book is that the PAM approach to agricultural policy analysis can provide decision-makers and analysts with both a helpful conceptual construct for understanding the effects of policy and a
useful technique for measuring the magnitudes of policy transfers. Because the accounting matrix is simultaneously a teaching tool and a way of undertaking and reporting empirical analysis, PAM results can be communicated easily to policy-makers, who might not be specialists in economics.

Three related questions can be addressed with the PAM approach. Ministries of agriculture are concerned with the competitiveness of their countries' principal farming systems; actual income received by farmers is thus the first issue examined with the PAM method. Ministries of economic planning focus on the growth and distribution of national income, and planning agencies of agricultural ministries want to maximize agricultural income; the efficient allocation of resources in agriculture (and elsewhere in the domestic economy) is therefore the second issue addressed by the PAM. Decision-makers throughout the government—including those acting on agricultural price policy, others concerned with macroeconomic policy, and yet others dealing with the allocation of public investment to the agricultural sector—want to be informed about the effects of policy and of market failures. Each policy analysis matrix is thus constructed to address these three central issues of agricultural policy—competitiveness, efficiency, and policy transfers.

For PAM analysis to be carried out, an accounting matrix is constructed for each representative agricultural commodity system. An agricultural commodity system consists of a farm technology for producing a commodity (or set of commodities) in a given agroclimatic zone, a way of moving the crop from the farm to a processing site, a technology for processing the crop into marketable products, and a way of transporting the products to wholesale markets. Because all farms differ somewhat from one another, some aggregation needs to be done so that the empirical analysis becomes manageable. The identification of representative agricultural systems reflects differing aggregate combinations of commodities produced, technologies used, and agroclimatic locations of production. A study of one staple food commodity in a country might identify few or many representative systems for that commodity, depending on the complexity of technologies and agroclimatic conditions.

Each matrix is a combination of two accounting identities, one defining the rows and the other the columns. The first identity is the profits identity: revenues less costs equal profits. The second identity is a definitional statement of efficiency, or social valuations of revenues, costs, or profits. Actual market, or private, valuations of these entries are observed by surveying analysts. These private observations can diverge from the underlying social valuations for one of two reasons. The first source of divergence between private and social valuations is the category of market failures—factor market imperfections, monopolies or monopsonies, and externalities, including public goods. Any of these failures of markets to work efficiently can cause inefficient pricing signals. The second and more widespread source of divergence is the existence of distorting government policies. As noted earlier, efficient policies offset market failures; all other policies distort the economy, moving it away from its most efficient allocation of inputs and outputs.

Distorting policies are not necessarily inappropriate; they can be justified if their efficiency losses are more than offset by gains from the furthering of nonefficiency objectives. The two sources of divergences—market failures and distorting policies—cause private prices to differ from social prices of revenues, costs, and profits. The definitional identity for each column of a PAM is therefore known as the "effects of divergences" identity: private prices less social prices equal the effects of divergences.

The empirical estimation of PAMs proceeds from these two identities. Two fundamental steps are involved in preparing the research inputs into a PAM. The first is building budgets in private prices for the representative systems. To complete this step, the analyst compiles existing information on farm management studies and verifies and completes the farm budget data through field surveys. The farm budgets are then complemented with postfarm budget data on transporting and processing. This private budget information
on revenues and costs is entered into the first row of PAM. Use of the profits identity allows calculation of private profits or competitiveness, the first research output of the PAM analysis.

The second step in building a PAM is to convert the entries for revenues and costs in private (actual market) prices into counterpart entries in social (efficiency) prices. The calculation of social prices is a combination of science, art, and guesswork, as all practitioners of social benefit-cost analysis are well aware. The approach followed in this book has been to explain fully why some dimensions of social valuations are extraordinarily complicated to handle empirically and then to suggest shortcuts that usually work well. The social valuations of outputs and inputs that would enter into international trade (in the absence of distorting trade policy) are given by their comparable world prices (cif import prices for importables and fob export prices for exportables). World prices, even if set in less than fully competitive international markets, provide a valuation standard of the choice the country has to use world markets or not. In the absence of distorting trade policy, the world prices determine the domestic prices of tradables and create efficient allocation.

Social valuation of inputs that do not enter into international trade is more difficult on both conceptual and empirical grounds. Most problematic are the social prices of the primary factors of production—labor, capital, and land. In principle, the observed, private factor prices have to be corrected for the distorting influences of divergences in output markets, market failures in factor markets, and distorting government policies in factor markets—in short, for all divergences in the economy. This practically impossible task is therefore roughly approximated with a series of rules of thumb meant to guide the analyst in careful observation of key factor markets and policies. The other kind of inputs that are nontradable internationally are some intermediate inputs into farming, marketing, and processing. The nontradable inputs, such as electrical power and truck transportation, are disaggregated into their component costs of tradable inputs and primary factors. These indirect costs are then added to the direct costs of tradables and factors used in the system. For this reason, each PAM has only two cost column categories—tradable inputs and primary domestic factors.

The second research output from PAM analysis, the calculation of social profits or efficiency, follows easily from application of the profits identity—once the analyst has found social valuations for revenues (the world prices of outputs), tradable input costs (their world prices), and factor costs (their social opportunity costs, or the amounts of national income forgone from their not having been used in their best alternative occupations). Positive social profit is a measure of efficiency, or comparative advantage, because the value of the goods produced by the agricultural system exceeds the costs of production after all causes of inefficiency-distorting policies and market failures have been (hypothetically) removed. Negative social profit indicates the opposite result; the country is wasting resources by allowing inefficient production, which occurs because of distorting policies (which might be serving other government objectives) or market failures (which the government is unable or unwilling to correct with efficient policy).

The third row of each PAM, which measures the effects of divergences, is determined by application of the second definitional identity: private prices less social prices equal the effects of divergences. Occasionally, an analyst has better information on a third row entry than on its second row counterpart; thus social valuation is an output of rather than an input into the analysis. Typically, however, the divergences are research outputs. The analyst’s job is not always completed at this point. Sometimes policy-makers need to have the effects of divergences broken down into those associated with market failures and those caused by particular policies. For the product markets (in which private prices of tradable outputs and inputs are determined), the analyst should try to identify market failures; if none are found, product market failures can be assumed to be nonexistent, unimportant, or unmeasurable. For the factor markets, the opposite expectation is held, and divergences that cannot be associated with distortions in the output or factor markets are assumed to be the result of factor market imperfections. The measured divergences or transfers for outputs
and tradable inputs will generally be the result of distorting policy, whereas those for factors will be caused by a combination of distorting policy and factor market imperfections.

The close linkages between exchange-rate policy and price policy are also observed readily in the PAM. When distorting policies cause private product prices to diverge from their social values under an appropriate exchange rate, all of the measured transfer in the third row of a PAM is caused by price policies. But when the exchange rate is over-valued, the social valuations of both tradable outputs and tradable inputs need to be adjusted to reflect the degree of overvaluation; for example, a 20 percent overvaluation would need to be corrected by a 20 percent increase in the amounts for social revenues, social input costs, and social profits. The third row would show exchange-rate policies taxing output revenues, subsidizing input costs, and taxing profits.

The construction of a PAM, therefore, normally entails the finding of information on private revenues, private tradable input costs, private factor costs, social revenues, social tradable input costs, and social factor costs. Application of the profits identity yields two research outputs-private profits (competitiveness) and social profits (efficiency). The four other research outputs-output transfers, tradable-input transfers, factor transfers, and net policy transfers-are found through use of the divergence identity. The net transfer-the difference between private and social profits or the combination of all three other kinds of transfers-results from the complete set of agricultural price and macroeconomic policies and market failures that influence the system.

Because the data for the PAM represent a chosen base year, the results are static and potentially applicable to only that year. Projections of changing future world prices, technologies, and factor prices can be made to simulate paths of dynamic comparative advantage, as social profits change in response to varying parameters. Investment policy analysis can be assisted by the construction of baseline PAMs, identifying social profits before any public investment, and by analyses of dynamic comparative advantage with and without the prospective investment. The PAM approach can thus be used to illuminate baseline conditions and then to measure the effects of changing price, macroeconomic, or investment policies on the private and social profits of agricultural systems in the base year or in the future as key parameters change.

**Price Policy Graphs**

A set of PAMs for the country's principal representative agricultural systems provides analysts and policymakers with informative pictures of the existing structure of policies affecting agriculture and with a useful analytic tool for investigating the effects of future policy change. However, in most countries, there is no information base to permit construction of historical PAMs that would show changes every two or three years as trends in world or factor prices and technologies changed. Budget data might be available at best for a few systems during scattered years. But informed policy analysis requires an understanding of the recent history of policy changes as well as the detailed array of profitabilities in a given base year. This need can be met at least partially by the construction of price policy graphs.

A price policy graph is a device to permit easy visual comparisons of year-to-year movements in three price series-world prices (cif import or fob export, adjusted to a domestic wholesale market level), domestic market prices (at both the wholesale and farm levels), and domestic policy prices (guaranteed floor prices to producers and announced ceiling prices to consumers). Price policy graphs, based on annual data for fifteen to twenty years in the recent past, can be constructed for the principal agricultural commodities produced and for the main tradable inputs into agriculture. They allow a quick visual review of the pattern of price levels and price stability. If historic price policy graphs are continuously updated, they can serve as particularly useful complements to PAMs in the presentation of policy analysis.
Concluding Comments

Several practical lessons for practitioners emerge from this study of agricultural policy analysis. Approaches to issues and the policy agenda can be organized within the objectives-constraints-policies framework, and diagrammatic analysis can be used to identify the general direction of policy effects. Historical perspective can be provided through a compilation of price policy graphs for the most important agricultural products and inputs. Much insight is gained from using the PAM approach to the quantitative analysis of agricultural systems. The construction of PAMs, complemented by historical price graphs, provides essential baseline information for the analysis of agricultural policy.

The standard approach to agricultural policy analysis relies on estimated elasticities of supply and demand. When policies raise or lower market prices, use of the elasticities permits the analyst to quantify changes in amounts produced and consumed; income transfers among producers, consumers, and the government treasury; and efficiency losses or gains. The PAM calculations usually are based on budget data, not elasticities. A strength of the PAM method is the disaggregation of supply in terms of technology and agroclimatic zone. Such disaggregation permits a detailed understanding of constraints on systems and provides a basis for the analysis of investment and technological change influencing the dynamic comparative advantage of agricultural systems. The principal weakness of the PAM approach is that empirical applications may not correctly specify all the marginal adjustments to alterations in output and input prices. Without sufficient information (such as elasticities of output supply and input demand), exact PAMs cannot be constructed, and approximations must be made. Unless this is done, the empirical researcher will be left with nothing more than a numberless diagram, little understanding of how the many divergences affecting agricultural systems offset one another, and no input into the policy-making process. Budget-based PAMs fill this gap in agricultural policy analysis.

SECTION II. INTRODUCTION TO THE POLICY ANALYSIS MATRIX

This chapter explains the construction of the policy analysis matrix and the derivation of measures of efficiency and policy transfer used in agricultural policy analysis. The study of agricultural policy spans three levels-microeconomic behavior of producers, marketing and trade, and macroeconomic linkages. Practitioners of agricultural economics typically give different emphasis to these three topics; micro production issues receive the greatest attention, marketing and trade get less, and macroeconomic links receive little or no coverage. This book argues that excessive specialization precludes successful policy analysis; applied agricultural economists need to understand all of the components of and links among farming systems, domestic and international markets, and macroeconomic policy. Policy analysts have to appreciate feedbacks and tradeoffs within the big picture.

The PAM approach is a system of double-entry bookkeeping. Analysts using PAM have to provide complete and consistent coverage to all policy influences on returns and costs of agricultural production. With this method, applied economists need to be equally capable of analyzing, for example, fertilizer response functions, quantitative restrictions on trade, and real effective exchange rates. The main empirical task is to construct accounting matrices of revenues, costs, and profits. A PAM is constructed for the study of each selected agricultural system-using data on farming, farm-to-processor marketing, processing, and processor-to-wholesaler marketing. The impact of commodity and macroeconomic policies can then be gauged by comparison with the absence of policy.
Practical Issues Addressed

Three principal issues-the impact of policy on competitiveness and farm-level profits, the influence of investment policy on economic efficiency and comparative advantage, and the effects of agricultural research policy on changing technologies-can be investigated with the PAM approach. The results can be used to identify what kinds of farmers-categorized by the commodities they grow, the technologies they use, and the agroclimatic zones in which their farms are located are competitive under current policies affecting crop and input prices and how their profits change as the policies are altered. This issue of farm policy-how agricultural prices affect farming profits-is of primary importance to ministries of agriculture. In the PAM approach, farm budget data (sales revenues and input costs) are collected for the principal, agricultural systems. The determination of profit actually received by farmers is a straightforward and important initial result of the analysis. It shows which farmers are currently competitive and how their profits might change if price policies were changed.

A second issue concerns the economic efficiency (or comparative advantage) of agricultural systems and how additional public investment might change the current pattern of efficiency. In what commodity production systems, defined by technology and agroclimatic zone, does the country currently exhibit strong or weak comparative advantage, and how might new investments, using government revenues or foreign aid funds, improve this picture? Investment policy is of primary interest to economic planners who allocate capital budgets, including foreign aid, in attempts to increase efficiency and speed the growth of national income.

With the PAM method, the analyst reassesses the revenues, costs, and profits indicated in farm-level and marketing budgets. Efficiency valuations of outputs and inputs are meant to lead to the highest possible levels of national income. The difference between revenues and costs for a system-both valued in social prices-is social profits, a measure of economic efficiency. New investments that reduce social costs also increase social profits and improve efficiency. An understanding of the array of social profitabilities of agricultural systems greatly reduces the number of detailed benefit-cost analyses needed to evaluate investment alternatives.

A third and closely related set of issues is how best to allocate funds for agricultural research. How can economic analysis be used to help determine the most fruitful directions for primary and applied research to raise crop yields and reduce social costs, thereby increasing social profits? This question is faced by decision-makers in the international agricultural research centers, in several international organizations, and in the agricultural research establishments of certain countries. It is a question also asked by central planners who make allocations to agricultural research budgets.

The approach used in PAM analysis begins with the calculation of existing levels of private (actual market) and social (efficiency) revenues, costs, and profits. This calculation reveals the extent to which actual profits are generated by policy transfers rather than by underlying economic efficiency. Next, agricultural scientists need to project changes in yields and inputs resulting from alternative research programs. The effectiveness of such changes can then be gauged by an examination of how they alter private and social profits of current technologies.

The Policy Analysis Matrix

The policy analysis matrix is a product of two accounting identities, one defining profitability as the difference between revenues and costs and the other measuring the effects of divergences (distorting policies...
and market failures) as the difference between observed parameters and parameters that would exist if the divergences were removed. By filling in the elements of the PAM for an agricultural system, an analyst can measure both the extent of transfers occasioned by the set of policies acting on the system and the inherent economic efficiency of the system.

Profits are defined as the difference between total (or per unit) sales revenues and costs of production. This definition generates the first identity of the accounting matrix. In the PAM, profitability is measured horizontally, across the columns of the matrix, as demonstrated in Table 2.1. Profits, shown in the right-hand column, are found by the subtraction of costs, given in the two middle columns, from revenues, indicated in the left-hand column. Each of the column entries is thus a component of the profits identity—revenues less costs equals profits.

Each PAM contains two cost columns, one for tradable inputs and the other for domestic factors. Intermediate inputs—including fertilizer, pesticides, purchased seeds, compound feeds, electricity, transportation, and fuel—are divided into their tradable-input and domestic factor components. This process of disaggregation of intermediate goods or services separates intermediate costs into four categories—tradable inputs, domestic factors, transfers (taxes or subsidies that are set aside in social evaluations), and nontradable inputs (which themselves have to be further disaggregated so that ultimately all component costs are classified as tradable inputs, domestic factors, or transfers).

An example illustrates the process of disaggregating intermediate goods or services. Fertilizer is for most countries a tradable intermediate input. If a particular country is a net importer of fertilizer, the social valuation of a specific kind of fertilizer for its agricultural system is given by the cif (costs, insurance, freight) import price for that fertilizer plus the social costs of moving the input to the representative location in the system. Finding the import price is usually straightforward. Finding the social valuation of the domestic

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<th>Table 2.1: Policy Analysis Matrix</th>
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<td>Revenues</td>
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<td>Tradable Inputs</td>
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<td>Private Prices</td>
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<td>Social Prices</td>
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<td>Divergences</td>
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Table Notes:

Private profits, D, equal A minus B minus C. Social profits, H, equal E minus F minus G. Output transfers, I, equal A minus E. Input transfers, J, equal B minus F. Factor transfers, K, equal C minus G. Net transfers, L, equal D minus H; they also equal I minus J minus K.

Ratio Indicators for Comparison of Unlike Outputs:


in social evaluations, and nontradable inputs (which themselves have to be further disaggregated so that ultimately all component costs are classified as tradable inputs, domestic factors, or transfers).
marketing costs is another story, however. It is necessary to study the transportation industry-road or rail-and disaggregate the costs into labor, capital, fuel, and so forth. Each type of cost then needs to be further broken down through use of an appropriate world price and an estimate of local transportation costs.

**Private Profitability**

The data entered in the first row of Table 2.1 provide a measure of private profitability. The term private refers to observed revenues and costs reflecting actual market prices received or paid by farmers, merchants, or processors in the agricultural system. The private, or actual, market prices thus incorporate the underlying economic costs and valuations plus the effects of all policies and market failures. In Table 2.1, private profits, D, are the difference between revenues (A) and costs (B + C); and all four entries in the top row are measured in observed prices. The calculation begins with the construction of separate budgets for farming, marketing, and processing. The components of these budgets are usually entered in PAM as local currency per physical unit, although the analysis can also be carried out using a foreign currency per unit.

The private profitability calculations show the competitiveness of the agricultural system, given current technologies, output values, input costs, and policy transfers. The cost of capital, defined as the pretax return that owners of capital require to maintain their investment in the system, is included in domestic costs (C); hence, profits (D) are excess profits-above-normal returns to operators of the activity. If private profits are negative (D < 0), operators are earning a subnormal rate of return and thus can be expected to exit from this activity unless something changes to increase profits to at least a normal level (D = 0). Alternatively, positive private profits (D > 0) are an indication of supernormal returns and should lead to future expansion of the system, unless the farming area can not be expanded or substitute crops are more privately profitable.

**Social Profitability**

The second row of the accounting matrix utilizes social prices, as indicated in Table 2.1. These valuations measure comparative advantage or efficiency in the agricultural commodity system. Efficient outcomes are achieved when an economy's resources are used in activities that create the highest levels of output and income. Social profits, H, are an efficiency measure because outputs, E, and inputs, F + G, are valued in prices that reflect scarcity values or social opportunity costs. Social profits, like the private analogue, are the difference between revenues and costs, all measured in social prices-H = (E - F - G).

For outputs (E) and inputs (F) that are traded internationally, the appropriate social valuations are given by world prices-cif import prices for goods or services that are imported or fob export prices for exportables. World prices represent the government's choice to permit consumers and producers to import, export, or produce goods or services domestically; the social value of additional domestic output is thus the foreign exchange saved by reducing imports or earned by expanding exports (for each unit of production, the cif import or fob export price). Because of global output fluctuations or distorting policies abroad, the appropriate world prices might not be those that prevail during the base year chosen for the study. Instead, expected long-run values serve as social valuations for tradable outputs and inputs.

The services provided by domestic factors of production-labor, capital, and land-do not have world prices because the markets for these services are considered to be domestic. The social valuation of each factor service is found by estimation of the net income forgone because the factor is not employed in its best alternative use. This approach requires the commodity systems under analysis to be excluded from social factor price determination. For example, if land is planted to wheat, it cannot grow barley during the identical crop season; the social opportunity cost of the land for the wheat system is thus the net income lost
because the land cannot produce barley. Similarly, the labor and capital used to produce wheat cannot simultaneously provide services elsewhere in agriculture or in other sectors of the economy. Their social opportunity costs are measured by the net income given up because alternative activities are deprived of the labor and capital services applied to wheat production.

The practice of social valuation of domestic factors begins with a distinction between mobile and fixed factors of production. Mobile factors, usually capital and labor, are factors that can move from agriculture to other sectors of the economy, such as industry, services, and energy. For mobile factors, prices are determined by aggregate supply and demand forces. Because alternative uses for these factors are available throughout the economy, the social values of capital and labor are determined at a national level, not solely within the agricultural sector. Actual wage rates for labor and rates of return to capital investment are therefore affected by a host of policies, some of which may distort factor prices directly. An enforced and binding minimum-wage law, for example, raises the market wage above what it would have been in the absence of policy and causes observed wages to be higher than the social opportunity cost of labor. But indirect effects can also be important. Distortions of output prices cause different activities to expand or contract, altering in turn the demand and prices of mobile domestic factors.

Fixed, or immobile, factors of production are the factors whose private or social opportunity costs are determined within a particular sector of the economy. The value of agricultural land, for example, is usually determined only by the land's worth in growing alternative crops. Because land is immobile, its value is not directly affected by events in the industrial and service sectors of the economy. But the social opportunity cost of farmland is sometimes difficult to estimate. Within any agroclimatic zone, complete specialization in the most profitable crop is rarely observed. Instead, farmers prefer rotations or intercropping systems that reduce risks of income losses from price variability, yield losses, and pest and disease infestation. Therefore, the social opportunity cost of the land is not accurately approximated by the net profitabilities of a single best alternative crop; instead, it is measured by some weighted average of the social profits accruing from the set of crops planted. Because the correct weights and social profits associated with each crop in the set are generally not known, it is convenient in assessing farming activities to reinterpret crop profits as rents to land and other fixed factors (for example, management and the ability to bear risk) per hectare of land used. This reinterpretation includes private (and social) returns to land as parts of D (and H). Profitability per hectare is then interpreted as the ability of a farming activity to cover its long-run variable costs, in either private or social prices or as a return to fixed factors such as land, management skill, and water resources.

Effects of Divergences
The second identity of the accounting matrix concerns the differences between private and social valuations of revenues, costs, and profits. For each entry in the matrix—measured vertically—any divergence between the observed private (actual market) price and the estimated social (efficiency) price must be explained by the effects of policy or by the existence of market failures. This critical relationship follows directly from the definition of social prices. Social prices correct for the effects of distorting policies—policies that lead to an inefficient use of resources. These policies often are introduced because decision-makers are willing to accept some inefficiencies (and thus lower total income) in order to further nonefficiency objectives, such as the redistribution of income or the improvement of domestic food security. In this circumstance, assessing the tradeoffs between efficiency and nonefficiency objectives becomes a central part of policy analysis.

But not all policies distort the allocation of resources. Some policies are enacted expressly to improve efficiency by
Table Notes:

Private profits, $D$, equal $A$ minus $B$ minus $C$. Social profits, $H$, equal $E$ minus $F$ minus $G$. Output transfers, $I$, equal $A$ minus $E$; they also equal $M$ plus $Q$ plus $U$. Input transfers, $J$, equal $B$ minus $F$; they also equal $N$ plus $R$ plus $V$. Factor transfers, $K$, equal $C$ minus $G$; they also equal $O$ plus $S$ plus $W$. Net transfers, $L$, equal $D$ minus $H$; they also equal $I$ minus $J$ minus $K$; and they equal $P$ plus $T$ plus $X$.

Whenever monopolies or monopsonies (seller or buyer control over market prices), externalities (costs for which the imposer cannot be charged or benefits for which the provider cannot receive compensation), or factor market imperfections (inadequate development of institutions to provide competitive services and full information) prevent a market from creating an efficient allocation of products or factors. Hence, one needs to distinguish distorting policies, which cause losses of potential income, from efficient policies, which offset the effects of market failures and thus create greater income. Because efficient policies correct divergences, they reduce the differences between private and social valuations.

Interpretation of the effects of divergences can be clarified by the expansion of the PAM to include six rows, as shown in Table 2.2. In this expanded PAM, each entry measuring the effects of divergences ($I$, $J$, $K$, and $L$) is disaggregated into three categories—market failures (fourth row), distorting policies (fifth row), and efficient policies (sixth row). The introduction of efficient policies to offset market failures would change the entries in the first and third rows. To bring about perfect efficiency, a government would introduce efficient policies to offset the effects of market failures and avoid distorting policies, thereby ensuring equality of private and social prices.

In the absence of market failure in the product markets, all divergences between private and social prices of tradable output and inputs are caused by distorting policy. Because the principles are identical for all tradable products, the matrix entries for revenues (tradable outputs)

and tradable inputs can be considered together. Output transfers, $I = (A - E)$, and input transfers, $J = (B - F)$, arise from two kinds of policies that cause divergences between observed and world product prices: commodity-specific policies and exchange-rate policy.

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<th>Table 2.2: Expanded Policy Analysis Matrix</th>
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and tradable inputs can be considered together. Output transfers, $I = (A - E)$, and input transfers, $J = (B - F)$, arise from two kinds of policies that cause divergences between observed and world product prices: commodity-specific policies and exchange-rate policy.
Policies that apply to specific commodities include a wide range of taxes or subsidies and trade policy. For example, producer revenues per unit can be raised by producer subsidies (sometimes called deficiency payments in agriculture), tariffs or import quotas on outputs (which raise domestic prices), or domestic price supports enforced by government stockpiling (which require a complementary trade restriction for tradable products). Commodity-specific policies on inputs also affect private profitability. For example, per unit producer costs can be lowered by direct input subsidies or by subsidies on imported inputs.

Typically, PAM accounting is done in domestic currency, but world prices are quoted in foreign currency. Hence, a foreign exchange rate is needed to convert world prices into domestic equivalents. The social exchange rate may differ from observed exchange rates. Undervalued exchange rates reflect an excess supply of foreign exchange that is accumulating as excessive reserves and reducing potential income. Overvalued exchange rates correspond to conditions of excess demand; this demand results in extra foreign borrowing, excessive drawing down of exchange reserves, or rationing of foreign exchange among domestic users.

An overvalued exchange rate is an implicit tax on producers of tradable products because too little domestic currency is earned by exports or paid out for imports. In the absence of commodity policy, the world price of a tradable good determines its domestic price. When the exchange rate is overvalued, the domestic price is lower than its efficiency level and domestic producers are effectively taxed. Undervalued exchange rates exert the opposite effects. Correction for this distortion in PAM is done by conversion of world prices (E and F in the matrix) at the social exchange rate rather than at the official rate. Because exchange rates affect both product prices and factor prices, exchange-rate adjustments are limited to special circumstances-the appearance of multiple exchange-rate regimes or the government's failure to adjust the exchange rate enough to offset the effects of domestic inflation.

The social costs of domestic factors (G) reflect underlying supply and demand conditions in domestic factor markets. Factor prices are thus influenced by the prevailing set of macroeconomic and commodity price policies. In addition, the government can affect factor costs with tax or subsidy policies for one or more of the factors (capital, labor, or land) that create a divergence between private costs (C) and social costs (G). Finally, market imperfections, arising from imperfect information or underdeveloped institutions-which are often characteristic of developing country economies-further influence factor prices. If factor market imperfections exist along with distorting factor policy, both O and S and possibly W are positive components of K. The net transfer, L, thus combines the effects of distorting policy (I, J, and the S part of K) with those of factor market failures (the O part of K) and efficient policies to offset them (the W part of K).

The net transfer caused by policy and market failures (L in the matrix) is the sum of the separate effects from the product and factor markets, L = (I - J - K). (Positive entries in the two cost categories, J and K, represent negative transfers because they reduce private profits, whereas negative entries in J and K represent positive transfers; hence, J and K are subtracted from I, a positive transfer, in the calculation of the net transfer, L.) The net transfer from distorting policy is the sum of all factor, commodity, and exchange-rate policies (apart from efficient policies that offset market failures).

The net transfer can also be found by a comparison of private and social profits. These measures of the net transfer must by definition be identical in the double-entry accounting matrix, L = (I - J - K) - (D - H). Disaggregation of the total net transfer shows whether each distorting policy provides positive or negative transfers to the system. The PAM thus permits comparison of the effects of market failures and distorting policies for the entire set of commodity and macroprice (factor and exchange-rate) policies. This comparison can be made for the complete agricultural system and for each of its outputs and inputs.
Comparisons among Agricultural Systems Producing Different Outputs

The entries in PAM allow comparisons among agricultural systems that produce identical outputs, either within a single country or across two or more countries. In the accounting matrix, all measures are given as monetary units per physical unit of some commodity. If interest focuses solely on a comparison of one wheat system with another, for example, the matrix entries provide all information necessary for the analysis. Comparisons can be drawn readily by construction of PAM entries for two or more different systems that produce the same quality of wheat. (If necessary, premiums or discounts can be used to correct for quality differences.) Further comparisons can be made between the wheat systems in one country and those in other wheat-producing countries; social exchange rates, incorporating corrections for differential inflation not otherwise offset by exchange-rate changes, are used to convert the other countries’ currencies into domestic currency.

Comparisons between wheat and barley—or apples and oranges are another story, however. To permit comparisons among systems producing different outputs, some common numeraire must be generated. One technique involves the expression of all values relative to a constraining domestic factor resource, such as land. A more common method uses ratios. Both the numerator and the denominator of each ratio are PAM entries defined in domestic currency units per physical unit of the commodity. Therefore, the ratio is a pure number free of any commodity or monetary designation.

Private Profitability

For comparisons of systems producing identical outputs, private profits, \( D = (A - B - C) \), indicate competitiveness under existing policies. Construction of a ratio is required to permit comparisons among systems producing different commodities. Direct inspection of the data for private profits is not sufficient. Profitability results are residuals and might have come from systems using very different levels of inputs to produce outputs with widely varying prices. This difficulty might not be apparent in a wheat versus corn example, but it would arise in a comparison of a wheat system with one producing a high-value crop, such as strawberries. This ambiguity is inherent in comparisons of private profits of systems producing different commodities with differing capital intensities.

The problem is circumvented, by construction of a private cost ratio (PCR)—the ratio of domestic factor costs (C) to value added in private prices (A - B); that is, \( PCR = C/(A - B) \). Value added is the difference between the value of output and the costs of tradable inputs; it shows how much the system can afford to pay domestic factors (including a normal return to capital) and still remain competitive—that is, break even after earning normal profits, where \( (A - B - C) = D = 0 \). The entrepreneurs in the system prefer to earn excess profits \( (D > 0) \), and they can achieve this result if their private factor costs (C) are less than their value added in private prices \( (A - B) \). Thus they try to minimize the private cost ratio by holding down factor and tradable input costs in order to maximize excess profits.

Social Profitability

Social profits measure efficiency or comparative advantage. For a comparison of identical outputs, results can be taken directly from the second row of the PAM matrix—social profits equal social revenues less social costs, \( H = (E - F - G) \). When social profits are negative, a system cannot survive without assistance from the government. Such systems waste scarce resources by producing at social costs that exceed the
costs of importing. The choice is clear for efficiency-minded economic planners: enact new policies or remove existing ones to provide private incentives for systems that generate social profits, subject to non-efficiency objectives.

When systems producing different outputs are compared for relative efficiency, the domestic resource cost ratio (DRC), defined as $G/(E - F)$, serves as a proxy measure for social profits. No new information beyond social revenues and costs is required to calculate a DRC. The DRC plays the same substitute role for social profits as does the PCR for private profits; in both instances, the ratio equals 1 if its analogous profitability measure equals 0. Minimizing the DRC is thus equivalent to maximizing social profits. In cross-commodity comparisons, DRC ratios replace social profit measures as indicators of relative degrees of efficiency.

**Policy Transfers**

Transfers are shown in the third row of the PAM. If market failures are unimportant, these transfers measure mainly the effects of distorting policy. Efficient systems earn excess profits without any help from the government, and subsidizing policy ($L > 0$) increases the final level of private profits. Because subsidizing policy permits inefficient systems to survive, the consequent waste of resources needs to be justified in terms of nonefficiency objectives.

Comparisons of the extent of policy transfers between two or more systems with different outputs also require the formation of ratios (for reasons analogous to those offered in the discussions of private and social profits). The nominal protection coefficient (NPC) is a ratio that contrasts the observed (private) commodity price with a comparable world (social) price. This ratio indicates the impact of policy (and of any market failures not corrected by efficient policy) that causes a divergence between the two prices. The NPC on tradable outputs (NPCO), defined as $A/E$, indicates the degree of output transfer; for example, an NPC of 1.10 shows that policies are increasing the market price to a level 10 percent higher than the world price. Similarly, the NPC on tradable inputs (NPCI), defined as $B/F$, shows the degree of tradable input transfer. An NPC on inputs of 0.80 shows that policies are reducing input costs; the average market prices for these inputs are only 80 percent of world prices.

The effective protection coefficient (EPC), another indicator of incentives, is the ratio of value added in private prices $(A - B)$ to value added in world prices $(E - F)$, or $EPC = (A - B)/(E - F)$. This coefficient measures the degree of policy transfer from product market-output and tradable-input-policies. But, like the NPC, the EPC ignores the transfer effects of factor market policies. Hence, it is not a complete indicator of incentives.

An extension of the EPC to include factor transfers is the profitability coefficient (PC), the ratio of private and social profits or $PC = (A - B - C)/(E - F - G)$, or $D/H$. The PC measures the incentive effects of all policies and thus serves as a proxy for the net policy transfer, since $L = (D - H)$. Its usefulness is restricted when private or social profits are negative, since the signs of both entries must be known to allow clear interpretation.

A final incentive indicator is the subsidy ratio to producers (SRP), the net policy transfer as a proportion of total social revenues or $SRP = L/E = (D - H)/E$. The SRP shows the proportion of revenues in world prices that would be required if a single subsidy or tax were substituted for the entire set of commodity and macroeconomic policies. The SRP permits comparisons of the extent to which all policy subsidizes agricultural systems. The SRP measure can also be disaggregated into component transfers to show separately the effects of output, input, and factor policies.
Dynamic Comparative Advantage

The ability of an agricultural system to compete without distorting government policies can be strengthened or eroded by changes in economic conditions. Dynamic comparative advantage refers to shifts in a system's competitiveness that occur over time because of changes in three categories of economic parameters—long-run world prices of tradable outputs and inputs, social opportunity costs of domestic factors of production (labor, capital, and land), and production technologies used in farming or marketing. Together, these three parameters determine social profitability and comparative advantage.

The appropriate world prices for measuring efficiency or comparative advantage are long-run equilibrium levels that approximate best guesses of expected future prices. If the country's decisions to buy or sell on world markets will not have any measurable effect on world price levels, those price levels can be considered exogenous and, once arrived at, can be taken as given for domestic agricultural systems. The world prices are the correct indicators of social valuation of tradable commodities even if a country's decisions to buy or sell internationally do affect the world price of a good. When a large country has market power, however, the analyst needs to take into account the impact of that country's trading decisions on world prices.

In the absence of knowledge of future prices, most analysts project constant long-run real prices rather than fluctuating prices. If new information results in changes in the constant price guess or in the projection of continually increasing or decreasing future prices, these changes can be incorporated easily into the PAM. Separate PAMs can be constructed for each year, and each can have different assumed world prices.

Costs of factor services in any country can be expected to change over time. But cyclical variations in the real wage and the real return to capital, associated with swings in macroeconomic policy, are not the primary focus of the PAM method. Instead, interest centers on long-run trends in the costs of labor, capital, and land. As economies grow, real wages typically rise, both in absolute terms and relative to real costs of capital and land. For agricultural systems, changes in the social opportunity costs of labor and of capital depend on changes in the national environment for investment and growth. Land rental rates are endogenous to agriculture but will be constrained by changes in world prices and in real wage and interest rates, because payments to land and other permanently fixed factors come out of profits. Analysis of projected comparative advantage therefore includes both the future pressures that changing real factor prices might exert on agricultural systems and the influences of likely world prices for tradable outputs and inputs. The results identify systems that can readily expand and those that will have to contract or change in order to survive.

Changes over time in factor and commodity prices can also influence agricultural technologies. Farmers and researchers innovate, often by finding new ways of using less of factors that are relatively expensive (usually labor) and more of other inputs. Successful technological change permits commodities to be produced with reduced costs of one or more inputs. Empirical analysis of intra-system change can be done with partial budgeting, a technique in which individual cost-saving or revenue-increasing changes can be analyzed within the PAM for the initial system.
Concluding Comments

The central purpose of PAM analysis is to measure the impact of government policy on the private profitability of agricultural systems and on the efficiency of resource use. Private profitability and competitiveness are likely to be uppermost in the minds of those concerned specifically with agricultural incomes. Social profitability and efficiency are often emphasized by economic planners whose concern is the allocation of resources among sectors and the growth of aggregate income in the economy. Both sets of issues ultimately focus on the incentive effects of policy-part of the difference between private and social profitability—and on how policy incentives might be altered. Through evaluation of private and social revenues and costs, the PAM method is designed to illuminate these related issues of agricultural policy analysis. The approach is particularly well suited to empirical analysis of agricultural price policy and farm incomes, public investment policy and efficiency, and agricultural research policy and technological change.

The PAM approach to policy evaluation advocates a disaggregated view of efficiency effects (as measured by social profitability) and of nonefficiency effects. The analyst can do much in describing the contributions of a particular system to nonefficiency objectives and in quantifying implications for efficiency (aggregate income gains or losses). But it is left to the discretion of each policy-maker to determine whether tradeoffs between efficiency and nonefficiency objectives merit changes in policy or maintenance of incentives to particular systems.

In other approaches to policy analysis, it is desirable to aggregate measures of efficiency and nonefficiency effects into a single measure. Income distribution concerns, for example, can be introduced into the social cost estimates by weighting (with a value less than 1) of the efficiency-determined value of unskilled labor wages. Concerns for food self-sufficiency can be introduced by the addition of a premium to the world market value of output. If these weights were incorporated in the calculations of social profitability, the policy-makers' decision would become automatic and predetermined: encourage all systems with positive social profitability and discourage all systems with negative profitability.

The disadvantage of the aggregate approach lies in its tendency to lump together high-quality information (observable data on prices and input-output relationships) with relatively poor-quality information (implicit weights of society or of policy-makers regarding various prices of inputs and outputs). Moreover, attempts to quantify implicit policy weights presume the existence of some dictatorial policy-maker who speaks on behalf of society. Policy-making rarely occurs in such an environment. Policies are the outcomes of negotiated conflict between interest groups both within and outside the government. Quantitative studies provide improved information and thus increase the probability of good policy decisions. But these decisions, and the tradeoffs implied between efficiency and nonefficiency objectives, are the outcomes of debate based on this information, not inputs into the collection of information.

SECTION III. INTERPRETATION AND COMMUNICATION OF PAM RESULTS

The principal task of this chapter is to show how to interpret the results of the PAM method. Because measures of divergences can include the effects of efficient and distorting policies and of market failures, it is useful to know how much of the difference between private and social valuations is attributable to each influence. These issues are examined in the first section of the chapter. The second section illustrates the use of PAM results for agricultural planning analyses of commodity price, public investment, and agricultural research policies. But it is desirable to go beyond pure analytics in policy analysis. Effective analysts will draw insights from the results to explain their meaning and limitations to policy-makers. The final section discusses strategies for the communication of PAM results to policy-makers.
Interpretation of the Effects of Divergences

Divergences include two types of influences that cause the economy to use its scarce resources inefficiently so that it does not create the highest possible levels of income. One type is caused by government policies that distort the pattern of production, moving it away from the most efficient use of domestic resources and international trading opportunities. Governments usually enact distorting policies to favor particular interest groups or because they are consciously trading off the consequent efficiency losses against their perception of such nonefficiency gains as changes in income distribution and improvement in the countries' ability to feed themselves. The second type of influence arises because certain markets fail to bring about an efficient allocation of goods or services. Market failures are usually far more prominent in factor markets than in product markets.

Output Transfers

An output transfer, I, is defined as the difference between the actual market price of a commodity produced by an agricultural system, A, and the efficiency valuation for that commodity, E. If the system has more than one output, the matrix entries A, E, and I will be made up of the sum of market prices, efficiency prices, and output transfers for all outputs. However, since the actual analysis is constructed on a commodity-by-commodity basis, this discussion assumes that only one output is produced. In most countries agricultural outputs enter into international trade in the absence of trade-distorting policies. For these tradables the appropriate efficiency valuation is given by the world price (fob export or cif import).

The lack of participation in international trade does not in itself mean that the output is nontradable; when a government effectively bans imports of a commodity, no trade will be observed. But this absence of trade is the direct result of the distorting policy. Because most agricultural outputs are internationally tradable, this discussion focuses on tradable commodities. In practice, whether a commodity is tradable or nontradable is an important empirical question. Entries into the E box of the matrix, the social valuations, are thus either comparable world prices for tradable outputs or marginal social costs for nontradable outputs.

Divergences, which cause private valuations to depart from their social counterparts, are always the result of either distorting policies or market failures. Governments can, at least in principle, enact efficient policies that correct the inefficiency influences of market failures. This effort is observed only rarely, because failures in output markets are difficult to identify empirically and are thought to be fairly unimportant (on the basis of sketchy evidence), especially in the context of more pressing economic and social concerns. As a practical matter, therefore, in most contexts the measured effects of divergences in output markets are attributed solely to distorting policy.

Governments choose between two principal policy instruments-trade restrictions and taxes or subsidies-if they want private prices to differ from social values set by world prices. If a government wishes the private price to be above the world price for imported goods (as illustrated in Box 12.1), its policy-makers can either restrict international trade or levy a tax on all production, domestic and imported. Alternatively, if the desire is to lower domestic prices of importables relative to cif import prices, the government has only one choice-to subsidize imports with payments from the treasury. The opposite results apply to exportable outputs.

If all agricultural systems under study have identical outputs, the analyst can compare their output transfers simply by contrasting the absolute sizes of the entries in I for all PAMs within or across countries. For example, the output transfer for one wheat system in Portugal can be compared with that of another wheat system in Mexico—if both systems produce only wheat grain and wheat straw. One needs only an appropriate exchange rate to convert both PAM results to a single currency. However, a comparison of the output transfer for a wheat system with that for a corn system requires construction of a ratio to compare the unlike products. This ratio is the nominal protection coefficient on tradable outputs (NPCO), defined as the private price divided by the comparable world price. If there is a single product in the system, the NPCO is
given by the ratio of two PAM output entries, A / E. When more than one output is produced, the average NPCO for all products is found by the adding up of all outputs in private prices and then in social prices and by the formation of a ratio of these two sums. This procedure is illustrated in Box 12.1.

** Tradable-Input Transfers **

The tradable-input transfers, J, are defined as the difference between the total costs of the tradable inputs valued in private prices, B, and the total costs of the same inputs measured in social prices, F. A private output price above its social price means that policy is providing a positive transfer, causing the production system to realize higher private profits or cover greater private costs than it could without the aid of the policy. This positive transfer has a positive sign in the third row of the PAM. Correspondingly, subsidies on tradable inputs cause production to have greater private profitability. The PAM allows aggregation of all of the effects of divergences, combining those influencing outputs, tradable inputs, and factors. The principles underlying the interpretation of tradable-input transfers are equivalent to those just set out for output transfers. World prices serve as social valuations of all tradable inputs. Nontradable inputs are decomposed into their component tradable-input and

<table>
<thead>
<tr>
<th>Box 12.1 Output Transfers in a Portuguese Wheat System</th>
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<tbody>
<tr>
<td><strong>Revenues (escudos per kilo)</strong></td>
</tr>
<tr>
<td>Wheat Grain</td>
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<tr>
<td>----------------</td>
</tr>
<tr>
<td>Private prices</td>
</tr>
<tr>
<td>Social prices</td>
</tr>
<tr>
<td>Effects of divergences</td>
</tr>
</tbody>
</table>

The table above shows the revenues for wheat grain, wheat straw, and total for private and social prices, along with the effects of divergences.
An analyst searching for the sources of divergences in tradable-input markets finds that departures from world prices nearly always are caused by distorting policies rather than market failures. This situation is identical to that of divergences affecting outputs. Although one should always look carefully for the existence of market failures, in most empirical analyses product market failures (for both outputs and tradable inputs) are assumed to be nonexistent or unimportant. This assumption is made in the study summarized in

### Box 12.1 Output Transfers in a Portuguese Wheat System

<table>
<thead>
<tr>
<th>Revenues (escudos per kilo)</th>
</tr>
</thead>
</table>
| In this example, the effects of divergences are entirely the result of distorting policy, not of market failures. The actual policy was a quantitative restriction against imports of wheat, which had an effect equivalent to that of an import tariff of 25 percent: 
$(23.00 \div 18.37 \div 1.00) \times 100 \%$. No policies affected the price of wheat straw, a nontradable by-product of wheat grain used for animal feed. If the government had chosen to permit an unrestricted supply of wheat imports, the private (actual market) price would have fallen to the social (cif import) price. At that lower price, the country would have imported more wheat, produced less domestically, and consumed more is the outcome would have been more efficient than the actual one, because too many domestic resources were used to produce a product that could have been imported more cheaply and because local processors (and ultimately consumers) were forced to pay too much for wheat. In effect, the protectionist policy caused the country to give up some of the potential gains from international trade. To evaluate the effectiveness of this policy, one needs to compare the efficiency losses from producing, consuming, and trading inefficiently with whatever gains might have arisen for the government in pursuing nonefficiency objectives, such as income redistribution (favoring wheat farmers over wheat product consumers) and food security (which would be enhanced if domestic variability in wheat quantities and prices were less than variability on the national market for wheat).

The NPCO permits comparison of systems producing unlike outputs. The NPCO on wheat grain only is given by the ratio of the private price of wheat to the social price of wheat, or $23.00 / 18.37 = 1.25$. This result shows that the country’s trade-restrictive policy has permitted the private price to be 25 percent higher than without the policy. The private price could be compared with other single-commodity NPCOs. The NPCO for the entire wheat system is found by formation of a ratio of total revenues in private and social prices. This result, $27.42 / 22.79 = 1.20$, indicates somewhat lesser protection for the total output of the system than for the main product, wheat grain, because the secondary product, wheat straw, is totally unprotected (and thus has an NPCO of $4.42 / 4.42 = 1.00$).

primary factor costs to permit social valuation. All intermediate input costs are thus divided into tradable-input or factor cost categories.
Interpretation of the transfer effects of tradable-input price policies follows closely that of output price policies. If a government desires to raise domestic prices, it can restrict imports (if the product is imported), subsidize exports (if the country is a net exporter of the item), or tax all domestic consumption of the good. To reduce input costs, a government can subsidize importables, restrict exportables by imposing export taxes or quotas, or subsidize all domestic consumption of the input item.

Often governments decide to subsidize specific agricultural inputs, such as improved seeds or chemical fertilizers, in order to encourage greater use of these inputs and adoption of new technologies. In this respect, tradable-input price policy may have different goals and results from output price policy. Whereas output policy raises or lowers profits per ton for all systems, tradable-input policy can be designed to favor systems whose technologies use the subsidized inputs intensively.

Nominal protection coefficients on tradable inputs (NPCIs) can be calculated to permit comparisons among agricultural systems that produce dissimilar outputs. Calculations of NPCIs for single inputs and for the total of tradable inputs are contained in Box 12.2. These results are the opposite from those for the NPCOs, because both higher private prices of output and lower private costs of tradable inputs lead to greater private profits. Hence, the larger the NPCOs and the smaller the NPCIs, the greater the policy transfers to agricultural systems.

These separate influences of commodity price policies can be combined in an indicator called the effective protection coefficient (EPC), which is defined as \((A - B) / (E - F)\). This measure uses the same information as the NPCO \((A\) and \(E\)) and the NPCI \((B\) and \(F\)). It is a useful way to indicate the extent of incentives or disincentives that systems receive from product policies. The EPC concept is illustrated in Box 12.3. Its main limitation as an indicator of incentives is that it does not incorporate any effects of policies that influence factor prices. This omission means that EPC results should be interpreted as measures of the incen

<table>
<thead>
<tr>
<th>Box 12.2 Tradable -Input Transfers in a Portuguese Wheat System</th>
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<tbody>
<tr>
<td>** Tradable input costs (in escudos per kilogram)**</td>
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<td></td>
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<tr>
<td></td>
</tr>
<tr>
<td><strong>Fertilizer (urea)</strong></td>
</tr>
<tr>
<td>Private prices</td>
</tr>
<tr>
<td>Social prices</td>
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<tr>
<td>Effects of divergences</td>
</tr>
<tr>
<td>(private prices less social prices)</td>
</tr>
</tbody>
</table>
As in Box 12.1, the effects of divergences are the result of distorting policy only, not of market failures. A number of distorting policies caused the observed market (private) prices of tradable inputs to differ from comparable world prices. The government provided a subsidy on all sales of urea fertilizer, including that produced locally and that imported; this subsidy amounted to 0.86 escudos per kilogram, or 39 percent of the cif import price: (2.21 - 1.35) / 2.21 x 100 percent.

In contrast, the government levied an import tariff on tradable spare parts (used in making repairs), which increased the average domestic price for these inputs by 22 percent: (1.93 - 1.58) / 1.58 x 100 percent. The tariff on tradable inputs thus caused domestic producers of wheat to have to pay more for their spare parts than they would have without the tariff. This policy, therefore, created a negative transfer of 0.35.

Numerous other tradable inputs are aggregated in the column titled "Other." The most important of these inputs is compound fertilizer, nitrogen-phosphorus-potassium (NPK), which was subsidized to 38 percent of the cif import price. That subsidy accounted for most of the positive transfer on "other" tradable inputs.

The last column in the table shows that the wheat system enjoyed a total positive transfer of 2.26 escudos per kilogram on its tradable-input costs. If the government had not intervened, the wheat farmers would have had to pay 11.79 escudos per kilogram, but the actual policies permitted this cost to be reduced to 9.53. This total positive transfer of 2.26 resulted from the policy combination of subsidies on urea fertilizer of 0.86 and on other tradable inputs (mostly compound fertilizer) of 1.75 and of an import tariff on spare parts that created a negative transfer of (0.35). The signs for entries in the table are the opposite of those here because each input transfer is subtracted from the output transfer in the calculation of net transfers (L = I - J - K).

The NPCI allows the analyst to contrast the effects of distorting policies on tradable-input costs in two or more agricultural systems that produce either identical or dissimilar tradable outputs. An NPCI equal to 1 indicates no transfer, an NPCI greater than 1 shows a negative transfer (because input costs are raised by policy), and an NPCI less than 1 denotes a positive transfer (since input costs are lowered by policy). In this example, the NPCI for urea fertilizer is 1.35 / 2.21 = 0.61, and that for other inputs is 6.25 / 8.00 = 0.78, both showing the effects of the subsidies. However, the NPCI for spare parts, 1.93 / 1.58 = 1.22, exceeds 1 because the price-raising import tariff created a negative transfer. The average NPCI for all tradable inputs is 9.53 / 11.79 = 0.81, which again points to the positive transfer from the entire set of policies affecting tradable inputs.

### Box 12.3. Effective Protection Coefficient for a Portuguese Wheat System

<table>
<thead>
<tr>
<th></th>
<th>Amounts (in escudos per kilogram)</th>
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</thead>
<tbody>
<tr>
<td></td>
<td>Revenues</td>
</tr>
<tr>
<td>Private prices</td>
<td>27.42 (A)</td>
</tr>
<tr>
<td>Social prices</td>
<td>22.79 (E)</td>
</tr>
<tr>
<td>Effects of divergences</td>
<td>4.63(l)</td>
</tr>
</tbody>
</table>
The EPC is the ratio of the difference between revenues and tradable-input costs in private prices to that in social prices. In PAM notation, $EPC = (A - B) / (E - F)$. The numerator of EPC, $A - B$, is value added in private prices; the denominator, $E - F$, is value added in world prices. The ratio thus shows by how much policies in the product markets cause observed value added to differ from what it would be in the absence of commodity price policies.

EPC is an indicator of the net incentive or disincentive effect of all commodity policies affecting prices of tradable outputs and inputs. An EPC greater than 1 means that private profits are higher than they would be without commodity policies; the transfer from both output and tradable-input policies, taken together, is positive. An EPC less than 1 indicates the opposite result; the net effect of policies that alter prices in product markets is to reduce private profits, and the combined transfer effect is thus negative.

An EPC can be calculated for each agricultural system. For the wheat system of this example, it is $(27.42 - 9.53 = 17.89) / (22.79 - 11.79 = 11.00) = 1.63$. The interpretation of this result is that the net impact of government policy influencing product markets—that is, output price policy and tradable-input price policy—is to allow the wheat system depicted to have a value added in private prices 63 percent greater than the value added without policy transfers (as measured in world prices). The NPCO ($A / E$) of 1.20 indicates that policies caused output prices to be 20 percent higher than they would have been if world prices had been allowed to set domestic prices. The NPCI ($B / F$) on all tradable inputs of 0.81 showed that costs of tradable inputs were only 81 percent of what they would have been at world prices. The EPC is a single indicator that combines these two results by using the data from both. It is a useful measure of the combined effects of commodity price policies, but it does not account for any effects of policy in factor markets.

**Factor Transfers**

Factor transfers, $K$, are defined as the difference between the costs of all factors of production (unskilled and skilled labor and capital) valued in actual market prices, $C$, and the social costs of these factors, $G$. One distinguishes between the inefficiency-causing effects of distorting policies affecting either output or factor markets and of market failures in factor markets.

The existence of factor market failures in developing countries is the rule rather than the exception. Analysts will usually assume that factor markets are going to be imperfect unless careful examination shows that the private factor prices are reasonable approximations of social prices. An illustration of factor transfer interpretation is given in Box 12.4.

**Net Transfers**

Net transfers, $L$, are output transfers ($I$) minus tradable input transfers ($J$) minus factor transfers ($K$). Because each of the components of the net transfer is defined as the effects of divergences between private and social valuations, $L$ is the net difference between private profits ($D$) and social profits ($H$). This double accounting definition of $L$ follows directly from PAM's two accounting identities.

The measure of net transfer, a principal result of the PAM approach, is illustrated in Box 12.5. The value of $L$ shows the extent of inefficiency in an agricultural system. If market failures are a large source of the net
transfer, this measure indicates how much long-term government effort (price policy, investment, and regulation) will be required eventually to permit the economy to operate efficiently. If, instead, most of the L is traced to distorting policies, the government can increase efficiency by reducing the degree of distortion—unless such changes will seriously impair the attainment of nonefficiency objectives. L is, therefore, a key input into policy analysis.

These measures of net transfer can be applied to a wide range of agricultural and nonagricultural systems. Comparisons can be made among different systems producing the same output, a variety of agricultural systems, and different sectors in the economy. However, L alone is not sufficient for such comparisons, because it is denominated in currency units per hectare, per ton or kilogram of the commodity produced. Once again, ratios are required so that the indicators will be free of specific units.

The profitability coefficient (PC), defined as \( PC = D / H \), is a measure of the degree to which net transfers have caused private profits to exceed social profits. Because \( D = (A - B - C) \) and \( H = (E - F - G) \), the PC extends the effective protection coefficient—defined earlier as \( (A - B) / (E - F) \)—to include factor transfers. PC is a more complete measure than EPC because it provides an indication of the total incentive effect

<table>
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<tr>
<th>Box 12.4 Factor Transfers in a Portuguese Wheat System</th>
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<tbody>
<tr>
<td><strong>Factor costs (in escudos per kilo)</strong></td>
</tr>
<tr>
<td>Unskilled labor</td>
</tr>
<tr>
<td>-----------------</td>
</tr>
<tr>
<td>Private prices</td>
</tr>
<tr>
<td>Social prices</td>
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<tr>
<td>Effects of divergences</td>
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</table>
The effects of divergences in the factor markets are the result of both underlying market failures and distorting policies. Both of these distorting influences typically cause observed factor prices to diverge from their social valuations. Three primary factors were identified in the illustrated wheat system; but only two of them, skilled labor and capital, were important costs. Unskilled labor was a minor cost element, amounting to only 0.02 escudos per kilogram in both private and social prices. The factor transfer for unskilled labor is thus 0. The private wage rate is taken as a reasonable indicator of the social price of unskilled labor because neither significant market failures nor distorting policies were identified after careful observation. Information about employment opportunities was widely available to potential searchers, and a considerable amount of seasonal and multiyear migration of unskilled laborers occurred. Government policies to have employees pay pension contributions and health insurance were largely unenforced and thus were ignored by unskilled labor in agriculture. For skilled labor, market failures were also judged to be absent. Again, ample information and widespread migration of workers showed evidence of a well-functioning market for skilled labor. The wage rate paid by wheat farmers and millers exceeded the social wage rate for skilled laborers because of distorting government policy. Above the market wage, employers also had to pay a percentage of the wage as a tax to provide funds for employee health insurance and pensions (akin to social security in the United States). These policies caused private wages for skilled labor to be an estimated 23 percent higher than social wages—that is, the level that might have been expected without the policies. The result for the system was a negative factor transfer of (0.66) because the social price, 2.82, was raised by policy to a higher private price, 3.48. The factor transfer for capital was in the opposite direction. The social opportunity cost of capital was estimated at 8 percent plus inflation for the country. The actual interest rates being paid by wheat farmers, which ranged between 2 and 6 percent plus inflation, were less than the estimated social rate. This divergence resulted from the market failure of an underdeveloped capital market, associated with insufficient numbers of financial institutions in rural areas; a government subsidy on agricultural credit for borrowers, usually larger farmers, who qualified for it; and a government policy to ration credit at controlled interest rates that were below market-clearing levels. As a result of these divergences, the private costs of capital, 3.90, were only 76 percent of their full social value, 5.13; the level of the positive factor transfer was 1.23. The total factor transfer is found by summation of the amounts for the individual factors. In this example, the negative transfer of (0.66) resulting from the tax on skilled labor is more than offset by the positive transfer of 1.23 caused by the capital subsidizing policies. The net result is a small positive factor transfer of 0.57.

<table>
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<tr>
<th>Box 12.5 Net Transfers, Profitability Coefficient, and Subsidy Ratios to Producers for a Portuguese Wheat System</th>
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<tbody>
<tr>
<td><strong>Revenues</strong></td>
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<tr>
<td>Private prices</td>
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<tr>
<td>Social prices</td>
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<tr>
<td>Effects of divergence</td>
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</tbody>
</table>
of policies, including those influencing factor markets. An illustration of PC is also provided in Box 12.5.

A second ratio indicator, used to measure net transfers across dissimilar systems, is the subsidy ratio to producers (SRP), defined as $L / E$. It shows how large net transfers from divergences are in relation to the social revenues of the system. The smaller the SRP, the less distorted the agricultural system. The SRP, converted to a percentage, also shows the output tariff equivalent required to maintain existing private profits if all other policy distortions and market failures are eliminated. It thus indicates how much incentive or disincentive the system is receiving from all the effects of divergences. Box 12.5 illustrates the calculation and interpretation of the SRP ratio.

The Policy Analysis Matrix and Agricultural Planning

Good policy analysts know that one key ingredient of success in their profession is to stay ahead of the game. In most instances, policy-makers claim to need answers within periods of time that are too short to permit analysis to be done. "I need it done yesterday" is the common request. If unprepared, the policy analyst has to employ methods without proper reflection on their appropriateness, cut corners in gathering and cleaning data, and rush results into drafts without time for reflection and full interpretation. In contrast, a prepared policy analyst is fully aware that the process of decision making in government will often leave inadequate time for complete analysis. Preparation entails adopting methods that can be flexible (that is, carried out with varying degrees of completeness) and gathering essential data in advance on a regular
basis. The key, therefore, is to choose a small number of flexible methods and to do basic data gathering and analysis ahead of requests for information.

The purpose here is not to suggest an ideal set of methods and analyses that might be appropriate for any agricultural planning agency; the division of policy responsibilities differs enough among countries to make such a task unworkable. Rather, the idea is to show how PAM analyses can form an integral part of three types of agricultural policy analysis—agricultural prices, public investment projects, and public agricultural research allocations. Policy-makers typically want to know how agricultural price policies affect farm incomes, where new public investments in agriculture should be made, or why public funds should be spent on one line of agricultural research instead of another. If a planning agency were assigned responsibility for all three policy areas, the PAM could assist that agency in setting its research agenda.

The PAM and Price Policy Analyses

Policies are enacted with the intent of bringing about change. But to measure change, one needs to know the existing situation and to understand something about how it has evolved during the recent past. For price policy analysis, PAMs fulfill the first of these needs. One purpose of PAMs is to show the extent to which policies and market failures have influenced the levels of revenues and costs facing producers in some recent base year. The PAM method is designed specifically to permit a clear demonstration to policymakers of the effects of agricultural and macroeconomic policies.

For price policy analysis, the PAM demonstrates empirically the relationships among different policies and market failures that cause private prices to diverge from their social values. It allows calculation of competitiveness (private profits), and it shows how profits change as policies are altered. The accounting framework is a consistent means of tabulating information required for price policy analysis. The results need to be qualified to permit comparisons of the PAM's efficiency focus with nonefficiency objectives. Ideally, one would like to construct PAMs for all main systems biannually over a fifteen-to-twenty-year period in order to trace the evolution of policy effects. For nearly all countries, this goal is unattainable because of data limitations. As a partial substitute, one can usually construct price policy graphs for up to two decades. These graphs are drawn separately, using annual data, for each main agricultural commodity and input. Each graph shows the domestic wholesale price of the commodity (or input), the comparable world price (cif import or fob export), and the domestic policy prices (floor price for producers and ceiling prices for consumers), if such exist. The graphs provide visual interpretations of the recent history of price policy and complement PAMs constructed for one or two recent years. Reasonably up-to-date PAMs and price policy graphs are thus two essential pieces of baseline information needed for price policy analysis. An illustration of a price policy graph, showing rice prices in Indonesia between 1974 and 1985, is presented in Box 12.6. An example of the PAM method used to undertake analysis of the projected impact of policy changes in agricultural system profits is summarized in Box 12.7.
### Box 12.6. Price Policy Graph for Rice In Indonesia

A price policy graph is an illustrative device to permit easy visual comparisons of year-to-year movements in three kinds of price series: world prices (CIF import or FOB export, adjusted to a domestic wholesale level), domestic market prices (at both the wholesale and farm levels), and domestic policy prices (guaranteed floor price to producers and announced ceiling prices to consumers). Price policy graphs allow quick visual reviews of the patterns of price levels and price stability. One item of interest is the extent to which domestic prices are higher or lower than world prices because of price policy. For price stability, the issues are whether intrayear domestic prices have been successfully maintained between announced producer floor and consumer ceiling prices, because of trade and buffer stocking policy, and whether interyear domestic or world prices, both adjusted for inflation, have been more variable. Such historical graphs, when continuously updated, are excellent complements to PAMs.

The following figure describes rice prices in Indonesia between 1974 and 1985. The National Food Logistics Agency (BULOG) successfully implemented a buffer stock policy for rice. Through good management and well-designed and well-located warehouses, BULOG defends a paddy floor price to farmers by buying at the announced floor price. The success of the floor price is demonstrated in the price policy graph; the wholesale price in East Java (the main production and consumption region in Indonesia) only rarely and temporarily fell beneath the policy-determined floor price.

The graph also shows the annual and trend levels of Indonesian and comparable world prices of rice. In setting domestic rice price levels, Indonesian policy-makers have attempted for the most part to approximate the expected trend of world prices. Between 1973 and 1982, the trend domestic price on average was somewhat lower than the trend world price. This disincentive to production was countered with technology and investment policies and with substantial subsidies on fertilizer to induce adoption of fertilizer-intensive high yielding varieties of rice.

### PAM and Investment Policy Analysis

If the planning agency has constructed PAMs for the country's major agricultural systems, these matrices can also provide results that aid in the process of determining the allocation of public investment in agriculture. PAMs show the levels of efficiency (social profitability, or $H$) of each agricultural system studied. Calculation of domestic resource cost ratios (DRCs) allows the comparison of efficiency among systems that produce unlike outputs. These DRCs offer useful information to investment planners.
Box 12.7. The Projected Impact of Price Policy Changes on the Private Profitability of Portuguese Agricultural Systems

The following table contains the results of private profitability calculations for thirty-three Portuguese agricultural systems during the base year of data collection, 1983, and projections for 1996. The set of agricultural prices that faced producers in 1983 will undergo major changes because Portugal joined the European Community in 1986. Moreover, until 1996, the country will gradually align its agricultural prices to those of the Common Agricultural Policy. The projected private profitability for 1996 thus reflect projections of CAP prices and hence of Portuguese prices for that year.

Complete PAM analysis was carried out for all thirty-three systems, organized by commodity, region, and technology. But only the private profits are reported in the table, because the policy question is whether adoption of the CAP price regime will cause the need for large adjustments in any of Portugal's agricultural regions. The projection results indicate that relatively easy adjustments are in store for the main farming systems in the center (the Ribatejo) and in the good-soil areas in the south (the Alentejo); wheat and corn are projected to become less profitable and sunflowers, sugar beets, tomatoes, melons, and rice more profitable within the CAP regime. The private profits of dairying in the Azores will decline but will remain positive, so no major difficulty is foreseen there. Large losses in private profits are projected for the poor-soil areas of the south (the Alentejo) and for the northwest. The large farms in the south might need to convert their grain farms to pasture, forages, or forestry. But the very-small-scale farmers in the densely populated northwest are likely to experience a process of accelerated structural change if CAP prices cause private profits to become negative as those projected. In this way, construction of PAM budgets for all of Portugal's principal commodity systems permits identification of whether large changes in price policy will likely trigger difficult or easy regional adjustment.

Nearly all public investments in agriculture are made with the intention of reducing social costs in agricultural systems. (The exceptions are those made to introduce new crops or technologies.) A critical element in deciding on a strategy for a sequence of public investments is to know the social profitability of the existing systems. Social benefits to public investment are additions to positive social profits. Negative social profits could be reversed by removal of distorting policies. Hence, it is critical for planners to know how socially profitable or unprofitable systems are before the investment. PAMs provide this necessary baseline information. They must be complemented with complete social benefit-cost analyses of the most promising projects, selected on the basis of the baseline social profits and expected improvements from the investments.

<table>
<thead>
<tr>
<th>Farm-level profitability by soil type and crop, 1983 and 1996 (in thousands of escudos per hectare)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>1983 Profitability</strong></td>
</tr>
<tr>
<td>The Alentejo</td>
</tr>
<tr>
<td>Dryland, A and B soils:</td>
</tr>
<tr>
<td>Wheat</td>
</tr>
<tr>
<td>Crop</td>
</tr>
<tr>
<td>-----------------------</td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td>Wheat</td>
</tr>
<tr>
<td>Sheep, medium-technology</td>
</tr>
<tr>
<td>Sheep, high-technology</td>
</tr>
<tr>
<td>Beef, pasture-fed</td>
</tr>
<tr>
<td>Rice</td>
</tr>
<tr>
<td>Tomatoes</td>
</tr>
</tbody>
</table>

**The Ribatejo**

<table>
<thead>
<tr>
<th>Crop</th>
<th>Dryland, sprinkler irrigation:</th>
<th>Flood irrigated:</th>
</tr>
</thead>
<tbody>
<tr>
<td>Wheat</td>
<td>60.2</td>
<td>24.0</td>
</tr>
<tr>
<td>Corn</td>
<td>87.5</td>
<td>28.4</td>
</tr>
<tr>
<td>Sunflowers</td>
<td>31.9</td>
<td>33.8</td>
</tr>
<tr>
<td>Sugar beets</td>
<td>140.5</td>
<td>35.4</td>
</tr>
<tr>
<td>Wine</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**The Azores**

<table>
<thead>
<tr>
<th>Crop</th>
<th>Dryland:</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Milk</td>
</tr>
<tr>
<td></td>
<td>36.0</td>
</tr>
</tbody>
</table>

**The Northwest**

<table>
<thead>
<tr>
<th>Crop, traditional technologies:</th>
<th>Dryland, medium technologies:</th>
</tr>
</thead>
<tbody>
<tr>
<td>Milk</td>
<td>-85.4</td>
</tr>
<tr>
<td>Corn</td>
<td>-0.5</td>
</tr>
<tr>
<td>Potatoes</td>
<td>48.2</td>
</tr>
<tr>
<td>Wine</td>
<td>-43.4</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Crop, medium technologies:</th>
<th>Milk, Corn</th>
</tr>
</thead>
<tbody>
<tr>
<td>Milk</td>
<td>75.9</td>
</tr>
<tr>
<td>Corn</td>
<td>9.6</td>
</tr>
</tbody>
</table>
Evaluations of alternative investment projects, therefore, can use the PAM baseline results to discover which systems are currently socially profitable and which are creatures of supportive policy. Project analysis consists of carefully altering certain costs or technical coefficients and comparing discounted time streams of costs and returns. The main caveat is that critical parameters—world prices, factor prices, and technologies—can change in the future; such changes must also be considered in project analysis.

**PAM and Agricultural Research Policy Analysis**

A similar situation arises in the analysis of public expenditures for agricultural research. Almost all such expenditures are intended to improve crop yields or to reduce input needs, thereby raising profits in existing agricultural systems. But it is not enough to know that the improved technology will reduce costs in a system. The key issue in choosing which system should receive attention is to know the relative social profitabilities of all of the systems for which technological improvements are possible. No social benefits accrue if technological change merely offsets existing negative social profit. Complementary analyses include projections of changes in world prices and factor prices along with technological changes arising from agricultural research, since the new technologies would be used in the future under differing economic environments.

The baseline PAMs show how well current systems are operating. The technological changes (yield increases or cost reductions) needed to arrive at improved private or social profits can then be determined relative to some starting point. Efficiency and nonefficiency objectives need to be evaluated separately, especially when potential technologies are developed for systems that begin with large negative social profits. An application of partial budgeting is described in Box 12.8; the example considers labor-saving technical changes in rice-farming systems in three West African countries—Burkina Faso, Mali, and Niger.

**Communicating Results to Policy-Makers**

Policy memoranda and oral reports are essential aspects of good policy analysis. If done effectively, they are the basis of the development of strong working relationships and mutual trust between economic technicians and policy-makers. Ultimately, economic analysis will be used importantly by policy-makers only if they are convinced that the analysis has been done correctly, has been based on all available information, and has been interpreted in ways that illuminate the choice they face. Effective communication, therefore, is a critical final step of policy analysis.

Some analysts are very good at the first three parts of policy analysis—understanding methods, collecting information, and interpreting results—but their effectiveness is limited because they are unsure how to explain the results to policy-makers. The inability to write a good policy memo is only rarely caused by the

<table>
<thead>
<tr>
<th>Potatoes</th>
<th>61.4</th>
<th>48.4</th>
</tr>
</thead>
<tbody>
<tr>
<td>Wine, ramada</td>
<td>27.7</td>
<td>19.0</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Dryland, specialized technologies:</th>
</tr>
</thead>
<tbody>
<tr>
<td>Milk</td>
</tr>
<tr>
<td>Potatoes</td>
</tr>
<tr>
<td>Wine, cordao</td>
</tr>
</tbody>
</table>

analyst's lack of skill in writing. Instead, it is often an inability to state information in ways that are easily understood by policy-makers.

Policy-makers as a group are busy people. Most have not studied economics at all (or lately), and some seem to believe that economics and economists exist more to cause problems for them than to help them make better-informed decisions. Only the few highly trained economists among them have any patience with technical economics jargon, and usually the few policy-makers who have been formally trained in economics are the only ones who receive much intellectual excitement from understanding the intricacies of economic methods. For many policy-makers, therefore, an inherent distrust of economics is combined with an intense dislike of economic jargon and methods. This common situation puts most economic analysts at a severe disadvantage. They must be able to communicate clearly, or they may be ignored.

Brevity and clarity in composing policy memos are aided by the use of consistent principles of organization. Busy policy-makers want to be sure that all relevant topics are covered in a logical order. For this reason, analysts are well advised to adopt a standard format to use in writing policy memos. One format for presenting the essential elements of policy memos is summarized in the seven numbered paragraphs below. The remainder of this section discusses each of the seven elements of this format. By following this organization for policy memos, analysts who have experienced difficulty in communicating with policy-makers should be able to improve the clarity and shorten the length of their memos. A series of short examples in the format is presented at the end of the section.

### Box 12.8. Profitability and Technological Change in Rice Production in Three West African Countries

The table presents the results of partial budgeting analyses that investigated the social gain or loss from the introduction of alternative labor-saving technical changes in rice systems located in Burkina Faso, Mali, and Niger. The table was constructed with detailed information on several labor constraints, which appeared in the article from which the table is drawn. The results show the possibility of social gains from the introduction of animal traction, improved manual equipment, and small motorized threshers and the likelihood of social losses from the introduction of motorized techniques, which saved labor time but reduced labor productivity. This kind of analysis is also very informative for project planners or allocators of research funds, if the technical changes they might introduce would attempt to break labor constraints in the rice-farming systems. With relatively little effort beyond the initial construction and analysis of the budgets, the analyst can thus point out both baseline efficiencies and likely social gains or losses from specific technical changes.

<table>
<thead>
<tr>
<th>Description</th>
<th>Labor-saved(days)</th>
<th>Value of labor saved</th>
<th>Other indirect savings</th>
<th>Additional-direct costs of techniques</th>
<th>Other indirect costs</th>
<th>Possible yield effects</th>
<th>Net-gain</th>
</tr>
</thead>
</table>

Net savings over manual cultivation from changes in techniques, inland countries* (in francs per hectare, except as noted)
<p>| | | | | | | | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Basic manual system dam irrigation</strong></td>
<td>250</td>
<td>50,000</td>
<td>0</td>
<td>104,108</td>
<td>0</td>
<td>3.5</td>
<td>0</td>
</tr>
<tr>
<td><strong>Ox land preparation and transport</strong></td>
<td>36-41</td>
<td>7,800</td>
<td>812</td>
<td>5,264</td>
<td>112</td>
<td>Ambiguous</td>
<td>3,236</td>
</tr>
<tr>
<td><strong>Power tillers</strong></td>
<td>45</td>
<td>9,000</td>
<td>860</td>
<td>14,410</td>
<td>576</td>
<td>Nil</td>
<td>5,1268</td>
</tr>
<tr>
<td><strong>Tractor plowing, seeding, and transport:</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Compared to transplanting</strong></td>
<td>95</td>
<td>19,000</td>
<td>1,760</td>
<td>21,0518</td>
<td>2,697</td>
<td>Negative</td>
<td>-2,988</td>
</tr>
<tr>
<td><strong>Compared to broadcasting</strong></td>
<td>58</td>
<td>11,600</td>
<td>3,024</td>
<td>22,209</td>
<td>521</td>
<td>Ambiguous</td>
<td>8,106</td>
</tr>
<tr>
<td><strong>Manual rotary hoe</strong></td>
<td>12</td>
<td>2,400</td>
<td>48</td>
<td>223</td>
<td>0</td>
<td>Nil</td>
<td>2,225</td>
</tr>
<tr>
<td><strong>Ox-drawn seeder and weeder:</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Compared to transplanting</strong></td>
<td>55</td>
<td>11,000</td>
<td>720</td>
<td>972</td>
<td>2,186</td>
<td>Negative</td>
<td>8,562</td>
</tr>
<tr>
<td><strong>Compared to broadcasting</strong></td>
<td>20</td>
<td>4,000</td>
<td>2,140</td>
<td>972</td>
<td>2</td>
<td>Positive</td>
<td>5,166</td>
</tr>
<tr>
<td><strong>Herbicides</strong></td>
<td>30</td>
<td>6,000</td>
<td>120</td>
<td>7,070</td>
<td>274</td>
<td>Nil</td>
<td>-1,224</td>
</tr>
<tr>
<td><strong>Small motorized thresher:</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>2.5 metric ton</strong></td>
<td>23</td>
<td>4,500</td>
<td>0</td>
<td>2,120</td>
<td>0</td>
<td>Positive</td>
<td>2,380</td>
</tr>
<tr>
<td><strong>per hectare yield</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>3.5 metric ton</strong></td>
<td>32</td>
<td>6,300</td>
<td>0</td>
<td>2,968</td>
<td>0</td>
<td>Positive</td>
<td>3,332</td>
</tr>
</tbody>
</table>
Large-scale stationary threshers:

<table>
<thead>
<tr>
<th></th>
<th>Without</th>
<th>With transport by tractor</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>27</td>
<td>37</td>
</tr>
<tr>
<td></td>
<td>5,400</td>
<td>7,400</td>
</tr>
<tr>
<td></td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td>13,045</td>
<td>17,122</td>
</tr>
<tr>
<td>Values</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Incremental savings or costs</td>
<td>Negative</td>
<td>Negative</td>
</tr>
<tr>
<td></td>
<td>-7,645</td>
<td>-9,722</td>
</tr>
</tbody>
</table>


a. At 200 francs per day.
b. Includes estimated interest on working capital for labor and other inputs saved.
c. Includes the estimated value of charges for working capital on expenses for operation and maintenance of new equipment and on other additional inputs.
d. Values are totals per hectare, not incremental savings or costs.
e. Based on thirty-nine labor days.
f. Includes 500 francs saved because there is less use of hand tools.
g. Assumes double cropping.
h. Requires 35 horsepower tractor, disc plow, disc harrow, seed drill, and trailer.
i. Includes 1,000 francs for hand tools.
j. Includes 35 kilograms of extra seeds for drilling.
k. Includes 25 kilograms of seeds saved by drilling.
l. Assumes yields of 3.5 tons per hectare.

### Essential Elements of Policy Memos

1. **Policy issues**: brief statement of (a) the specific policy issues to be addressed in the memo, (b) the aspects of the issues that the analysis covers, and (c) the wider policy context within which to view the specific policy under consideration.

2. **Method of analysis**: intuitive summary of (a) the basic logic of the method of analysis to be used; (b) why the method is appropriate for the particular policy question being studied; (c) how extensively the method has been applied in academic and policy analyses, locally and abroad; (d) the principal strengths and limitations of the method; and (e) the main qualifications that the method entails.

3. **Information needs**: summary listing of (a) the essential data requirements for the analysis, (b) complementary information that assists in the interpretation of results but is not essential for application of the method, (c) principal assumptions used for exogenous parameters or missing data, and (d) historical information used to provide a context for interpretation of the results.

4. **Interpretation of results**: full explanation of (a) the results obtained from analysis of the empirical information in the context of the selected method; (b) the sensitivity of the base-case results to changes in key data, parameters, or assumptions; (c) the meaning of the results within the selected method and within the context of the policy issue being studied; and (d) qualification of the results arising from limitations inherent in the method selected and from missing information.
5. Implication of results for national interest groups: brief summary of (a) the policy choices (usually to continue the status quo, do more, or do less), (b) the beneficiaries of successful research results, (c) the likely size of gains and losses for principal interest groups, (d) the main government objectives that would seem to be furthered or harmed by the policy choices, and (e) rough orders of magnitude of the likely tradeoffs of government objectives associated with each of the policy choices.

6. International ramification of results: short discussion of (a) rough magnitude of the influence of policy choices on the country's quantities of import demands or export supplies of affected commodities, (b) likely impact of the policy choices on international flows of capital or labor, and (c) likely effect of the policy choices on the country's international diplomacy, including obligations to international organizations such as the World Bank, the International Monetary Fund, and the General Agreement on Tariffs and Trade.

7. Summary of the pros and cons of policy changes: single-paragraph summary that (a) highlights the lessons of the empirical analysis, (b) states clearly what the analysis contributes to the policy debate, and (c) identifies the likely consequences for interested parties of each of the policy choices, but does not offer any recommendations on selection among the policy choices.

Policy Issues
The first suggested element in the policy memo is a brief, clear statement of the specific policy issues addressed in the memo. This statement then should be both narrowed and broadened. It is narrowed by clarification of the exact aspects of the issue that can be addressed in the analysis, and it is broadened by the statement of how the specific issue fits into the wider policy context. The point is to be very clear about the limits of the analysis and about how the results fit into the bigger picture. This task is best done in one long or two short paragraphs of less than one page.

Method of Analysis
The next entry in the memo is an intuitive summary of the method of analysis that has been used to generate the results. This section is often the hardest one for analysts to write effectively because they tend to tell policy-makers more than they want or need to know. This part of the memo, above all others, must be clear and brief; otherwise, policy-makers will be forced to take the results on faith—since they will not have been able to understand how they were obtained—or to ignore the whole exercise.

How much to write depends in part on the complexity of the method. In general, however, the entire discussion of methods of analysis should not be more than one page. It should normally cover the five components outlined under the heading "Methods of Analysis" above. The first two are the most important. Even though the policy-maker probably is not interested in technical details, the basic logic of the method and why it is appropriate for the specific policy question being studied should be addressed. Stating these two things briefly can be difficult; teachers of economics often require several years before they understand methods well enough to explain them in simplified terms. Analysts new to a method thus might want to seek the assistance of those who have had more experience with it. The explanation needs to be made intuitive for policy-makers or it will fail.

The three other parts of summarizing the method are more straightforward. Policy-makers should be told whether the method is well known, fairly standard, or experimental; what strengths and weaknesses of the method will influence the results for the policy in question; and what qualifications are usually made to results obtained with the method. The discussion in this part should focus solely on method; it should not anticipate the results that will be reported later in the memo.
Information Needs

The section on information needs is perhaps the easiest to prepare, because it is rarely difficult for policy-makers to follow a discussion of information needs. There is sometimes a temptation, however, for analysts to offer excessive and lengthy detail. The rule, again, is to provide only as much as the policy-maker needs to know. But because the results from the analysis are necessarily only as good as the quality of the information used to generate them, policy-makers do need to know a lot of the detail concerning data inputs. This section, therefore, often runs to two pages.

It is helpful to divide information needs into four categories. The most critical category lists the essential data requirements for the analysis. In all economic methods, certain kinds of data are so important that they drive the system, since the results depend fundamentally on them. The second category assists in interpretation of the results but is not required for application of the method. If data in the first category are unavailable, the method cannot be used; if data in the second category cannot be found, the method can still be used, but some of the richness in interpretation of the results is lost. Policy-makers also need to hear briefly about a third kind of information—the main assumptions used for parameters that are entered from outside the method and the procedures used to substitute for missing data. Finally, it is desirable to provide policy-makers with historical information to help them place the results in a broader context. Often, they will already have this background information.

Interpretation of Results

Because the interpretation of results is the central part of the exercise, it is located at the center of the policy memo. Here is where the analyst has to explain what the results are and what they mean for the issues under study. This process can require up to two pages (or even more for larger studies).

Experience points to a four-step procedure in setting forth and explaining results of policy analysis. The first and most obvious step is to catalog the principal results obtained from analysis of the empirical information through use of the selected method. The trick is to scale down the mass of possible results and to report only those that are specifically used in the policy discussion. Usually, a second category of results comes from carrying out sensitivity analysis—that is, changing key data, parameters, or assumptions to study the effects on major results. A third and more difficult task is explaining the meaning of the results, first in the context of the method and then for the policy issue under examination. This task requires a focus on the results from the viewpoint of information and insights that policy-makers will need to make better decisions. The fourth kind of interpretation is qualification of the meaning of the results because of inherent limitations in the method or missing information. The purpose is to let policy-makers know how much faith they should have in the results.

Implications of the Results for National Interest Groups

The extension and summary of the results for national interest groups include several lessons that policy-makers typically require. Five steps are suggested: (1) reviewing the policy choices; (2) pointing out the likely gains and losses with each of the main choices; (3) making rough estimates, if possible, of the magnitude of the gains and losses for each of the principal interest groups; (4) identifying the primary government objectives (efficiency, income distribution, food security) that would be affected positively or negatively by the policy choices; and (5) sketching estimates, where feasible, of the size of the likely tradeoffs of government objectives associated with each of the policy choices. The purpose is to clarify the impact of policy change on political interest groups and on government objectives. It is not desirable for the analyst to include personal value judgments about good or bad outcomes. The task of the analyst is to make objective evaluations of the likely impacts of potential policies. The policy-makers then must choose among the outcomes.
**International Ramifications of the Results**

The section on international ramifications of the results is especially important for countries that are large traders on international markets and key actors in the international economy. It is less critical for small developing countries that are price-takers in the world markets and that generally follow rather than make international economic trends. Still, all countries need to be concerned about the international ramifications of their domestic policy actions.

Policy-makers need to be warned if domestic policies might have negative international effects. What is suggested here is a brief summary—only one paragraph unless the international effects are unusually large. The summary might contain references to three possible kinds of international influences: international trade effects and consequent impacts on world prices, if any; international factor effects (foreign investment and labor migration); and implications for international diplomatic obligations, including consistency with membership in international organizations and impacts on bilateral foreign policy.

**Summary of the Pros and Cons of Policy Choices**

The executive summary of pros and cons of policy choices should consist of a single paragraph aimed at exceptionally busy people in the highest ranks of government. It should state the essence of the policy memo. Like the body of the memo, it should not recommend policy choices. The summary should focus on three topics: (1) lessons of the empirical analysis—that is, the principal results; (2) contributions of the analysis to the policy debate for the specific issues being addressed; and (3) identification of the likely consequences of the policy choices for interested parties.

**Illustration of Elements of a Policy Memo**

1. **Policy Issues**
   a. Our government is considering whether to allocate a substantial amount of agricultural research resources to the development of high-yielding wheat varieties for the good-soil areas of the southern region.
   b. This memo summarizes the results of research measuring the degree of efficiency and the effects of government policy on the existing technology for producing wheat in the target zone.
   c. These research results need to be complemented by similar analyses of the existing efficiency of other agricultural systems and of the potentials for cost-reducing technological improvements in those systems so that the government can allocate its agricultural research resources most effectively.

2. **Method of Analysis**
   a. The method of analysis used to measure the efficiency and effects of policy for the good-soil southern wheat system is the policy analysis matrix (PAM), which measures profitability in actual market (private) prices and in efficiency (social) prices.
   b. The PAM method thus shows the actual revenues, costs, and profits that southern wheat farmers and millers are experiencing and those they would realize if they received sales revenues and paid the costs of production based on prices that would allocate resources most efficiently.
   c. Variations of this method have been widely used in academic studies locally and abroad and in policy work in international aid agencies and agricultural research centers. However, this study is the first one based on the PAM in this ministry.
   d. The principal strength of the PAM is that it gives measures of the economic efficiency of existing agricultural systems and of the effects of policy on those systems. Its main limitation is that its results are for a base year and thus need to be altered as principal parameters (such as world prices of outputs and inputs, wage rates, interest rates, and farming and processing technologies) change over time. The method, however, can readily accommodate such parameter changes.
e. The PAM efficiency measure, social profitability, is a requisite first step in the analysis. The next steps are to examine how much improved wheat technologies, developed with the research expenditure, might increase yields or save on inputs and thus reduce per unit costs and to contrast the results with those of similar studies for other systems that could benefit from more agricultural research.

3. Information Needs

a. The basic information required for PAM analysis is budget data (revenues and costs), broken down into prices and quantities for a representative wheat farm in the good-soil area of the southern region and for postfarm marketing and flour milling, world prices for products or inputs that are either imported or exported, and estimates of the efficiency values of wage and interest rates.

b. The basic PAM data need to be complemented by anticipated future changes in the budgets (related to the newly developed technologies), world prices, and factor (labor and capital) prices.

c. The budget data are complete and reliable, because they were compiled from agricultural census data, farm group information, and field surveys. The principal assumptions are that the social value of capital is 8 percent plus the rate of inflation and that the social value of skilled labor is 23 percent less than the actual market wage rate, reflecting taxes for pension contributions paid by employers.

d. No complete historical budget data for this area are known to exist. The current representative technology has spread gradually through the region during the past two decades.

4. Interpretation of Results

a. In the base year (1983), the representative wheat system was very profitable; private revenues were 27.42 (esudos per hectare) and private costs were 16.92; thus private profits were 10.50. Profitability was maintained at social prices. Social revenues, 22.79, were 4.63 less than private revenues because of import quotas on wheat; social costs, 19.76, were 2.84 above private costs mainly because of subsidies on fertilizers and credit; and therefore social profits, 3.03, although positive, were 7.47 less than private profits.

b. Projections to 1995 were made, using various assumptions about future world prices and factor costs, and the wheat system remained socially profitable under all reasonable sets of assumptions. No changes in technology were projected, because that analysis awaits information from agricultural research.

c. Two principal lessons emerge from these results. First, the current system operates efficiently, so all increases in social profit arising from new agricultural research will be net gains to the economy. Second, government policies-the import restrictions on wheat and the subsidies on fertilizer and credit-are resulting in excess private profits for good-soil wheat farmers.

d. The efficiency results appear robust because they are based on complete data and because they were realized under a wide variety of assumptions for key variables.

5. Implications of Results for National Interest Groups

a. The policy choice is whether the government should decide to allocate new research funds for southern region good-soil wheat.

b. The main beneficiaries of successful research results would be the wheat farmers and, to a lesser extent, the flour millers in the target region. The wheat farmers have farm wages and incomes that are currently among the highest in the country. They are already benefiting from agricultural price policies affecting wheat and inputs (see item 4). There are no obvious losers, other than taxpayers or those who would benefit if the research funds were spent elsewhere.

c. The size of the gains for wheat farmers is not yet estimable because no new budget data are now available on potential revenues and costs for the technologies to be developed with the research funds.
d. Successful research on wheat for the target area would likely advance two of the objectives of food policy but probably not the third. It would improve the efficiency of an already efficient system, and it would increase the productivity and reduce required imports for one of the country's staple foods, hence probably furthering food security. But the income distribution effects are not likely to be positive, because the technical innovations would aid mainly large, well-off farms that employ capital-intensive production technologies.

e. The policy tradeoff is thus a comparison of gains in efficiency and (probably) in food security with costs of income distribution. The decision will depend on the results of similar analyses for other commodities, technologies, and regions.

6. International Ramification of Results

a. Successful research is expected to reduce recent levels of imports of wheat by up to one-third, or a maximum of about 150,000 metric tons. This result is not expected to cause problems with the country's foreign wheat suppliers or to have any noticeable impact on price levels or variability in international markets.

b. A marked expansion of domestic wheat production is not expected to have any important impact on foreign investment or on international flows of migrant laborers.

c. No negative ramifications for the country's foreign policy are anticipated. Investment in agricultural research to develop new technology creates no large conflicts, except for some unhappiness among wheat exporters abroad. The new research, if approved, would be done in collaboration with the International Maize and Wheat Improvement Center (CIMMYT).

7. Summary of the Pros and Cons of Policy Choices

a. Wheat in the good-soil areas of the southern region is currently produced efficiently. Farmers there could earn profits even if they did not receive the transfers from existing policies that substantially protect wheat prices and subsidize fertilizer and credit.

b. The government is deciding whether to allocate large new amounts of agricultural research resources to improve good-soil wheat production in the south. Because the current production system is efficient, all gains from newly discovered or newly adopted wheat technologies will lead to increases in national as well as wheat farmer incomes.

c. Allocation of public funds for successful wheat research would thus increase economic efficiency and probably improve the country's food security as well. But most of the benefits would accrue to farmers who are already among the best off in the country. Similar analyses of the extent and distribution of gains from research on alternative commodities need to be carried out to assure the best allocation of funds.

Concluding Comments

Appropriate choice of research methods to meet policy needs is the first step in policy analysis, careful compilation of relevant information is the second, and correct interpretation of results in the context of policy choices is the third. Without good research design, therefore, the analyst has no story to tell. But that story needs to be heard by policy-makers or all of the research work will have only academic value. If both the design of research and the communication of its results are equally essential, the relationship between design and communication should be recognized from the start. Research designs need to be simplified so that their results can be easily communicated to nontechnical policy-makers. For this reason, the PAM approach was designed both as a logical framework for understanding policy and efficiency and as a method for empirical application. PAM results, consequently, can be interpreted and communicated easily to policy-makers.
SECTION I. IDENTIFYING PROJECT COSTS AND BENEFITS

We undertake economic analyses of agricultural projects to compare costs with benefits and determine which among alternative projects have an acceptable return. The costs and benefits of a proposed project therefore must be identified. Furthermore, once costs and benefits are known, they must be priced, and their economic values determined. All of this is obvious enough, but frequently it is tricky business.

What costs and benefits in agricultural projects are, and how we can define them in a consistent manner, are the topics of this chapter. In chapter 3 we will examine how we can obtain market prices. After the financial analyses are discussed in chapters 4-6, the economic analysis is addressed in chapter 7 with a discussion of how to adjust market prices to reflect the real resource flows.

Objectives, Costs, and Benefits

In project analysis, the objectives of the analysis provide the standard against which costs and benefits are defined. Simply put, a cost is anything that reduces an objective, and a benefit is anything that contributes to an objective.

The problem with such simplicity, however, is that each participant in a project has many objectives. For a farmer, a major objective of participating is to maximize the amount his family has to live on. But this is only one of the farmer's interests. He may also want his children to be educated; as a result, they may not be available to work full time in the fields. He may also value his time away from the fields: a farmer will not adopt a cropping pattern, however remunerative, that requires him to work ten hours a day 365 days a year. Taste preference may lead a farmer to continue to grow a traditional variety of rice for home consumption even though a new, high-yielding variety might increase his family income more. A farmer may wish to avoid risk, and so may plan his cropping pattern to limit the risk of crop failure to an acceptable level or to reduce the risk of his depending solely on the market for the food grains his family will consume. As a result, although he may be able to increase his income over time if he grows cotton instead of wheat or maize, he would rather continue growing food grains to forestall the possibility that in any one year the cotton crop might fail or that food grains might be available for purchase in the market only at a very high price. All these considerations affect a farmer's choice of cropping pattern and thus the income-generating capacity of the project. Yet all are sensible decisions in the farmer's view. In the analytical system presented here, we will try to identify the cropping pattern that we think the farmer will most probably select, and then we will judge the effects of that pattern on his incremental income and, thus, on the new income generated by the project.

For private business firms or government corporations, a major objective is to maximize net income, yet both have significant objectives other than simply making the highest profit possible. Both will want to diversify their activities to reduce risk. The private store owner may have a preference for leisure, which leads him to hire a manager to help operate his store, especially during late hours. This reduces the income since the manager must be paid a salary-but it is a sensible choice. For policy reasons, a public bus corporation may decide to maintain services even in less densely populated areas or at off-peak hours and thereby reduce its net income. In the analytical system here, we first identify the operating pattern that the firms in the project will most likely follow and then build the accounts to assess the effects of that pattern on the income-generating capacity of the project.
A society as a whole will have as a major objective increased national income, but it clearly will have many significant, additional objectives. One of the most important of these is income distribution. Another is simply to increase the number of productive job opportunities so that unemployment may be reduced—which may be different from the objective of income distribution itself. Yet another objective may be to increase the proportion of savings in any given period so there will be more to invest, faster growth, and, hence, more income in the future. Or, there may be issues to address broader than narrow economic considerations—such as the desire to increase regional integration, to upgrade the general level of education, to improve rural health, or to safeguard national security. Any of these objectives might lead to the choice of a project (or a form of a project) that is not the alternative that would contribute most to national income narrowly defined.

No formal analytical system for project analysis could possibly take into account all the various objectives of every participant in a project. Some selection will have to be made. In the analytical system here, we will take as formal criteria very straightforward objectives of income maximization and accommodate other objectives at other points in the process of project selection. The justification for this is that in most developing countries increased income is probably the single most important objective of individual economic effort, and increased national income is probably the most important objective of national economic policy.

For farms, we will take as the objective maximizing the incremental net benefit—the increased amount the farm family has to live on as a result of participating in the project—derived as outlined in chapter 4. For a private business firm or corporation in the public sector, we will take as the objective maximizing the incremental net income, to which we will return in chapter 5. And for the economic analysis conducted from the standpoint of the society as a whole, we will take as the objective maximizing the contribution the project makes to the national income—the value of all final goods and services produced during a particular period, generally a year. This is virtually the same objective, except for minor formal variations in definition, as maximizing gross domestic product (GDP). It is important to emphasize that taking the income a project will contribute to a society as the formal analytical criterion in economic analysis does not downgrade other objectives or preclude our considering them. Rather, we will simply treat consideration of other objectives as separate decisions. Using our analytical system, we can judge which among alternative projects or alternative forms of a particular project will make an acceptable contribution to national income. This will enable us to recommend to those who must make the investment decision a project that has a high income-generating potential and also will make a significant contribution to other social objectives. For example, from among those projects that make generally the same contribution to increased income, we can choose the one that has the most favorable effects on income distribution, or the one that creates the most jobs, or the one that is the most attractive among those in a disadvantaged region.

Thus, in the system of economic analysis discussed here, anything that reduces national income is a cost and anything that increases national income is a benefit. Since our objective is to increase the sum of all final goods and services, anything that directly reduces the total final goods and services is obviously a cost, and anything that directly increases them is clearly a benefit. But recall, also, the intricate workings of the economic system. When the project analyzed uses some intermediate good or service—something that is used to produce something else—by a chain of events it eventually reduces the total final goods and services available elsewhere in the economy. On the one hand, if we divert an orange that can be used for direct consumption and thus is a final good to the production of orange juice, also a final good, we are reducing the total available final goods and services, or national income, by the value of the orange and increasing it by the value of the orange juice. On the other hand, if we use cement to line an irrigation canal, we are not directly reducing the final goods and services available; instead, we are simply reducing the availability of an intermediate good. But the consequence of using the cement in the irrigation project is to shift the
By this mechanism, the project leads to an increase in the total amount of final goods and services, which is to say it increases the national income. Again, part of the analyst's task in the economic analysis is to estimate the amount of this increase in national income available to the society; that is, to determine whether, and by how much, the benefits exceed the costs in terms of national income. If this rather simple definition of economic costs and benefits is kept in mind, possible confusion will be avoided when shadow prices are used to value resource flows, a matter taken up in chapter 7.

Note that, by defining our objective for economic analysis in terms of change in national income, we are defining it in real terms. (Real terms, as opposed to money terms, refer to the physical, tangible characteristics of goods and services.) To an important degree, economic analysis, in contrast to financial analysis, consists in tracing the real resource flows induced by an investment rather than the investment's monetary effects.

With these objectives defined, we may then say that in financial analysis our numeraire—the common measurement used as the unit of account—is a unit of currency, generally domestic currency, whereas in economic analysis our numeraire is a unit of national income, generally also expressed in domestic currency. We will return to this topic in our discussion of determining economic values in chapter 7.

In the economic analysis we will assume that all financing for a project comes from domestic sources and that all returns from the project go to domestic residents. [This is one reason why we identify our social objective with the gross domestic product (GDP) instead of the more familiar gross national product (GNP).] This convention—almost universally accepted by project analysts—separates the decision of how good a project is in its income-generating potential from the decision of how to finance it. The actual terms of financing available for a particular project will not influence the evaluation. Instead, we will assume that the proposed project is the best investment possible and that financing will then be sought for it at the best terms obtainable. This convention serves well whenever financing can be used for a range of projects or even versions of roughly the same project. The only case in which it does not hold well is the rather extreme case in which foreign financing is very narrowly tied to a particular project and will be lost if the project is not implemented. Then the analyst may be faced with the decision of implementing a lower-yielding project with foreign financing or choosing a higher-yielding alternative but losing the foreign loan.

"With" and "Without" Comparisons

Project analysis tries to identify and value the costs and benefits that will arise with the proposed project and to compare them with the situation as it would be without the project. The difference is the incremental net benefit arising from the project investment. This approach is not the same as comparing the situation "before" and "after" the project. The before-and-after comparison fails to account for changes in production that would occur without the project and thus leads to an erroneous statement of the benefit attributable to the project investment.
A change in output without the project can take place in two kinds of situations. The most common is when production in the area is already growing, if only slowly, and will probably continue to grow during the life of the project. The objective of the project is to increase growth by intensifying production. In Syria at the time the First Livestock Development Project was appraised, for example, production in the national sheep flock was projected to grow at about 1 percent a year without the project. The project was to increase and stabilize sheep production and the incomes of seminomadic flock owners and sheep fatteners by stabilizing the availability of feed and improving veterinary services. With the project, national flock production was projected to grow at the rate of 3 percent a year. In this case, if the project analyst had simply compared the output before and after the project, he would have erroneously attributed the total increase in sheep production to the project investment. Actually, what can be attributed to the project investment is only the 2 percent incremental increase in production in excess of the 1 percent that would have occurred anyway (see figure 2-1).

A change in output can also occur without the project if production would actually fall in the absence of new investment. In Guyana, on the north coast of South America, rice and sugarcane are produced on a strip of clay and silt soil edging the sea. The coast was subject to erosion from wave action. Under the Sea Defense Project, the government of Guyana has built seawalls to prevent the erosion. The benefit from this project, then, is not increased production but avoiding the loss of agricultural output and sites for housing. A simple before-and-after comparison would fail to identify this benefit (figure 2-2).

In some cases, an investment to avoid a loss might also lead to an increase in production, so that the total benefit would arise partly from the loss avoided and partly from increased production. In Pakistan, many areas are subject to progressive salinization as a result of heavy irrigation and the waterlogging that is in part attributable to seepage from irrigation canals. Capillary action brings the water to the surface where evaporation occurs, leaving the salt on the soil. If nothing is done to halt the process, crop production will fall. A project is proposed to line some of the canals, thus to reduce the seepage and permit better drainage between irrigations. The proposed project is expected to arrest salinization, to save for profitable use the irrigation water otherwise lost to seepage, and to help farmers increase their use of modern inputs. The combination of measures would not only avoid a loss but also lead to an increase in production. Again, a simple before-and-after comparison would fail to identify the benefit realized by avoiding the loss (figure 2-3).

Of course, if no change in output is expected in the project area without the project, then the distinction between the before-and-after comparison and the with-and-without comparison is less crucial. In some projects the prospects for increasing production without new investment are minimal. In the Kemubu Irrigation Project in northeastern Malaysia, a pump irrigation scheme was built that permitted farmers to produce a second rice crop during the dry season. Without the project, most of the area was used for grazing, and with the help of residual moisture or small pumps some was used to produce tobacco and other cash crops. Production was not likely to increase because of the limited amount of water available. With the project now in operation, rice is grown in the dry season. Of course, the value of the second rice crop could not be taken as the total benefit from the project. From this value must be deducted the value forgone from the grazing and the production of cash crops. Only the incremental value could be attributed to the new investment in pumps and canals (figure 2-4).

Another instance where there may be no change in output without the project is the obvious one found in some settlement projects. Without the project there may be no economic use of the area at all. In the Alto Turi Land Settlement Project in northeastern Brazil, settlers established their holdings by clearing the forest, planting upland rice, and then establishing pasture for production of beef cattle. At the time the settlers took up their holdings the forest had not been economically exploited—nor was it likely to be, at least for
many years, in the absence of the project. In this case, the output without the project would be the same as the output before the project (figure 2-5).

**Direct Transfer Payments**

Some entries in financial accounts really represent shifts in claims to goods and services from one entity in the society to another and do not reflect changes in national income. These are the so-called direct transfer payments, which are much easier to identify if our definition of costs and benefits is kept in mind. In agricultural project analysis four kinds of direct transfer payments are common: taxes, subsidies, loans, and debt service (the payment of interest and repayment of principal).

Take taxes, for example. In financial analysis a tax payment is clearly a cost. When a farmer pays a tax, his net benefit is reduced. But the farmer's payment of tax does not reduce the national income. Rather, it transfers income from the farmer to the government so that this income can be used for social purposes presumed to be more important to the society than the increased individual consumption (or investment) had the farmer retained the amount of the tax. Because payment of tax does not reduce national income, it is not a cost from the standpoint of the society as a whole. Thus, in economic analysis we would not treat the payment of taxes as a cost in project accounts. Taxes remain a part of the overall benefit stream of the project that contributes to the increase in national income.

Of course, no matter what form a tax takes, it is still a transfer payment—whether a direct tax on income or an indirect tax such as a sales tax, an excise tax, or a tariff or duty on an imported input for production. But some caution is advisable here. Taxes that are treated as a direct transfer payment are those representing a diversion of net benefit to the society. Quite often, however, government charges for goods supplied or services rendered may be called taxes. Water rates, for example, may be considered a tax by the farmer, but from the standpoint of the society as a whole they are a payment by the farmer to the irrigation authority in exchange for water supplied. Since building the irrigation system reduces national income, the farmer's payment for the water is part of the cost of producing the crop, the same as any other payment for a production input. Other payments called taxes may also be payments for goods and services rendered rather than transfers to the government. A stevedoring charge at the port is not a tax but a payment for services and so would not be treated as a duty would be. Whether a tax should be treated as a transfer payment or as a payment for goods and services depends on whether the payment is a compensation for goods and services needed to carry out the project or merely a transfer, to be used for general social purposes, of some part of the benefit from the project to the society as a whole.

Subsidies are simply direct transfer payments that flow in the opposite direction from taxes. If a farmer is able to purchase fertilizer at a subsidized price, that will reduce his costs and thereby increase his net benefit, but the cost of the fertilizer in the use of the society's real resources remains the same. The resources needed to produce the fertilizer (or import it from abroad) reduce the national income available to the society. Hence, for economic analysis of a project we must enter the full cost of the fertilizer.

Again, it makes no difference what form the subsidy takes. One form is that which lowers the selling price of inputs below what otherwise would be their market price. But a subsidy can also operate to increase the amount the farmer receives for what he sells in the market, as in the case of a direct subsidy paid by the government that is added to what the farmer receives in the market. A more common means to achieve the same result does not involve direct subsidy. The market price may be maintained at a level higher than it otherwise would be by, say, levying an import duty on competing imports or forbidding competing imports altogether. Although it is not a direct subsidy, the difference between the higher controlled price set by
such measures and the lower price for competing imports that would prevail without such measures does
represent an indirect transfer from the consumer to the farmer.

Credit transactions are the other major form of direct transfer payment in agricultural projects. From the
standpoint of the farmer, receipt of a loan increases the production resources he has available; payment of
interest and repayment of principal reduce them. But from the stand-point of the economy, things look differ-
ent. Does the loan reduce the national income available? No, it merely transfers the control over resources
from the lender to the borrower. Perhaps one farmer makes the loan to his neighbor. The lending farmer can-
not use the money he lends to buy fertilizer, but the borrowing farmer can. The use of the fertilizer, of course,
is a cost to the society because it uses up resources and thus reduces the national income. But the loan transac-
tion does not itself reduce the national income; it is, rather, a direct transfer payment. In reverse, the same
thing happens when the farmer repays his loan. The farmer who borrowed cannot buy fertilizer with the
money he uses to repay the loan his neighbor made, but his neighbor can. Thus, the repayment is also a direct
transfer payment.

Some people find the concept of transfer payments easier to understand if it is stated in terms of real resource
flows. Taking this approach in economic analysis, we see that a tax does not represent a real resource flow; it
represents only the transfer of a claim to real resource flows. The same holds true for a direct subsidy that rep-
resents the transfer of a claim to real resources from, say, an urban consumer to a farmer. This line of reason-
ing also applies to credit transactions. A loan represents the transfer of a claim to real resources from the
lender to the borrower. When the borrower pays interest or repays the principal, he is transferring the claim to
the real resources back to the lender-but neither the loan nor the repayment represents, in itself, use of the
resources.

**Costs of Agricultural Projects**

In almost all project analyses, costs are easier to identify (and value) than benefits. In every instance of
examining costs, we will be asking ourselves if the item reduces the net benefit of a farm or the net income
of a firm (our objectives in financial analysis), or the national income (our objective in economic analysis).

*Physical goods*

Rarely will physical goods used in an agricultural project be difficult to identify. For such goods as con-
crete for irrigation canals, fertilizer and pesticides for increasing production, or materials for the construc-
tion of homes in land settlement projects, it is not the identification that is difficult but the technical
problems in planning and design associated with finding out how much will be needed and when.

*Labor*

Neither will the labor component of agricultural projects be difficult to identify. From the highly skilled
project manager to the farmer maintaining his orchard while it is coming into production, the labor inputs
raise less a question of what than of how much and when. Labor may, however, raise special valuation
problems that call for the use of a shadow price. Confusion may also arise on occasion in valuing family
labor. Valuing family labor will be discussed with farm budgets in chapter 4, and the overall question of
valuing unskilled labor will be taken up in chapter 7.

*Land*

By the same reasoning, the land to be used for an agricultural project will not be difficult to identify. It gen-
erally is not difficult to determine where the land necessary for the project will be located and how much
will be used. Yet problems may arise in valuing land because of the very special kind of market conditions that exist when land is transferred from one owner to another. These valuation problems will also be considered with farm budgets in chapter 4 and with determining economic values in chapter 7.

**Contingency allowances**

In projects that involve a significant initial investment in civil works, the construction costs are generally estimated on the initial assumption that there will be no modifications in design that would necessitate changes in the physical work; no exceptional conditions such as unanticipated geological formations; and no adverse phenomena such as floods, landslides, or unusually bad weather. In general, project cost estimates also assume that there will be no relative changes in domestic or international prices and no inflation during the investment period. It would clearly be unrealistic to rest project cost estimates only on these assumptions of perfect knowledge and complete price stability. Sound project planning requires that provision be made in advance for possible adverse changes in physical conditions or prices that would add to the baseline costs. Contingency allowances are thus included as a regular part of the project cost estimates.

Contingency allowances may be divided into those that provide for physical contingencies and those for price contingencies. In turn, price contingency allowances comprise two categories, those for relative changes in price and those for general inflation. Physical contingencies and price contingencies that provide for increases in relative costs underlie our expectation that physical changes and relative price changes are likely to occur, even though we cannot forecast with confidence just how their influence will be felt. The increase in the use of real goods and services represented by the physical contingency allowance is a real cost and will reduce the final goods and services available for other purposes; that is, it will reduce the national income and, hence, is a cost to the society. Similarly, a rise in the relative cost of an item implies that its productivity elsewhere in the society has increased; that is, its potential contribution to national income has risen. A greater value is forgone by using the item for our project; hence, there is a larger reduction in national income. Physical contingency allowances and price contingency allowances for relative changes in price, then, are expected—if unallocated—project costs, and they properly form part of the cost base when measures of project worth are calculated.

General inflation, however, poses a different problem. As we will note in chapter 3 in discussing future prices, in project analysis the most common means of dealing with inflation is to work in constant prices, on the assumption that all prices will be affected equally by any rise in the general price level. This permits valid comparisons among alternative projects. If inflation is expected to be significant, however, provision for its effects on project costs needs to be made in the project financing plan so that an adequate budget is obtained. Contingency allowances for inflation would not, however, be included among the costs in project accounts other than the financing plan.

**Taxes**

Recall that the payment of taxes, including duties and tariffs, is customarily treated as a cost in financial analysis but as a transfer payment in economic analysis (since such payment does not reduce the national income). The amount that would be deducted for taxes in the financial accounts remains in the economic accounts as part of the incremental net benefit and, thus, part of the new income generated by the project.

**Debt service**
The same approach applies to debt service—the payment of interest and the repayment of capital. Both are treated as an outflow in financial analysis. In economic analysis, however, they are considered transfer payments and are omitted from the economic accounts.

Treatment of interest during construction can give rise to confusion. Lending institutions sometimes add the value of interest during construction to the principal of the loan and do not require any interest payment until the project begins to operate and its revenues are flowing. This process is known as "capitalizing" interest. The amount added to the principal as a result of capitalizing interest during construction is similar to an additional loan. Capitalizing interest defers interest cost, but when the interest payments are actually due, they will, of course, be larger because the amount of the loan has been increased. From the standpoint of economic analysis, the treatment of interest during construction is clear. It is a direct transfer payment the same as any other interest payment, and it should be omitted from the economic accounts. Often interest during construction is simply added to the capital cost of the project. To obtain the economic value of the capital cost, the amount of the interest during construction must be subtracted from the capital cost and omitted from the economic account.

In economic analysis, debt service is treated as a transfer within the economy even if the project will actually be financed by a foreign loan and debt service will be paid abroad. This is because of the convention of assuming that all financing for a project will come from domestic sources and all returns from the project will go to domestic residents. This convention, as noted earlier, separates the decision of how good a project is from the decision of how to finance it. Hence, even if it were expected that a project would be financed, say, by a World Bank loan, the debt service on that loan would not appear as a cost in the economic accounts of the project analysis.

**Sunk costs**

Sunk costs are those costs incurred in the past upon which a proposed new investment will be based. Such costs cannot be avoided, however poorly advised they may have been. When we analyze a proposed investment, we consider only future returns to future costs; expenditures in the past, or sunk costs, do not appear in our accounts.

In practice, if a considerable amount has already been spent on a project, the future returns to the future costs of completing the project would probably be quite attractive even if it is clear in retrospect that the project should never have been begun. The ridiculous extreme is when only one dollar is needed to complete a project, even a rather poor one, and when no benefit can be realized until the project is completed. The "return" to that last dollar may well be extremely high, and it would be clearly worthwhile to spend it. But the argument that because much has already been spent on a project it therefore must be continued is not a valid criterion for decision. There are cases in which it would be preferable simply to stop a project midway or to draw it to an early conclusion so that future resources might be freed for higher-yielding alternatives.

For evaluating past investment decisions, it is often desirable to do an economic and financial analysis of a completed project. Here, of course, the analyst would compare the return from all expenditures over the past life of the project with all returns. But this kind of analysis is useful only for determining the yield of past projects in the hope that judgments about future projects may be better informed. It does not help us decide what to do in the present. Money spent in the past is already gone; we do not have as one of our alternatives not to implement a completed project.
Tangible Benefits of Agricultural Projects

Tangible benefits of agricultural projects can arise either from an increased value of production or from reduced costs. The specific forms in which tangible benefits appear, however, are not always obvious, and valuing them may be quite difficult.

**Increased production**

Increased physical production is the most common benefit of agricultural projects. An irrigation project permits better water control so that farmers can obtain higher yields. Young trees are planted on cleared jungle land to increase the area devoted to growing oil palm. A credit project makes resources available for farmers to increase both their operating expenditures for current production—for fertilizers, seeds, or pesticides—and their investment—for a tubewell or a power thresher. The benefit is the increased production from the farm.

In a large proportion of agricultural projects the increased production will be marketed through commercial channels. In that case identifying the benefit and finding a market price will probably not prove too difficult, although there may be a problem in determining the correct value to use in the economic analysis.

In many agricultural projects, however, the benefits may well include increased production consumed by the farm family itself. Such is the case in irrigation rehabilitation projects along the north coast of Java. The home-consumed production from the projects increased the farm families’ net benefit and the national income just as much as if it had been sold in the market. Indeed, we could think of the hypothetical case of a farmer selling his output and then buying it back. Since home-consumed production contributes to project objectives in the same way as marketed production, it is clearly part of the project benefits in both financial and economic analysis. Omitting home-consumed production will tend to make projects that produce commercial crops seem relatively high-yielding, and it could lead to a poor choice among alternative projects. Failure to include home-consumed production will also mean underestimating the return to agricultural investments relative to investments in other sectors of the economy.

When home-consumed crops will figure prominently in a project, the importance of careful financial analysis is increased. In this case, it is necessary to estimate not only the incremental net benefit—including the value of home-consumed production and money from off-farm sales—but also the cash available to the farmer. From the analysis of cash income and costs, one can determine if farmers will have the cash in hand to purchase modern inputs or to pay their credit obligations. It is possible to have a project in which home-consumed output increases enough for the return to the economy as a whole to be quite attractive, but in which so little of the increased production is sold that farmers will not have the cash to repay their loans.

**Quality improvement**

In some instances, the benefit from an agricultural project may take the form of an improvement in the quality of the product. For example, the analysis for the Livestock Development Project in Ecuador, which was to extend loans to producers of beef cattle, assumed that ranchers would be able not only to increase their cattle production but also to improve the quality of their animals so that the average live price of steers per kilogram would rise from S/5.20 to S/6.40 in constant value terms over the twelve-year development period. (The symbol for Ecuadorian sucre is S/.) Loans to small dairy farmers in the Rajasthan Smallholder Dairy Improvement Project in India are intended to enable farmers not only to increase output but also to improve the quality of their product. Instead of selling their milk to make ghee (cooking oil from clarified butter), farmers will be able to sell it for a higher price in the Jaipur fluid milk market. As in
these examples, both increased production and quality improvement are most often expected in agricultural projects, although both may not always be expected. One word of warning: both the rate and the extent of the benefit from quality improvement can easily be overestimated.

*Change in time of sale*

In some agricultural projects, benefits will arise from improved marketing facilities that allow the product to be sold at a time when prices are more favorable. A grain storage project may make it possible to hold grain from the harvest period, when the price is at its seasonal low, until later in the year when the price has risen. The benefit of the storage investment arises out of this change in "temporal value."

*Change in location of sale*

Other projects may include investment in trucks and other transport equipment to carry products from the local area where prices are low to distant markets where prices are higher. For example, the Fruit and Vegetable Export Project in Turkey included provision for trucks and ferries to transport fresh produce from southeastern Turkey to outlets in the European Common Market. The benefits of such projects arise from the change in "locational value."

In most cases the increased value arising from marketing projects will be split between farmers and marketing firms as the forces of supply and demand increase the price at which the farmer can sell in the harvest season and reduce the monopolistic power of the marketing firm or agency. Many projects are structured to ensure that farmers receive a larger part of the benefit by making it possible for them to build storage facilities on their farms or to band together into cooperatives, but an agricultural project could also involve a private marketing firm or a government agency, in which case much of the benefit could accrue to someone other than farmers.

*Changes in product form (grading and processing)*

Projects involving agricultural processing industries expect benefits to arise from a change in the form of the agricultural product. Farmers sell paddy rice to millers who, in turn, sell polished rice. The benefit to the millers arises from the change in form. Canners preserve fruit, changing its form and making it possible at a lower cost to change its time or location of sale. Even a simple processing facility such as a grading shed gives rise to a benefit through changing the form of the product from run-of-the-orchard to sorted fruit. In the Himachal Pradesh Apple Marketing Project in northern India, the value of the apples farmers produce is increased by sorting; the best fruit is sold for fresh consumption while fruit of poorer quality is used to make a soft drink concentrate. In the process, the total value of the apples is increased.

*Cost reduction through mechanization*

The classic example of a benefit arising from cost reduction in agricultural projects is that gained by investment in agricultural machinery to reduce labor costs. Examples are tubewells substituting for hand-drawn or animal-drawn water, pedal threshers replacing hand threshing, or (that favorite example) tractors replacing draft animals. Total production may not increase, but a benefit arises because the costs have been trimmed (provided, of course, that the gain is not offset by displaced labor that cannot be productively employed elsewhere).

*Reduced transport costs*
Cost reduction is a common source of benefit wherever transport is a factor. Better feeder roads or highways may reduce the cost of moving produce from the farm to the consumer. The benefit realized may be distributed among farmers, truckers, and consumers.

**Losses avoided**

In discussing with-and-without comparisons in project analyses earlier in this chapter, we noted that in some projects the benefit may arise not from increased production but from a loss avoided. This kind of benefit stream is not always obvious, but it is one that the with-and-without test tends to point out clearly. In Jamaica, lethal yellowing is attacking the Jamaica Tall variety of coconut. The government has undertaken a large investment to enable farmers to plant Malayan Dwarf coconuts, which are resistant to the disease. Total production will change very little as a result of the investment, yet both the farmers and the economy will realize a real benefit because the new investment prevents loss of income. The Lower Egypt Drainage Project involves the largest single tile drainage system in the world. The benefit will arise not from increasing production in the already highly productive Nile delta, but from avoiding losses due to the waterlogging caused by year-round irrigation from the Aswan High Dam.

Sometimes a project increases output through avoiding loss—a kind of double classification, but one that in practice causes no problem. Proposals to eradicate foot-and-mouth disease in Latin America envision projects by which the poor physical condition or outright death of animals will be avoided. At the same time, of course, beef production would be increased.

**Other kinds of tangible benefits**

Although we have touched on the most common kinds of benefits from agricultural projects, those concerned with agricultural development will find other kinds of tangible, direct benefits most often in sectors other than agriculture. Transport projects are often very important for agricultural development. Benefits may arise not only from cost reduction, as noted earlier, but also from time savings, accident reduction, or development activities in areas newly accessible to markets. If new housing for farmers has been included among the costs of a project, as is often the case in land settlement and irrigation projects, then among the benefits will be an allowance for the rental value of the housing. Since this is an imputed value, there are valuation problems that will be noted later.

**Secondary Costs and Benefits**

Projects can lead to benefits created or costs incurred outside the project itself. Economic analysis must take account of these external, or secondary, costs and benefits so they can be properly attributed to the project investment. (Of course, this applies only in economic analysis; the problem does not arise in financial analysis.)

When market prices are used in economic analysis, as has been the custom in the United States for water resource and other public works projects, it is necessary to estimate the secondary costs and benefits and then add them to the direct costs and benefits. This is a theoretically difficult process, and one easily subject to abuse. There is an extensive and complex literature on secondary costs and benefits that specifically addresses this analytical approach. For those who would like to review this literature, a good place to begin is the article by Prest and Turvey (1966), which outlines the historical development of the discussion. A highly technical review of the arguments can be found in Mishan (1971).

Instead of adding on secondary costs and benefits, one can either adjust the values used in economic analysis or incorporate the secondary costs and benefits in the analysis, thereby in effect converting them to
direct costs and benefits. This is the approach taken in most project analyses carried out by international agencies, in the systems based on shadow prices proposed in more recent literature on project analysis, and in the analytical system presented here.

Incorporating secondary costs or benefits in project analysis can be viewed as an analytical device to account for the value added that arises outside the project but is a result of the project investment. In the analytical system here, as will be explained in more detail in chapter 7, every item is valued either at its opportunity cost or at a value determined by a consumer's willingness to pay for the item. The effect is to eliminate all transfers—both the direct transfers discussed earlier in this chapter and the indirect transfers that arise because prices differ from opportunity costs. By this means we attribute to the project investment all the value added that arises from it anywhere in the society. Hence, it is not necessary to add on the secondary costs and benefits separately; to do so would constitute double counting.

One qualification must be made. If a project has a substantial effect on the quantity other producers are able to sell in imperfect markets—and most markets are imperfect—there may be gains or losses not accurately accounted for. Squire and van der Tak (1975, p. 23) cite the example of an improved road that diverts traffic from a railway that charges rates below marginal cost. This diversion entails a social gain from reduced rail traffic (in avoiding the social losses previously incurred on this traffic) in addition to the benefits to the road users measured directly. In agricultural projects, this is a rather infrequent case because prices generally are more flexible than in other sectors of the economy. In any event, in the practice of contemporary project analysis the size of these gains or losses is generally assumed to be insignificant, and no provision is made for them in the analysis.

Although using shadow prices based on opportunity costs or willingness to pay greatly reduces the difficulty of dealing with secondary costs and benefits, there still remain many valuation problems related to goods and services not commonly traded in competitive markets. One way to avoid some of these problems is to treat a group of closely related investments as a single project. For example, it is common to consider the output of irrigation projects as the increased farm production, since valuing irrigation water is difficult. Another example is found in development roads built into inaccessible areas. It is argued that the production arising from the induced investment activities of otherwise unemployed new settlers should be considered a secondary benefit of the road investment. One way of avoiding the problem is to view this case as a land settlement project in which the road is a component. New production is then properly included among the direct benefits of the project and can be included in the project accounts at market or shadow prices, and no attempt need be made to allocate the benefits between road investment and the other kinds of investment that must be made by settlers and government if settlement is to succeed.

Another group of secondary costs and benefits has been called "technological spillover" or "technological externalities." Adverse ecological effects are a common example, and the side effects of irrigation development are often cited as an illustration. A dam may reduce river flow and lead to increased costs for dredging downstream. New tubewell development may have adverse effects on the flow of existing wells. Irrigation development may reduce the catch of fish or may lead to the spread of schistosomiasis. When these technological externalities are significant and can be identified and valued, they should be treated as a direct cost of the project (as might be the case for reduced fish catches), or the cost of avoiding them should be included among the project costs (as would be the case for increased dredging or for investment to avoid pollution).

It is sometimes suggested that project investments may give rise to secondary benefits through a "multiplier effect." The concept of the multiplier is generally thought of in connection with economies having excess capacity. If excess capacity exists, an initial investment might cause additional increases in income as successive rounds of spending reduce excess capacity. In developing countries, however, it is shortage
of capacity that is characteristic. Thus, there is little likelihood of excess capacity giving rise to additional benefits through the multiplier. In any event, most of the multiplier effect is accounted for if we shadow-price at opportunity cost. Since the opportunity cost of using excess capacity is only the cost of the raw materials and labor involved, only variable costs will enter the project accounts until existing excess capacity is used up.

It is also sometimes suggested that there is a "consumption multiplier effect" as project benefits are received by consumers. Consumption multipliers are very difficult to identify and value. In any case, they presumably would be much the same for alternative investments, so omitting them from a project analysis would not affect the relative ranking of projects.

Intangible Costs and Benefits

Almost every agricultural project has costs and benefits that are intangible. These may include creation of new job opportunities, better health and reduced infant mortality as a result of more rural clinics, better nutrition, reduced incidence of waterborne disease as a result of improved rural water supplies, national integration, or even national defense. Such intangible benefits are real and reflect true values. They do not, however, lend themselves to valuation. How does one derive a figure for the long-term value of a child's life saved, or for the increased comfort of a population spared preventable, debilitating disease? Benefits of this kind may require a modification of the normal benefit-cost analysis to a least-cost type of analysis, a topic we will take up when we discuss valuation. Because intangible benefits are a factor in project selection, it is important that they be carefully identified and, where at all possible, quantified, even though valuation is impossible. For example, how many children will enroll in new schools? How many homes will benefit from a better system of water supply? How many infants will be saved because of more rural clinics?

In most cases of intangible benefits arising from an agricultural project, the costs are tangible enough: construction costs for schools, salaries for nurses in a public health system, pipes for rural water supplies, and the like. Intangible costs, however, do exist in projects. Such costs might be incurred if new projects disrupt traditional patterns of family life, if development leads to increased pollution, if the ecological balance is upset, or if scenic values are lost. Again, although valuation is impossible, intangible costs should be carefully identified and if possible quantified. In the end, every project decision will have to take intangible factors into account through a subjective evaluation because intangible costs can be significant and because intangible benefits can make an important contribution to many of the objectives of rural development.

SECTION II. PRICING PROJECT COSTS AND BENEFITS

Once costs and benefits have been identified, if they are to be compared they must be valued. Since the only practical way to compare differing goods and services directly is to give each a money value, we must find the proper prices for the costs and benefits in our analysis.

Prices Reflect Value

Underlying all financial and economic analysis is an assumption that prices reflect value-or can be adjusted to do so. In this chapter we will discuss how to find these prices. Before proceeding, however, it is necessary to define two economic concepts crucial to project analysis: marginal value product and opportunity cost.

Consider a Filipino farmer who applies nitrogenous fertilizer to his rice. In the 1979-80 season this fertilizer cost him P3.98 per kilogram of elemental nitrogen (N), and he received P1.050 for every kilogram of paddy rice he sold. (The symbol for Philippine pesos is P.) Table 3-1 shows the responsiveness of his rice
to fertilizer. At low levels of application, fertilizer has a great effect on rice yield. Increasing the application from no fertilizer to 10 kilograms of elemental nitrogen increased the farmer's

### Table 3-1. Crop Response to Nitrogen Fertilizer in the Philippines

<table>
<thead>
<tr>
<th>Nitrogen (kgs/ha)</th>
<th>Paddy rice</th>
<th>Shelled maize</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Yield (kgs/ha)</td>
<td>Value</td>
</tr>
<tr>
<td>0</td>
<td>3,442</td>
<td>3,614</td>
</tr>
<tr>
<td>10</td>
<td>3,723</td>
<td>3,909</td>
</tr>
<tr>
<td>20</td>
<td>3,971</td>
<td>4,170</td>
</tr>
<tr>
<td>30</td>
<td>4,187</td>
<td>4,396</td>
</tr>
<tr>
<td>40</td>
<td>4,370</td>
<td>4,588</td>
</tr>
<tr>
<td>50</td>
<td>4,520</td>
<td>4,746</td>
</tr>
<tr>
<td>60</td>
<td>4,637</td>
<td>4,869</td>
</tr>
<tr>
<td>70</td>
<td>4,721</td>
<td>4,957</td>
</tr>
<tr>
<td>80</td>
<td>4,772</td>
<td>5,011</td>
</tr>
<tr>
<td>90</td>
<td>4,791</td>
<td>5,031</td>
</tr>
<tr>
<td>100</td>
<td>4,777</td>
<td>5,016</td>
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<td>110</td>
<td>4,030</td>
<td>4,167</td>
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<tr>
<td>120</td>
<td>4,040</td>
<td>4,177</td>
</tr>
<tr>
<td>130</td>
<td>4,030</td>
<td>4,167</td>
</tr>
</tbody>
</table>

Personal communication from Pedro R. Sandoval, University of the Philippines at Los Banos, September 1980. Rice responses are based on Changes in Rice Farming in Selected Areas of Asia (Manila: International Rice Research Institute, 1978), p. 61. Maize responses are based on University of the Philippines at Los Banos Experiment Station records. Prices are from the Bureau of Agricultural Economics, Ministry of Agriculture, Republic of the Philippines.

- The farm-gate price of elemental nitrogen (N) in 1979-80 was F3.98 per kilogram
- The farmgate price of paddy rice in 1979-80 was F1.050 per kilogram.
- The marginal value product is the extra revenue that comes from increasing the quantity of an input used by one unit, all other quantities remaining constant. In this instance, the marginal value product is the increased value of paddy rice or shelled maize from using 1 additional kilogram of elemental nitrogen. Note that in this table the interval between levels of elemental nitrogen is 10 kilograms. Thus, the marginal value product of elemental nitrogen applied to rice between the 60- and 70-kilogram levels of application is the difference in value of output between the two levels divided by 10, or P8.80 [(4,957 - 4,869) / 10 = 8.80].
- The farm-gate price of shelled yellow maize in 1979-80 was P1.034 per kilogram.
- Beyond application of 100 kilograms of elemental nitrogen, all marginal value products for paddy rice are negative; therefore, figures for these applications of nitrogen to rice are not reported.

yield from 3,442 kilograms to 3,723 kilograms per hectare and increased the value of his output by P295, from P3,614 to P3,909. Thus, for every additional kilogram of elemental nitrogen the farmer applied at this
level, he received P29.50 in return \[(3,909 - 3,614) / 10 = 29.50\]. The extra revenue from increasing the quantity of an input used, all other quantities remaining constant, is the marginal value product of the input. In this case, then, the marginal value product of a kilogram of fertilizer is P29.50.

If the farmer could buy fertilizer for P3.98 a kilogram and use it to increase output by P9.50, it obviously would have paid him to apply more. But as the intensity of application increases, each additional kilogram of fertilizer has less and less effect on production. If the farmer had increased his application from 80 to 90 kilograms per hectare, he would have increased the value of his production by only P20, from P5,011 to P5,031, and the marginal value product of a kilogram of fertilizer would have fallen to only P2.00 \[(5,031 - 5,011) / 10 = 2.00\]. Since he would have had to pay P3.98 per kilogram, it clearly would not have been worthwhile to apply fertilizer at this rate. In fact, it would only have paid the farmer to apply fertilizer up to the rate at which the marginal value product just equaled the price. For this Filipino farmer, it would have paid him to apply approximately 80 kilograms of nitrogen: between 70 and 80 kilograms the marginal value product of each additional kilogram was some P5.40, whereas between 80 and 90 kilograms it fell to P2.00. Thus, the farmer would have expanded his fertilizer use until he reduced the marginal value product of the fertilizer to its market price, and the market price, therefore, is an estimate of the marginal value product of the fertilizer.

The optimal amount of fertilizer to use will change, of course, when the price of fertilizer changes relative to the price of rice. If the relative price of fertilizer were to rise, the farmer would respond by reducing the amount of fertilizer he applies, increasing the marginal value product of the fertilizer (but reducing the total amount and value of production) until the marginal value product of the fertilizer again just equals its price. Suppose fertilizer were to double in price to P8.00 per kilogram of elemental nitrogen, and rice prices remained unchanged. Then, table 3-1 indicates the farmer should reduce the amount of fertilizer applied to a hectare from 80 kilograms to 70 kilograms, since between 60 and 70 kilograms the marginal value product was some P8.80 but between 70 and 80 kilograms it was only some P5.40.

In practice, because of risk and limited resources, the farmer would probably not have applied the amounts indicated here. We may consider that the farmer reduces his expected return by some "risk discount." Even so, the principle we are illustrating remains the same: the farmer equates the expected marginal value product less some risk discount to the price of fertilizer.

If this farmer also grew maize, for which in 1979-80 he would have received P1.034 per kilogram of shelled grain, table 3-1 indicates it would have paid him (in the absence of risk) to apply some 100 kilograms of elemental nitrogen to each hectare, because between 90 and 100 kilograms the marginal value product of a kilogram of nitrogen applied to maize was P5.20, whereas between 100 and 110 kilograms the marginal value product fell to P3.10, below the price of fertilizer.

Now, suppose the farmer had limited resources and could not obtain sufficient credit to increase his fertilizer application on both rice and maize to where the marginal value product equaled the price. Suppose the farmer had only 2 hectares, 1 planted in rice and 1 in maize, and resources sufficient to purchase just 80 kilograms of nitrogen. How should he have used it? Should he have put it all on rice and none on maize? If he did, he would have applied fertilizer to his rice at the level where the marginal value product was just about equal to its market price. But suppose he had shifted some fertilizer, instead, to maize. If he had shifted 10 kilograms, he would have reduced the value of his rice production by P54- from P5,011 to P4,957, or by P5.40 for each kilogram shifted-but he could have obtained some P238 for the 10 kilograms applied to maize, since the marginal value product between 0 and 10 kilograms was some P23.80 per kilogram. In other words, at these levels each kilogram of nitrogen shifted would reduce the rice value by P5.40 but increase the value of maize output by some P23.80. In the language of economics, the opportunity cost of fertilizer shifted from rice to maize was P5.40. Opportunity cost, thus, is the benefit forgone by using a scarce resource for one purpose—in this case applying fertilizer to maize—instead of for its best alternative use-in
this case using the fertilizer to produce rice. Said another way, the opportunity cost is the return a resource can bring in its next best alternative use. What would be the opportunity cost if the farmer were to move a kilogram of fertilizer in the other direction, back from maize to rice? He would have given up P23.80 to gain only P5.40-not a very attractive proposition-and the opportunity cost, obviously, would be some P23.80.

Given his limited resources, it would pay the farmer to shift fertilizer from rice to maize until the marginal value product of fertilizer applied to both crops is the same. In the case of the Filipino farmer who could buy only 80 kilograms of fertilizer, if on the one hand he were to move 40 kilograms to maize, reducing his application on rice from 80 kilograms to 40 kilograms, he would have increased the marginal value product of the fertilizer on his rice to some P15. On the other hand, the 40 kilograms shifted away from rice and put on maize would have decreased the marginal value product of nitrogen applied to maize also to about P15. At these levels, there would be no advantage in shifting fertilizer between the two crops-the opportunity cost of shifting more fertilizer from rice to maize would be about P15, but the gain would also be only about P15-and the farmer would have reached the optimal level of application to both crops.

Note, however, that if the farmer could somehow have bought as much fertilizer as he wanted at the market price of P3.98 per kilogram-perhaps through a credit program-then the market price of fertilizer would have become its opportunity cost, and (in the absence of a risk discount) he should have increased his application to 80 kilograms on rice and 100 kilograms on maize.

From a single farmer to the economy as a whole, the same principles apply. In a "perfect" market-one that is highly competitive, with many buyers and sellers, all of whom have perfect knowledge about the market-every economic commodity would be priced at its marginal value product, since every farmer will have expanded his fertilizer use to where its marginal value product equals its price, and the same will have happened for every other item in the economy. That is, the price of every good and service would exactly equal the value that the last unit utilized contributes to production, or the value in use of the item for consumption would exactly balance the value it could contribute to additional production. If a unit of goods or services could produce more or bring greater satisfaction in some activity other than its present use, someone would have been willing to bid up its price, and it would have been attracted to the new use. When this price system is in "equilibrium," the marginal value product, the opportunity cost, and the price will all be equal. Resources will then have been allocated through the price mechanism so that the last unit of every good and service in the economy is in its most productive use or best consumption use. No transfer of resources could result in greater output or more satisfaction.

Without moving further into price theory, we can consider some direct implications for agricultural projects of the assumption that prices reflect value.

First, as everyone knows, markets are not perfect and are never in complete equilibrium. Hence, prices may reflect values only imperfectly. Even so, there is a great deal of truth in this price theory based on the model of perfect markets. In general, the best approximation of the "true value" of a good or service that is fairly widely bought and sold is its market price. Somebody in the economy is willing to pay this price. One can presume that this buyer will use the item to increase output by at least as much as its price, or that he is willing to exchange something of value equal to the price to gain the satisfaction of consuming the item. Hence, the market price of an item is normally the best estimate of its marginal value product and of its opportunity cost, and most often it will be the best price to use in valuing either a cost or a benefit. In financial analysis, as we have noted, the market price is always used. But in economic analysis some other price—a "shadow price"—may be a better indicator of the value of a good or service; that is, a better estimate of its true opportunity cost to the economy. When prices other than market prices are used in economic analysis, however, the burden of proof is on the analyst.
Finding Market Prices

Project analyses characteristically are built first by identifying the technical inputs and outputs for a proposed investment, then by valuing the inputs and outputs at market prices to construct the financial accounts, and finally by adjusting the financial prices so they better reflect economic values. Thus, the first step in valuing costs and benefits is finding the market prices for the inputs and outputs, often a difficult task for the economist.

To find prices, the analyst must go into the market. He must inquire about actual prices in recent transactions and consult many sources—farmers, small merchants, importers and exporters, extension officers, technical service personnel, government market specialists and statisticians, and published or privately held statistics about prices for both national and international markets. From these sources the analyst must come up with a figure that adequately reflects the going price for each input or output in the project.

Point of first sale and farm-gate price

In project analysis, a good rule for determining a market price for agricultural commodities produced in the project is to seek the price at the "point of first sale." If the point of first sale is in a relatively competitive market, then the price at which the commodity is sold in this market is probably a relatively good estimate of its value in economic as well as financial terms. If the market is not reasonably competitive, in economic analysis the financial price may have to be adjusted better to reflect the opportunity cost or value in use of the commodity.

For many agricultural projects in which the objective is increased production of a commodity, the best point of first sale to use is generally the boundary of the farm. We are after what the farmer receives when he sells his product—the "farm-gate" price. The increased value added of the product as it is processed and delivered to a market arises as a payment for marketing services. This value added is not properly attributed to the investment to produce the commodity. Rather, it arises from the labor and capital engaged in the marketing service. Usually the price at point of first sale can be accepted as the farm-gate price; even if this point is in a nearby village market, the farmer sells his output there and thus earns for himself any fee that might be involved in transporting the commodity from the farm to the point of first sale. But if any new equipment is necessary to enable the farmer to do this—say, a new bullock cart or a new truck—then that new equipment must be shown as a cost incurred to realize the marketing benefit in the project.

In projects producing commodities for well-organized markets, the farm-gate price may not be too difficult to determine. This would be true for most food grains traded domestically in substantial quantities. One may think of wheat in most countries of the Middle East and South Asia, of rice in South and Southeast Asia, and of maize in much of Latin America. It would also be true of farm products for which the processor is generally the first buyer (such as fresh fruit bunches for palm oil in Malaysia or milk in Jamaica), where the price quoted to the farmer is the price on his farm, and the firm responsible for the marketing comes to the farm to pick up the product.

In many cases, however, the prices in a reasonably competitive market or in the price records kept by the government statistical service will include services not properly attributable to the investment in the project itself. This may happen, for instance, when the only price series available for a product records the prices at which it has been sold in a central market—such as the price for eggs in Madras, for melons in Tehran, or for vegetables in Bogota. In that case, the project analyst will have to dig deeper to find out how
to value the marketing services. Then he can adjust the central market price to reduce it to the farm-gate price.

The farm-gate price is generally the best price at which to value home-consumed production. In some cases it may be extremely difficult to determine just what a realistic farm-gate price is for a crop produced primarily for home consumption because so little of the crop appears on markets. This is the case, for example, for manioc and cocoyam in Africa. On the one hand, some argue that the true value of the crop is overstated if the market price is used as a basis for valuation because such a small proportion of the product is actually sold. On the other hand, the same crop in different situations may not be so difficult to value. Manioc is sold extensively in Nigeria to make gari flour, and it is commonly traded in local markets in tropical Latin America and the Caribbean.

The farm-gate price may be a poor indicator of the true opportunity cost we want to use in economic analysis. In Ghana the Marketing Board takes some proportion of the cocoa price as a tax for development purposes. In Thailand, a rice "premium"—that is, a tax on rice exports—effectively keeps the domestic price well below what the international market would pay. In these cases, when the commodity is traded its economic value would have to be considered higher than the actual farm-gate price, and this price distortion will have to be corrected in the economic analysis. In other cases, just the opposite happens. In Mexico the price of maize is maintained at a high level to transfer income to ejidatarios, the small farmers. In Malaysia, the price of rice is supported above world market levels to encourage local production and to reduce imports. In these cases, part of the price does not really reflect the economic value of the product—its cost if it could be imported—but rather an indirect income transfer to small farmers. Again, this price distortion will have to be corrected in the economic analysis.

**Pricing intermediate goods**

By emphasizing the point of first sale as a starting point for valuing the output of our projects, we are also implying that imputed prices should be avoided for intermediate goods in our analysis. An intermediate good is an item produced primarily as an input in the production of another good. If an intermediate good is not freely traded in a competitive market, we cannot expect to obtain a price established by a range of competitive transactions. Fodder produced on a farm and then fed to the dairy animals on the farm is an example of such an intermediate product. If increased fodder production is an element in the proposed agricultural project, the analyst would avoid valuing it. Instead, the analyst would treat the whole farm as a unit and value the milk produced at its point of first sale or value the calves sold as feeder cattle. Treatment of intermediate products will vary from project to project depending on the particular marketing structures. In some countries it would hardly make sense in an egg production project to value the pullets produced in a pullet production enterprise and then "sell" these pullets to the egg production enterprise on the same farm. But in other countries there might be an active market in pullets, which would mean that we could expect to find a reasonably competitive price to use in the economic analysis. To avoid most of the problems that might be introduced by trying to impute values for intermediate products, the financial accounts in agricultural projects are based on budgets for the whole farm instead of on budgets for individual activities on the farm; that is, on the budget for the egg farm as a whole rather than on the budget for a pullet production activity.

A frequently encountered intermediate good in agricultural projects is irrigation water. The "product" of an irrigation system—water—is, of course, really intended to produce agricultural commodities. The price farmers are charged for the water is generally determined administratively, not by any play of competitive market forces. If the analyst were to try to separate the irrigation system from the production it makes possible, he would be faced with a nearly impossible task of determining the value of irrigation water. Hence, it is
not surprising that the economic analyses of most irrigation projects take as the basis for the benefit stream the value of the agricultural products that are offered in a relatively free market at the point of first sale.

Other problems in finding market prices
Considerable confusion often arises in determining the values for two important inputs in agricultural projects, land and labor. This happens primarily when the analysis moves from the financial project accounts to the economic analysis (to which we will turn in chapter 7). In the accounts prepared for the financial analysis, the treatment of prices for land and labor is quite straightforward: the price used is the price actually paid. Thus, if the farmers in a settlement project are expected to pay the project authority a price for the land they acquire, perhaps through a series of installments, then the actual price in the year it is paid is entered in the project accounts. In the financial analysis, we do not question whether this is a "good" price in economic terms. Similarly, if land must be bought for the right-of-way for canals in an irrigation project, the actual price to be paid is entered in the project accounts in the financial analysis. Or, if the project includes tenant farmers who will receive help in increasing wheat production, then in the financial accounts for these tenant farmers the analyst will enter the rent paid each year at the amount actually paid, or at the farm-gate value of the wheat delivered to the landowner if the tenants pay rent in kind.

If farm accounts are laid out on a with-and-without basis following the format suggested in chapter 4, in those instances where the project involves only changing the cropping pattern (say, a shift from pasture to irrigated sorghum), the cost of the land (in this instance an opportunity cost) need not be separately entered because of the form of the account. When the net benefit without the project is subtracted from the net benefit with the project, the contribution of the land to the old cropping pattern is also subtracted and only the incremental value remains.

In valuing labor for the financial analysis accounts, again, the problems arise when the financial accounts are adjusted to reflect economic values. For financial analysis, the analyst enters the amounts actually paid to hired labor, either in wages or in kind, in the farm budgets or project accounts. Family labor is treated differently. It is not entered as a cost; instead, the "wages" for the family become a part of the net benefit. Thus, if our project increases the net benefit, it also in effect increases the family's income or "wages" for its labor. Again, if we follow the format suggested in chapter 4, the account will automatically value the family labor at its opportunity cost, and the incremental net benefit will reflect any increased return the family may receive for its labor.

Prices for agricultural commodities generally are subject to substantial seasonal fluctuation. If this is the case, some decision must be made about the point in the seasonal cycle at which to choose the price to be used for the analysis. A good starting point is the farm-gate price at the peak of the harvest season. This is probably close to the lowest price in the cycle. The line of reasoning here is that as prices rise during the cycle at least some part of that rise is a result not of the production activities of the farmer but of the marketing services embodied in storing the crop until consumers want it. But, markets being what they are, there may be an element of imperfection in the harvest price level. Market channels may become so glutted that merchants try actively to discourage farmers from immediately bringing their crop to the market by offering a price that even the merchants themselves would admit is too low. Even so, the need to sell immediately to meet debt obligations may force farmers to offer their crops despite these artificially low, penalty prices. In some cases, therefore, a price higher than the farm-gate price in the harvest season may be selected. But there is an obligation here to justify the price chosen as more valid than the lowest seasonal price. One way to resolve this problem may be to include an element of credit in the project design. This would permit farmers to withhold their product from the market until prices have had a chance to rise from their seasonal lows but at the same time to have enough money to meet their cash obligations and family
living expenses. The credit element may also include credit for building on-farm storage so that farmers will have a safe place to store their production until they decide to market it at a better price.

Prices vary among grades of product, of course, and picking the proper price for project analysis may involve making some decisions about quality of the product. In general, it can be assumed that farmers will produce in the future much the same quality as they have in the past and will market their product ungraded. In many agricultural projects, however, one objective is to upgrade the quality of production as well as to increase the total output. Small dairy farmers, for instance, may be able with the help of the project investment to meet the sanitation standards of the fluid milk market and to command a higher price; or reduced time for delivery may hold down sucrose inversion in sugarcane; or better pruning will increase the average size of the oranges Moroccan farmers can offer European buyers. In such cases, the proper price to select is the average price expected for the quality to be produced.

A special problem occurs in pricing housing. If project investment includes housing construction, as would be the case for a settlement project, then one benefit arising from the investment is the rental value of the house. Since the rental value will usually be an imputed value rather than a real market price, care must be exercised in determining it. No more should be allowed for the rental value than would normally be paid by a prospective tenant family. Nor should more rental value be allowed than the family would be expected to pay for a comparable house in the vicinity or in a similar area elsewhere (if the new settlement is in a distant locale). In particular, the temptation should be avoided to take as a rental value some arbitrary proportion of the housing cost. Otherwise, overly elaborated housing construction might be justified simply by assigning it an unrealistically high imputed value.

**Project boundary price**

Prices used in analyzing agricultural projects are not necessarily farm-gate prices. The concept of a farm-gate price may be expanded to a “project boundary” price if a project has a marketing component or if it is a purely marketing project. Many projects have a marketing component, perhaps because there is no competitive channel reaching down to the farm-gate level for the unprocessed product. Of concern in these projects are both the farm-gate price (on which to base the estimates of the net benefit to the farmer) and the price at which the processed product is sold in the market (after being handled in the facilities financed by the project). Such a case is found in the Rahad project in the Sudan. There the Roseires dam on the Blue Nile will provide irrigation water for the production of cotton, which will be ginned in new facilities financed by the project. The analyst, of course, is interested in the price of cotton paid to the farmers so that their incomes can be estimated. But, since this price is set administratively, it could not be used directly in the economic analysis of the project. The analyst is also interested in the price of ginned cotton because that is the first product the project will actually sell in a reasonably competitive market. In this case, the point of first sale is f.o.b. (free on board) Port Sudan, and the price there becomes the basis for the benefit stream.

**Predicting Future Prices**

Since project analysis is about judging future returns from future investment, as analysts we are immediately involved in judging just what future prices may be. This is a matter of judgment, not mechanics. No esoteric mathematical model exists to come to the aid of the project analyst; like everyone else he must take into consideration all the facts he can find, seek judgments from those he respects, and then come to a conclusion himself. It tends to be a rather unsettling process. The only consolation is that careful, considered judgment about the course of future prices is better than giving the matter no thought at all and wasting scarce resources on incompletely planned projects.
We have been discussing how to find market prices, and it is from these current prices that we begin. The best initial guess about future prices is that they will retain the present relationships, or perhaps the average relationship they have borne to each other over the past few years. We must consider, however, whether these average relationships will change in the future and how we will deal with a general increase in the level of prices owing to inflation.

*Changes in relative prices*

We may first raise the question of whether relative prices will change. Will some inputs become more expensive over time in relation to other commodities? Will some prices fall relatively as supplies become more plentiful? Not easy questions to deal with, but some approaches to answers can be made. In financial analysis, of course, a change in a relative price means a change in the market price structure that producers face either for inputs or for outputs. A change in a relative price, then, is reflected directly in the project's financial accounts. A rise in the relative price of fertilizer reduces the incremental net benefit—the amount the farm family has to live on. It is thus clearly a cost in the farm account. The same line of reasoning can be applied in the financial analysis for any other group participating in the project.

A change in the relative price of an item implies a change in its marginal productivity—that is, a change in its marginal value product—or a change in the satisfaction it contributes when it is consumed. In economic analysis, where maximizing national income is the objective, a change in the relative price of an input implies a change in the amount that must be forgone by using the item in the project instead of elsewhere in the economy; it is therefore a change in the contribution the output of the project makes to the national income. Thus, changes in relative prices have a real effect on the project objective and must be reflected in project accounts in the years when such changes are expected.

There are several kinds of commodities subject to future changes in relative prices. Most agricultural project analysts would probably agree that the relative price of energy-intensive agricultural inputs is likely to continue to rise over the next several years, just as it has done over the past few years. Thus, on the input side the project accounts might show an annual increase, at least for the first decade or so, in the cost of fuel for tractors, for transporting the harvested crop, for drying grain, and for such petroleum-based inputs as fertilizers and chemical pesticides. On the output side, there may be some commodities that will probably continue to be in short supply and whose prices will rise as incomes increase—one might think of mutton from fat-tailed sheep in Iran, or, for that matter, of most meat products worldwide. How much will prices increase relative to those of other products? Certainly a difficult question, but one the project analyst must confront. For a range of products—from industrial crops such as fibers or oilseeds to food grains and vegetables—judgments will have to be made on the best possible basis.

In some countries, relative wages of rural labor may rise as economic development proceeds during the life of a project. This will have implications not only for the prices assumed for hired labor, but also for the incentive effect exerted by a given change in net benefit and for the technology assumed as a basis for projections in the farm budgets and project accounts.

*Inflation*

In the past few years, virtually every country has experienced inflation, and the only realistic assessment is that this will continue. No project analyst can escape deciding how to deal with inflation in his analysis.
The approach most often taken is to work the project analysis in constant prices. That is, the analyst assumes that the current price level (or some future price level—say, for the first year of project implementation) will continue to apply. It is assumed that inflation will affect most prices to the same extent so that prices retain their same general relations. The analyst then need only adjust future price estimates for anticipated relative changes, not for any change in the general price level. By comparing these estimates of costs and benefits with the constant prices, he is able to judge the effects of the project on the incomes of participants and its income-generating potential for the society as a whole. Although the absolute (or money) values of the costs and benefits in both the financial and the economic analyses will be incorrect, the general relations will remain valid, and so the measures of project worth discussed in chapter 9 may be applied directly. Working in constant prices is simpler and involves less calculation than working in current prices; for the latter, every entry has to be adjusted for anticipated changes in the general price level.

It is quite possible, however, to work the whole project analysis in current prices. This has the advantage that all costs and benefits shown would be estimates of what the real prices will be in each year of the project. Furthermore, estimates of investment costs will be in current terms for the year in which they are expected to occur, so that the finance ministry can more easily anticipate these needs and budget the amounts necessary to finance the project on schedule. The problem in this approach is that it involves predicting inflation rates. For items to be imported, some help is available in the World Bank report on Price Prospects for Major Primary Commodities (1982a), which is published biennially and updated in six-month intervals and includes an estimate of inflation in developed countries. For domestic inflation rates in developing countries, other sources will have to be consulted, but obtaining an estimate in which one can place even minimal confidence will be difficult, to say the least. Even casting the project analysis in current terms may raise problems for the project analyst. Many governments have policy goals that call for greatly reduced inflation, and they cannot permit the circulation of official documents that assume rapid inflation will continue.

The mere mechanics of using current prices presents no analytical problem in project analysis, although it does complicate the computations. When we consider measures of project worth, some means of deflating future prices must be adopted for comparing future cost and benefit streams in terms that are free from the effects of general price increases. We will illustrate the methodology in chapter 10 in the section "Calculating Measures of Project Worth Using Current Prices."

Even when constant prices are used in the more conventional approach to project analysis, a table estimating the budgetary effects of the project in current terms that will prevail at least during the investment phase should be included either in the analysis or as a separate memorandum. It would list in current prices domestic currency needs, foreign exchange requirements, and subsidies. The finance ministry would then have better estimates to work with, and delays because of budgetary shortfalls could more easily be avoided.

**Prices for Internationally Traded Commodities**

For commodities that enter significantly in international trade, whether inputs or outputs, project analysts usually obtain price information from various groups of specialists who follow price trends and make projections about relative prices in the future. In many countries where agricultural exports are important, there are groups in the agriculture ministry or the finance ministry whose help may be sought.

There are also several international organizations and trade groups to which the analyst may turn. The World Bank, for instance, publishes its projections under the title Price Prospects for Major Primary Commodities. The Food and Agriculture Organization (FAO) sponsors intergovernmental groups that
publish price information on rice; grains (other than rice); citrus; hard fibers; fibers (other than hard fibers); oilseeds, oils and fats; bananas; wine and wine products; tea; meat; and cocoa. Information may be obtained from the secretary of the relevant intergovernmental group at the FAo headquarters in Rome or from the FAo representative in individual countries.

Several international commodity organizations keep detailed price information for the products of their interest. These include the International Tea Committee, the International Cocoa Organization, the International Wool Secretariat, the International Coffee Organization, the International Association of Seed Crushers, the International Rubber Study Group, and the International Sugar Organization, all with headquarters in London; the International Olive Oil Council in Madrid; and the International Cotton Advisory Committee in Washington.

Some individual nations systematically collect production and price information for crops and livestock products of interest to them, and they often are willing to share this information with analysts in other countries without charge or restriction. The United States Department of Agriculture—probably the most important of these—publishes detailed studies about most major crops traded in international markets. Information may be obtained from agricultural attaches in American embassies, or directly from the department's Foreign Agriculture Service. The Commonwealth Secretariat in London publishes information about price trends for commodities of interest to its member nations. A detailed list of "Sources of Information on World Prices" is available from the World Bank (Woo 1982).

Financial Export and Import Parity Prices

In projects that produce a commodity significant in international trade, the price estimates are often based on projections of prices at some distant foreign point. The analyst must then calculate the appropriate price to use in the project accounts, either at the farm gate or at the project boundary.

If the farm-gate or project boundary prices for the internationally traded commodities in the project are already known, and the prices in the particular country tend to follow world market prices, the farm-gate prices may be adjusted by the same relative amount as indicated, say, by the medium trend projected in the future relative prices supplied by one or another international organization. Also, in financial analysis, if the farm-gate price is set administratively and is not allowed to adjust freely to world prices, the relevant price to use is the administratively set price.

Simply adjusting domestic prices by the same relative amount as foreign prices often arrives at figures too rough for project analysis. The approach ignores the fact that marketing margins in commodity trade tend to be less flexible than the commodity prices themselves. There are also many instances in estimating the economic value of a traded commodity that involve deriving a shadow price based on international prices. In such instances it is necessary to calculate export or import parity prices. (See chapter 7, the subsection "Economic export and import parity values.") These are the estimated prices at the farm gate or project boundary, which are derived by adjusting the c.i.f. (cost, insurance, and freight) or f.o.b. prices by all the relevant charges between the farm gate and the project boundary and the point where the c.i.f. or f.o.b. price is quoted. The elements commonly included in c.i.f. and f.o.b. are given in table 3-2.
One common case for which an export parity price has to be calculated is that of a commodity produced for a foreign market. Table 3-3 gives an example based on the Rahad project in the Sudan. It shows the generalized elements for calculating export parity prices so that the same methodology can be applied in other cases. As noted earlier, the Rahad project included cotton gins. Since the gins produce lint and cottonseed for export and scarto, a by-product of very short fibers not suitable for export and sold locally, the analyst needed three prices. For the lint and seed estimates, he began with forecasts of the 1980 c.i.f. prices in current terms at Liverpool, which were available from World Bank publications. From these c.i.f. prices, he then deducted insurance, ocean freight, export duties, port handling costs, and rail freight from the cotton gin at the project site to Port Sudan, thus obtaining the export parity prices at the project boundary: LSd 178.650 for lint and LSd 18.097 for seed. (The symbol for Sudanese pounds is LSd.) The price for scarto, which was not exported, was based on the prevailing domestic price.

To illustrate, we may continue to calculate the export parity price at the farm gate, although in the Rahad example, where the farm-gate price was set administratively, this calculation was not made. The computations are laid out in the part of table 3-3 that continues from the entry for "Equals export parity price at project boundary." Here a new issue arises. The three products that the gin produces—lint, seed, and scarto—must be converted into their seed cotton equivalents, since it is seed cotton that the farmer sells. Similar conversions have to be made in many other instances—for example,
**Table 3-3. Financial Export Parity Price for Cotton, Rahad Irrigation Project, Sudan (1980 forecast prices)**

<table>
<thead>
<tr>
<th>Step in the calculation</th>
<th>Relevant step in the Sudanese example</th>
<th>Value per ton</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Lint</td>
</tr>
<tr>
<td>C.i.f. at point of import</td>
<td>C.i.f. Liverpool (taken as estimate for all European ports)</td>
<td>US$639.33</td>
</tr>
<tr>
<td><em>Deduct</em> unloading at point of import</td>
<td>Freight and insurance</td>
<td>39.63</td>
</tr>
<tr>
<td><em>Deduct</em> freight to point of import</td>
<td>F.o.b. Port Sudan</td>
<td></td>
</tr>
<tr>
<td><em>Deduct</em> insurance</td>
<td></td>
<td></td>
</tr>
<tr>
<td><em>Equals</em> f.o.b. at point of export</td>
<td>F.o.b. Port Sudan</td>
<td>US 599.70</td>
</tr>
<tr>
<td><em>Convert</em> foreign currency to domestic currency at official exchange rate</td>
<td>Converted at official exchange rate of LSd 1.000=US$2.872</td>
<td>LSd 208.809</td>
</tr>
<tr>
<td><em>Deduct</em> tariffs</td>
<td>Export duties</td>
<td>17.813</td>
</tr>
<tr>
<td><em>Add</em> subsidies</td>
<td>(None)</td>
<td></td>
</tr>
</tbody>
</table>
| *Deduct* local port charges | Port handling cost  
Lint: LSd 5.564 per ton  
Seed: LSd 1.510 per ton | 5.564 | 1.510 | |
| *Deduct* local transport and marketing costs from project to point of export (if not part of the project cost) | Freight to Port Sudan at LSd 6.782 per ton | 6.782 | 6.782 | |
| *Equals* export parity price at project boundary | Export parity price at gin at project site | LSd 178.650 | LSd 18.097 | |
| *Conversion allowance* (if necessary) | Convert ot seed cotton (LSd 178.650 x 0.4 + LSd 18.097 x 0.59 + LSd 110.200 x 0.01) | 71.460 | 10.677 | 1.102 |
| *Deduct* local storage, transport, and marketing costs (if not part of project cost) | Ginning, baling, and storage (LSd 15.229 per ton) | | 15.229 | |
| | Collection and internal transfer (LSd 1.064 per ton) | | 1.064 | |
| *Equals* export parity price at farm gate | Export parity price at the farm gate | | | LSd 66.946 |
LSd Sudanese pounds. US$ U.S. dollars


a. Scarto is a by-product of very short, soiled fibers not suitable for export and is sold locally at a price of LSd 110.200 per ton.

b. Seedcotton is converted into lint, seed, and scarto assuming 1 ton of seed cotton yields 400 kilograms seed, and 10 kilograms scarto. From this weighted price were deducted the ginning, baling, and storage charges and the costs of collection and transport from the farm gate to the gin; thus arriving at the farm-gate export parity price of LSd66.946.

A parallel computation leads to the import parity price. Here the issue is the price at which an import substitute can be sold domestically if it must compete with imports. Table 3-4 illustrates this issue with the example of maize production in Nigeria. The same example is presented diagrammatically in figure 3-1.

Nigeria is a net maize importer, and the project is to produce maize for domestic consumption to replace imported maize.

Table 3-4. Financial Import Parity Price of Early-crop Maize, Central Agricultural Development Projects, Nigeria

<table>
<thead>
<tr>
<th>Steps in the calculation</th>
<th>Relevant steps in the Nigerian example</th>
<th>Value per ton</th>
</tr>
</thead>
<tbody>
<tr>
<td>F.o.b. at point of export</td>
<td>F.o.b. U.S. Gulf ports, No. 2 U.S. yellow corn in bulk</td>
<td>US$116</td>
</tr>
<tr>
<td>Add freight to point of import</td>
<td>Freight and insurance</td>
<td>31</td>
</tr>
<tr>
<td>Add unloading at point of import</td>
<td>C.i.f. Lagos or Apapa</td>
<td>US$147</td>
</tr>
<tr>
<td>Add insurance</td>
<td>Converted at official exchange rate of N1 = US$1.62</td>
<td>N91</td>
</tr>
<tr>
<td>Equals c.i.f. at point of import</td>
<td>none</td>
<td>22</td>
</tr>
<tr>
<td>Convert foreign currency to domestic currency at official exchange rate</td>
<td>Landing and port charges (including the cost of bags)</td>
<td></td>
</tr>
<tr>
<td>Add tariffs</td>
<td>none</td>
<td></td>
</tr>
<tr>
<td>Deduct subsidies</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Add local port charges</td>
<td>Transport (based on a 350-kilometer average)</td>
<td>18</td>
</tr>
<tr>
<td>Equals price at market</td>
<td>Wholesale price</td>
<td>N 131</td>
</tr>
<tr>
<td>Conversion allowance if necessary</td>
<td></td>
<td>(Not necessary)</td>
</tr>
<tr>
<td>Deduct transport and marketing costs to relevant market</td>
<td>Primary marketing (includes assembly, cost of bags, and intermediary margins)</td>
<td>-14</td>
</tr>
<tr>
<td>Transport (based on a 350-kilometer average)</td>
<td></td>
<td>- 18</td>
</tr>
</tbody>
</table>
We begin with the f.o.b. price at the point of export—in this case U.S. ports on the Gulf of Mexico—derived from World Bank commodity estimates. To this we add freight and insurance to obtain the c.i.f. price at either Lagos or Apapa, the two Nigerian ports concerned. Then we would add any tariffs and subsidies (in this case there are none); add local port charges for harbor dues, fumigation, handling, and the like; and add local transport to the relevant inland market. The result is the wholesale price of imported maize. It is this wholesale price of maize in the inland market that is the focal point of our calculation. The alternative to project production is not to import the maize and transport it to the project area. Rather, the alternative is to import it and market it directly on the inland market. Thus the price the farmer can expect to receive in the absence of tariffs, subsidies, or an import ban is the wholesale price less the cost of moving his maize to the market. If the project had included processing facilities, then the relevant project boundary price would have been this wholesale price less handling costs from the processing facility to the wholesale market. In the Nigerian project, no processing facilities were included, so the relevant import parity price is the farm-gate price. As we move back from the wholesale market to the farm gate, we would have to provide for any conversion allowance. In this case none is necessary, since it is assumed that the farmer will sell shelled maize. From the wholesale price, then, we deduct local marketing costs including assembly, bags, and intermediary margins, transport from the farm to the market, and storage losses, thus obtaining the import parity price at the farm gate of N90. (The symbol for Nigerian naira is N.) This is the maximum price the farmer could expect to receive, again in the absence of tariffs, subsidies, or an import ban.

**SECTION III. DETERMINING ECONOMIC VALUES**

Once financial prices or costs and benefits have been determined and entered in the project accounts, the analyst estimates the economic value of a proposed project to the nation as a whole. The financial prices are the starting point for the economic analysis; they are adjusted as needed to reflect the value to the society as a whole of both the inputs and outputs of the project.

When the market price of any good or service is changed to make it more closely represent the opportunity cost (the value of a good or service in its next best alternative use) to the society, the new value assigned becomes the "shadow price" (sometimes referred to as an "accounting price"). In the strictest sense, a shadow price is any price that is not a market price, but the term usually also carries the connotation that it

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**Table 3-4. Financial Import Parity Price of Early-crop Maize, Central Agricultural Development Projects, Nigeria**

<table>
<thead>
<tr>
<th>Steps in the calculation</th>
<th>Relevant steps in the Nigerian example</th>
<th>Value per ton</th>
</tr>
</thead>
<tbody>
<tr>
<td><em>Deduct</em> local storage, transport, and marketing costs (if not part of the project costs)</td>
<td>Storage loss (10 percent of harvested weight)</td>
<td>-9</td>
</tr>
<tr>
<td><em>Equals</em> import parity price at farm gate</td>
<td>Imported parity price at farm gate</td>
<td>N 90</td>
</tr>
</tbody>
</table>

N = Nigerian naira


is an estimate of the economic value of the good or service in question, perhaps weighted to reflect income
distribution and savings objectives.

In chapter 2, for purposes of project analysis, we took the objective of a farm to be to maximize the farm
family's incremental net benefit, the objective of the firm to maximize its incremental net income, and the
objective of the society to maximize the contribution a project makes to the national income—the value of
all final goods and services produced in the country during a particular period. These objectives, and the
analysis to test their realization, were seen in financial terms for farms and firms. But economic analysis of
a project moves beyond financial accounting. Strictly speaking, we may say that in financial analysis our
numeraire—the common yardstick of account—is the real income change of the entity being analyzed valued
in domestic market prices and in general expressed in domestic currency. But in economic analysis, since
market prices do not always reflect scarcity values, our numeraire becomes the real, net national income
change valued in opportunity cost. As we will note below, one methodology expresses these economic val-
ues in domestic currency and uses a shadow price of foreign exchange; the shadow price increases the
value of traded goods to allow for the premium on foreign exchange arising from distortions caused by
trade policies. Another method in use expresses the opportunity cost value of real national income change
in domestic currency converted from foreign exchange at the official exchange rate and applies a conver-
sion factor to the opportunity cost or value in use of nontraded goods expressed in domestic currency; the
conversion factor reduces the value of nontraded goods relative to traded goods to allow for the foreign
exchange premium.

Before a detailed discussion of adjusting financial accounts to reflect economic values commences, an
important practical consideration must be emphasized. Many of the adjustments to the financial
accounts can become quite complex. Not every point made in this chapter will apply to every agricul-
tural project, nor will all points have the same importance in those projects where they do apply. The
complexity of some calculations and the relative importance of some adjustments recall the reason for
undertaking an economic analysis of a project: to improve the investment decision. Some adjustments
will make a considerable difference to the economic attractiveness of a proposed project; others will be
of minor importance, and no reasonable adjustment would change the investment decision. What we
need to do here is to adopt an accounting practice—the doctrine of materiality. The analyst must focus his
attention on those adjustments to the financial accounts that are likely to make a difference in the project
investment decision. He should use rough approximations or ignore trivial adjustments that will not
make any difference in the decision. There is an important balance to be struck between analytical ele-
gance and getting on with the job.

In this chapter we will adjust the financial prices of tangible items to reflect economic values in three suc-
cessive steps: (1) adjustment for direct transfer payments, (2) adjustment for price distortions in traded
items, and (3) adjustment for price distortions in nontraded items. Before embarking on this series of
adjustments, we will examine the problem of determining the appropriate premium for foreign exchange.
After completing the adjustments, we will summarize the main points in a "decision tree" for determining
economic values.

The series of successive adjustments to the financial accounts will lead to a set of economic accounts in
which all values are stated in "efficiency prices," that is, in prices that reflect real resource use or consump-
tion satisfaction and that are adjusted to eliminate direct and indirect transfers. These values will be market
prices when market prices are good estimates of economic value or they will be shadow prices when mar-
ket prices have had to be adjusted for distortions. When we adjust financial prices to reflect economic val-
ues better, in the vast majority of cases we will use the opportunity cost of the good or service as the
criterion. We will use opportunity costs to value all inputs and outputs that are intermediate products used
in the production of some other good or service. For some final goods and services, however, the concept
of opportunity cost is not applicable because it is consumption value that sets the economic value, not value in some alternative use. In these instances, we will adopt the criterion of "willingness to pay" (also called "value in use"). We need to do this, however, only when the good or service in question is nontraded (perhaps as a result of government regulation) during some part of the life of the project—a point to which we will return later in our discussion. Because the ultimate objective of all economic activity is to satisfy consumption wants, all opportunity costs are derived from consumption values, and thus from willingness to pay.

An example may clarify our use of willingness to pay and opportunity cost. Suppose a country that is a rather inefficient producer of sugar has a policy to forbid sugar imports to protect its local industry. The price of sugar may then rise well above what it would be if sugar were imported. Even at these higher prices, most consumers will still buy some sugar for direct consumption—say, in coffee or tea—even though they may use less sugar than if the price were lower. The domestic price of sugar will be above the world market price and will represent the value of the sugar by the criterion of willingness to pay. If we were now to consider the economic value of sugar from the standpoint of its use in making fruit preserves, its value would become the opportunity cost of diverting the sugar from direct consumption, where willingness to pay is the criterion and has set the economic value.

Economic analysis, then, will state the cost and benefit to the society of the proposed project investment either in opportunity cost or in values determined by the willingness to pay. The costs or values will be determined in part by both the resource constraints and the policy constraints faced by the project. The difference between the benefit and the cost—the incremental net benefit stream—will be an accurate reflection of the project's income-generating capacity—that is, its net contribution to real national income.

The system outlined here will make no adjustment for the income distribution effects of a proposed project nor for its effect on the amount of the benefit generated that will be invested to accelerate future growth. Rather, the economic project analysis, stated in efficiency prices, will judge the capacity of the project to generate national income. The analyst can then choose from those alternative projects (or alternative formulations of roughly the same project) the high-yielding alternative that in his subjective judgment also makes the most effective contribution to objectives other than maximizing national income—objectives such as income distribution, savings generated, number of jobs produced, regional development, national security, or whatever. The choice about the kind of project will of course be made rather early in the project cycle. Thus, it may be determined early on that for reasons of social policy a project will be preferred that encourages smallholder agriculture rather than plantations. Then, the choices will likely be several projects or variants of projects that encourage smallholders; the analytical technique presented here can determine from among the projects that will further the desired social objective the ones that are more economically efficient.

Although the system outlined here makes no adjustment for income distribution effects or for saving versus consumption, it is compatible with other analytical systems that do. In particular, Squire and van der Tak (1975) recommend evaluating proposed projects first by using essentially the same efficiency prices that will be estimated here and then by further adjusting these prices to weight them for income distribution effects and for potential effects on further investment of the benefits generated. The systems in Little and Mirrlees (1974) and the u xo Guidelines for Project Evaluation (1972a), with minor departures, also propose evaluating the project by first establishing its economic accounts in efficiency prices and then by adjusting these accounts to weight them for income distribution and savings effects. Making allowances for income distribution and savings effects involves somewhat more complex adjustments than those necessary to estimate efficiency prices; it also unavoidably incorporates some element of subjective judgment. Although these systems have attracted widespread interest among econ-
omists, their application has been only partial or on a limited scale. The system of economic analysis using efficiency prices that is outlined here is essentially the one currently used for all but a few World Bank projects and also the one used for most analyses of projects funded by other international organizations.

The economic analysis follows on the financial analysis presented in the preceding chapters; it will be based on projected farm budgets similar to those in chapter 4, on projected accounts for commercial firms such as those in chapter 5, and on projected government cash flows such as those in chapter 6. Since these accounts are projected for the life of the project, there will be no separate allowance for depreciation. Instead, as noted earlier, the costs will have been entered in the years they are incurred and the returns in the year they are realized.

In the economic analysis, we will want to work with accounts cast on a constant basis; thus we will want to be sure that any inflation contingency allowances have been taken out. As noted in chapter 2, however, physical contingency allowances and contingency allowances intended to allow for relative price changes are properly incorporated in the economic accounts, even when the accounts are in constant prices. Of course, any of the items included among the contingencies may be revalued, if necessary, to adjust them from their market prices to economic values. The projected financial accounts will usually not have any entry for cash. Instead, they will show separately the cash position of the farmer or note a cumulative cash surplus or deficit. It is possible, however, that some accounts may have a cash balance included in an entry for working capital or the like. If such an entry exists, it must be removed from the economic analysis; since we will be working on a real basis in the economic accounts, we will show real costs when they occur and real benefits when they are realized.

**Determining the Premium on Foreign Exchange**

Adjusting the financial accounts of a project to reflect economic values involves determining the proper premium to attach to foreign exchange. That determination quickly involves issues of obtaining proper values and of economic theory. Fortunately for most agricultural project analysts, the answer to the question about how to determine the foreign exchange premium is simple (and simplistic): ask the central planning agency. The point is that if various alternative investment opportunities open to a nation are to be compared, the same foreign exchange premium must be used in the economic analysis of each alternative. Otherwise we will be mixing apples and oranges and cannot use our analysis reliably to choose among alternatives. Sometimes, however, the analyst will be forced to make his own estimate of the foreign exchange premium. A practical approach, along with some of the theoretical and applied problems of the computation, is given by Ward (1976), Little and Mirrlees (1974), Squire and van der Tak (1975), and the UNIDO Guidelines (1972a) also outline in considerable detail how to make the conversion between foreign exchange and domestic currency when their analytical systems are used.

The need to determine the foreign exchange premium arises because in many countries, as a result of national trade policies (including tariffs on imported goods and subsidies on exports), people pay a premium on traded goods over what they pay for nontraded goods. This premium is not adequately reflected when the prices of traded goods are converted to the domestic currency equivalent at the official exchange rate. The premium represents the additional amount that users of traded goods, on an average and throughout the economy, are willing to pay to obtain one more unit of traded goods. Since all costs and benefits in economic analysis are valued on the basis of opportunity cost or willingness to pay, it is the relation between willingness to pay for traded as opposed to nontraded goods that establishes their relative value.

The premium people are willing to pay for traded goods, then, represents the amount that, on the average, traded goods are mispriced in relation to nontraded items when the official exchange rate is used to convert
foreign exchange prices into domestic values. By applying the premium to traded goods, we are able to compare the values of traded and nontraded goods by the criterion of opportunity cost or willingness to pay. Although this premium is commonly referred to as the foreign exchange premium, it should be recognized that the premium is actually a premium for traded goods; foreign exchange itself has no intrinsic value. The premium for traded goods is a premium on the particular "basket" of traded goods that the present and projected trade pattern implies. Of course, future patterns of trade could change the exact composition of the basket, and thus the premium would change; to estimate these changes involves a knowledge of elasticities—the way demand and supply of goods and services vary when prices change—that is generally not available. Where such elasticities are known, it is possible for a well-trained economist to provide the project analyst with a more accurate estimate of the expected premium on foreign exchange.

If traded items were to be taken into the project analysis at an economic value obtained by simply multiplying the border price by the official exchange rate without adjusting for the foreign exchange premium, imported items would appear too cheap and domestic items too dear. This would encourage overinvestment in projects that use imports. For example, if combine harvesters look cheap because no allowance is made for the premium on traded goods, then imported combines might displace local harvest labor, even though the local labor might have no other opportunities for employment.

There are two equivalent ways of incorporating the premium on foreign exchange in our economic analysis. The first is to multiply the official exchange rate by the foreign exchange premium, which yields a shadow foreign exchange rate. [Note that this derivation of the shadow exchange rate is appropriate for efficiency analysis of projects and thus has a discrete definition. Other definitions of the shadow exchange rate are appropriate depending on the uses to which the rate will be put. Bacha and Taylor (1972) discuss some of these alternatives.] The shadow exchange rate is then used to convert the foreign exchange price of traded items into domestic currency. The effect of using the shadow exchange rate is to make traded items relatively more expensive in domestic currency by the amount of the foreign exchange premium. (An alternative arithmetic formulation is to convert the foreign exchange price into domestic currency at the official exchange rate and then multiply by 1 plus the foreign exchange premium stated in decimal terms.) The shadow exchange rate approach has been used in the past in most World Bank projects when adjustments have been made to allow for the foreign exchange premium on traded goods, and it is also used in the UNIDO Guidelines (1972a).

An alternative way to allow for the foreign exchange premium on traded items that is increasingly coming into use is to reduce the domestic currency values for nontraded items by an amount sufficient to reflect the premium. This is sometimes called the "conversion factor" approach. In its simplest form, based on straightforward efficiency prices, a single conversion factor—the "standard conversion factor" of Squire and van der Tak—is derived by taking the ratio of the value of all exports and imports at border prices to their value at domestic prices (Squire and van der Tak 1975, p. 93). In this form, the standard conversion factor bears a close relation to our shadow exchange rate; indeed, the standard conversion factor may be determined by dividing the official exchange rate by the shadow exchange rate or by taking the reciprocal of 1 plus the foreign exchange premium stated in decimal terms. Market prices or shadow prices of nontraded items are then multiplied by this standard conversion factor, and this reduces them to their appropriate economic value. Little and Mirrlees and Squire and van der Tak both adopt the conversion factor approach. In addition, both pairs of authors recommend deriving specific conversion factors for particular groups of products that will allow for any difference between market prices and opportunity costs and for the foreign exchange premium on traded items. As a result, their specific conversion factors may always be applied directly to domestic market prices. These authors also recommend that their conversion factors be calculated in social prices by including distribution weights.
In the valuation system followed here, all items are valued at efficiency prices without allowance for distribution weights (the issue of selecting projects to achieve distributional objectives is treated as a subsequent decision). This being the case, consideration of the distribution-weighted conversion factors proposed by Little and Mirrlees and Squire and van der Tak may be left aside, and we may focus our discussion on the Squire and van der Tak standard conversion factor as it relates to efficiency prices.

The relation between the official exchange rate (in the equations below, OER), the foreign exchange premium (Fx premium), the shadow exchange rate (SER), and the standard conversion factor (SCF) is perhaps easier to understand in equation form:

\[ \text{OER} \times (1 + \text{premium}) = \text{SER} \]

and

\[ \frac{1}{(1 + \text{Fx premium})} = \text{SCF} \]

so that, as Squire and van der Tak note (1975, p. 93),

\[ \text{SER} = \frac{\text{OER}}{\text{SCF}} \]

and

\[ \text{SCF} = \frac{\text{OER}}{\text{SER}} \]

We may illustrate these relations by an example taken from the Agricultural Minimum Package Project in Ethiopia. At the time the project was appraised, the analyst knew that the official exchange rate of Eth$2.07 = US$1 failed to account for a foreign exchange premium of at least 10 percent. (The symbol for the Ethiopian dollar is Eth$; since this project was appraised the name of the currency unit has been changed to birr.) Thus, the analyst multiplied the official exchange rate by 1 plus a 10 percent foreign exchange premium to obtain a shadow exchange rate of Eth$2.28 = US$1 (2.07 \times 1.1 = 2.28) that he rounded up to Eth$2.30 = US$1. The shadow exchange rate was then applied to all traded items in the financial accounts, thereby increasing their relative value.

If the domestic currency is worth more per unit than the foreign exchange, the arithmetic is somewhat different. At the time the Nucleus Estate/Smallholder Oil Palm Project in Rivers State, Nigeria, was appraised, the official exchange rate was N 1 = US$1.54. (The symbol for Nigerian naira is N.) The project analysts were given a shadow exchange rate of N1 = US$1.27 to use in their economic evaluation. If, however, they had simply been informed that the foreign exchange premium was 21 percent, they could have determined the shadow exchange rate by dividing the dollar value by 1 plus the premium stated in decimal terms (1.54 - 1.21 = 1.27).

Of course, the effect of applying the shadow exchange rate to the traded items in the Ethiopian project was to make all nontraded items 10 percent less expensive in relation to the traded items in the economic accounts as opposed to the financial accounts. Now, instead of increasing the relative value of traded items, we could reduce the value of all nontraded items appearing in the financial accounts so that in the economic account they are relatively 10 percent less expensive. To do this we calculate the standard conversion factor, which is 1 divided by 1 plus the amount of the foreign exchange premium stated in decimal terms. In this case, the result is a factor of 0.909 (1 - 1.1 = 0.909). To obtain the economic values, we would then multiply all financial prices for non-traded items by this factor if these market prices have been judged
good estimates of opportunity cost or good estimates of economic value on grounds of willingness to pay. For nontraded items such as wage rates for unskilled labor for which it is felt that the market price has overstated the economic values, we would first determine a good estimate of the economic value in domestic currency and then multiply that by the standard conversion factor. Financial prices for traded items, whether imports or exports, would be left unchanged in the economic accounts except that any transfer payment included in these prices would be taken out. To get all values into the same currency, we would convert all foreign currency prices to domestic currency values using the official exchange rate.

When we turn to determining measures of project worth in chapter 9, we will find that the absolute value of the net present worth differs depending on which approach we use, shadow exchange rate or conversion factor, but that the relative net present worths of different projects analyzed by the same approach will not change. Whichever approach is used, the internal rate of return, the benefit-cost ratio, and the net benefit-investment ratio do not change. (Using a number of disaggregated conversion factors, rather than a standard conversion factor, can give different values for the measures of project worth. Hence, for projects at the margin of acceptability, using specific conversion factors rather than a standard conversion factor or a shadow exchange rate may result in a different decision on whether to accept or reject, but such cases are infrequent.)

**Adjusting Financial Prices to Economic Values**

Let us now proceed with the adjustments necessary to convert financial prices to economic values. We will divide these into three steps: (1) adjustment for direct transfer payments, (2) adjustment for price distortions in traded items, and (3) adjustment for price distortions in non-traded items. We will then note that, for what are termed "indirectly traded" items (locally produced items that use a high proportion of traded inputs, such as locally assembled tractors, or construction that uses imported materials), steps 2 and 3 must be done at the same time.

**Step 1. Adjustment for direct transfer payments**

The first step in adjusting financial prices to economic values is to eliminate direct transfer payments.

Direct transfer payments (see chapter 2) are payments that represent not the use of real resources but only the transfer of claims to real resources from one person in the society to another. In agricultural projects, the most common transfer payments are taxes, direct subsidies, and credit transactions that include loans, receipts, repayment of principal, and interest payments. Two credit transactions that might escape notice are accounts payable and accounts receivable. All these entries should be taken out before the financial accounts are adjusted to reflect economic values.

Many important subsidies in agriculture operate not by means of direct payments but through mechanisms that change market prices. These subsidies are not direct subsidies treated as direct transfer payments but rather are indirect subsidies. The financial price of an item for which the price has been changed because of an indirect subsidy is converted to an economic value according to the procedures outlined below for traded items in step 2 and, as appropriate, for nontraded items in step 3.

**Step 2. Adjustment for price distortions in traded items**
The second step in adjusting financial prices to economic values is the adjustment for distortions in market prices of traded items.

Traded items are those for which, if exports, f.o.b. price > domestic cost of production, or the items may be exported through government intervention by use of export subsidies and the like, and, if imports, domestic cost of production > c.i.f. price.

Conceptually—and usually in practice, too—prices for traded items in project analysis are more easily dealt with than those for nontraded items. We begin the valuation by determining the "border price." For imports, this normally will be the c.i.f. price and, for exports, normally the f.o.b. price. The border price is then adjusted to allow for domestic transport and marketing costs between the point of import or export and the project site; the result is the efficiency price to be used in the project account (see the subsection on "Economic export and import parity values," below).

If the proposed project produces something that can be used in place of imported goods—that is, if it produces an "import substitute"—the value to the society is the foreign exchange saved by using the domestic product valued at the border price, in this case the c.i.f. price. But if the project uses items that might otherwise have been exported—that is, if it uses "diverted exports"—then the opportunity cost to the society of these items is the foreign exchange lost on the exports forgone valued at the border price, this time the f.o.b. price.

If we are using conversion factors to allow for the foreign exchange premium, the economic value of a traded item would be obtained by converting the foreign exchange price to its domestic currency equivalent using the official exchange rate.

If we are using the shadow exchange rate to allow for the foreign exchange premium, the economic value of a traded item would be obtained by converting the foreign exchange price to its domestic currency equivalent using the shadow exchange rate.

To illustrate how these computations are made, we may take as an example an imported item such as a combine harvester for which the c.i.f. price is US$45,000. In the financial accounts, we will convert this price to domestic currency using the official exchange rate of, say, Rs10 = US$1, obtaining a c.i.f. price in domestic currency of Rs450,000 (45,000 x 10 = 450,000). To this would be added any import duty, say 10 percent, or Rs45,000 (450,000 x 0.10 = 45,000); the price of the combine in our financial accounts would therefore be Rs495,000 (450,000 + 45,000 = 495,000). (The costs of moving the harvester to the project site would also be added; see the subsection on "Economic export and import parity values," below.) If we are using the conversion factor approach to allow for the foreign exchange premium in our economic accounts, we would enter the combine in the accounts at the c.i.f. price expressed in domestic currency converted at the official exchange rate, or Rs450,000 (45,000 x 10 = 450,000). There would be no allowance for the duty because that is a transfer payment. If we are using the shadow exchange rate approach to allow for the foreign exchange premium, however, we would increase the price of the imported items to reflect the premium. Suppose we assume the foreign exchange premium to be 20 percent; our shadow exchange rate thus becomes Rs12 = US$1 (10 x 1.2 = 12). Now the Rs495,000 item in our financial accounts becomes Rs540,000 in our economic account (45,000 x 12 = 540,000). We could have accomplished the same thing, of course, by multiplying our domestic financial price (net of transfer payments) by 1 plus the foreign exchange premium (450,000 x 1.2 = 540,000). The effect of our computation, obviously, is to make imported items more expensive in our economic analysis.

The same logic works in reverse for exports. The ton of wheat that is worth $176 a ton f.o.b. at the port of export will be entered in the financial accounts by converting the foreign exchange price to its domestic

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currency equivalent using the official exchange rate. This gives a value of Rs1,760 (176 x 10 = 1,760), assuming that there is no export subsidy. The same rupee value would be entered in the economic accounts if we are using the conversion factor approach to allow for the foreign exchange premium. If we are using the shadow exchange rate approach to allow for the foreign exchange premium, we multiply the foreign exchange border price of the wheat by the shadow exchange rate instead of the official exchange rate to calculate the economic value expressed in domestic currency. This increases the relative value of the wheat, which now will be valued at Rs2,112 (176 x 12 = 2,112). We could have accomplished the same thing, of course, by multiplying our financial domestic price by 1 plus the foreign exchange premium stated in decimal terms (1,760 x 1.2 = 2,112). Now the ton of wheat, like other exported goods, is valued at its opportunity cost and is seen to be relatively much more valuable.

Diverted exports and import substitutes are valued by the same line of reasoning, except that for a diverted export we would take the f.o.b. price as the basis for valuation and for import substitutes we would take the c.i.f. price. In the examples of the previous paragraphs, if the country exported combines but diverted them to a domestic project, the opportunity cost would be based on the f.o.b. price instead of the c.i.f. price we assumed for imported combines. Similarly, if the wheat produced were to substitute for imports, we would base its value on the c.i.f. price of wheat rather than on the f.o.b. price we assumed for the case of exports.

In practice, values for most traded items are determined by taking the border price as we have been using it and then either subtracting or adding the domestic handling costs to obtain an economic value at the farm gate or project boundary—the economic export or import parity value (see the subsection on "Economic export and import parity values," below). Also, many items that are locally produced incorporate a significant proportion of imported components and may be considered indirectly imported items (see the section on "Indirectly Traded Items," below). To determine either parity values or values for indirectly traded items involves valuing separately not only the traded component but the nontraded component as well, so we will defer detailed discussion of these values until we have discussed valuing nontraded items.

**Step 3. Adjustment for price distortions in nontraded items**

The third step in adjusting financial prices to economic values is the adjustment for distortions in market prices of nontraded items. Nontraded items are those for which c.i.f. price > domestic cost of production > f.o.b. price, or the items are nontraded because of government intervention by means of import bans, quotas, and the like.

Often, nontraded items will be bulky goods such as straw or bricks, which by their very nature tend to be cheaper to produce domestically than to import but for which the export price is lower than the domestic cost of production. In other instances, nontraded items are highly perishable goods such as fresh vegetables or fluid milk for direct consumption.

In general, these are produced under relatively competitive conditions—they are produced either by many small farmers or by a few industrial producers for whom entry into the market is relatively easy; thus prices cannot rise too far out of line before new competition appears.

If we are using the shadow exchange rate approach to allow for the foreign exchange premium, and if the market price of a nontraded item is a good estimate of the opportunity cost, or willingness to pay is the criterion, we will accept the market price directly as our economic value. Otherwise, we will adjust the market price to eliminate distortions by the methods outlined in this section and then use the estimate of the opportunity cost we obtain as the shadow price to be entered in the economic accounts.
If we are using the conversion factor approach to allow for the foreign exchange premium, an additional step is necessary. All prices for non-traded items are reduced by multiplying them by the appropriate conversion factor. When willingness to pay is the criterion or when the market price is considered to be a good estimate of opportunity cost, the market price is accepted as the basis for valuation and then reduced by multiplying it by the conversion factor to obtain the economic value. But if we are using the standard conversion factor and the market price must be adjusted to obtain a better estimate of the opportunity cost, then the opportunity cost must, in turn, be multiplied by the standard conversion factor. (If specific conversion factors have been developed, as Little and Mirrlees and Squire and van der Tak suggest in their systems, then these factors incorporate the adjustments for nontraded goods distortions, opportunity costs, and distribution weights; the market price need only be multiplied by the specific conversion factor to reach the economic value.) Whether we use a shadow exchange rate or a standard conversion factor to allow for the foreign exchange premium, the adjustments we make to allow for distortions in market prices of nontraded items are essentially the same; only the step of multiplying the market price or the opportunity cost by the standard conversion factor differs.

As we said earlier in the chapter, prices for traded items are more easily adjusted to economic values than are prices for nontraded items. The following subsections treat some of the difficulties encountered in determining economic values for various nontraded items.

Market prices as estimates of economic value.

In a perfectly competitive market, the opportunity cost of an item would be its price, and this price would also be equal to the marginal value product of the item (see chapter 3). If a nontraded item is bought and sold in a relatively competitive market, the market price is the measure of the willingness to pay and is generally the best estimate of an opportunity cost. Most agricultural projects are expected to meet a growing demand for food or fiber and are small relative to the total agricultural production of the nation. If that is the case, in general we can accept the market price directly as our estimate of the economic value of a nontraded item. Also, if we are valuing a domestically produced project input that is produced by a supply industry operating near full capacity, we can generally accept the market price of the input as its economic value.

In some instances more common in industrial and transport projects than in agricultural, the output of the project is large relative to the market. The output from the project may therefore cause the price to fall. But the economic value of the new production, despite the fall in price, is not lower to the old users of the product; to them, it is still worth what the price was without the project. Yet to new users, the project output is not worth what the old price was; otherwise, the price would not have fallen. Under these circumstances, the economic value of the new output is neither the old price nor the new; rather, it is estimated by some weighted average of the old and new values. In technical economic terms, the total value of the new output is measured by the additional area under the demand curve as project output is increased, and the marginal value in use for each new buyer is measured by the demand curve at the point the buyer enters the market. The problem is that the precise shape of the demand curve is rarely known. As a result most project economists, when dealing with a project whose output is large relative to the market, adopt a simplifying rule of thumb—they assume that the demand curve is linear and downward sloping at 45 degrees. They then take the new estimate of the average value in use or opportunity cost—hence, of economic value—to be the average of the price without the project and the lower price with the project.

Sometimes a project will be proposed that does not meet new demand but replaces other goods or services in the market. Again, this is more common in industrial and transport projects than it is in agricultural. In
such situations, if the project accounts are cast on a with-and-without basis, the economic value of the incremental net benefit stream would reflect only the saving from the new project compared with the old. This is because one of the costs of the new project would be the benefit forgone from the old production no longer realized and because one of the benefits would be the cost avoided for the old production. Such a case might arise, for instance, if an inefficient food processing plant were to be replaced by a more modern and efficient one, or if a high-cost railway branch line were to be replaced by bus and truck transport along an existing highway. Occasionally, however, a project will be proposed for a new plant that will replace existing output, and the analyst fails to recognize the with-and-without situation. Instead, he values the output from the new plant as if it were meeting new demand and forgets to charge as a cost to the project the benefit forgone from the production of the old plant that is to be displaced. If the project is not to be cast on a with-and-without basis, then the analyst must take as his gross benefit only the economic value of the resources saved by replacing the old plant, not the economic value of the output from the new plant.

Note that some nontraded items may involve using significant amounts of imported raw materials. These will be considered below, in the discussion of indirectly traded items. Such items might include machinery assembled domestically from imported components or electricity that is generally nontraded but that may require imported generating equipment and traded fuels for production.

One nontraded item that can sometimes lead to confusion is insurance. At first glance, insurance might look like a transfer payment and thus would not be included in the economic accounts of the project. We may, however, look upon insurance as a kind of sharing of the risk of real economic loss. This would be the case for fire insurance if project buildings were to be pooled with many other buildings in the society. In the event of a fire, there is a real economic cost. The resources used to replace a burned building, or the output forgone because a building no longer is available, reduce the amount of final goods and services available to the society and thus create a real reduction of the national income. Therefore, to the extent an insurance cost represents sharing of risk, it represents a proportionate sharing of real economic cost and should be included in the economic accounts. The insurance rate is usually based on the probability of a real loss and the value of the item insured.

Although the market price can frequently be accepted as a good estimate of the economic value of a nontraded item, for institutional reasons of one kind or another the market price can vary significantly from the opportunity cost of the item to the society. Two such nontraded items are important in most agricultural projects: land and labor.

Valuing Land

The opportunity cost of land is the net value of production forgone when the use of the land is changed from its without-project use to its with-project use.

The simplest case to value is one in which land changes use but not management control, either because an owner-operator is farming the land or because the same tenant continues to farm it. This is a common case in agricultural projects in which farmers are simply encouraged to adopt a more productive technology. If the analyst has laid out the financial accounts to show the situations with and without the project for farm budgets as suggested in chapter 4, then the incremental net benefit (that is, the incremental cash flow) of the project, when financial prices have been converted to economic values and the accounts aggregated as suggested in chapter 8, will include an allowance for the net value of production forgone by changing the land use. Take, for example, the Kemubu Irrigation Project in Malaysia in which new irrigation water permitted changing the land use in the dry season from rather unproductive pasture to second-crop paddy rice production. The contribution of the land to the value of the pasture—hence, its opportunity cost—would be properly accounted for when the value of the weight gain of the livestock pastured on the land without the
project is subtracted from the value of the paddy rice produced on the land with the project. Converting
project financial prices to economic values—say, changing the market price of the weight gain of the ani-
imals on the pasture and the market price of paddy rice to their economic equivalents if these are seen to be
different from the market prices—automatically revalues the opportunity cost of the change in land use from
financial to economic terms.

In other instances, however, the financial accounts must show a cost for purchasing land or the right to use
it. Here problems arise because in many countries agricultural land is hardly sold at all, and, when it is,
considerations of investment security and prestige may push its price well above what the land could rea-
sonably be expected to contribute to agricultural production. In these instances, we will not want to accept
the market purchase price as a good estimate of the economic opportunity cost of the land and must search
for an alternative. Many times that alternative will be to take the rental value of the land. In a number of
countries, although land is infrequently sold, there is a fairly widespread and competitive rental market.
This may be true if there is considerable tenancy in the country, of course, but it may also hold true if the
dominant form of land tenure is the owner-occupied farm. Older farmers may not wish to cultivate all of
their holdings themselves and will be willing to rent a field to a younger neighboring farmer; widows may
not wish to operate their holdings themselves; or a farmer suffering from an illness may wish to rent part of
his farm for a season while he recovers. When such a rental market exists, it probably provides a fairly
good indication of the net value of production of the land and, hence, of the opportunity cost if the land use
is changed. A renter is not likely to pay any premium for prestige or investment security and thus will not
pay a rent higher than the contribution the land can make to the crop he proposes to grow. That rental value
may then be entered in the project's financial account year by year as a cost. Alternatively, it may be capi-
talized by dividing the rent by an appropriate rate of interest stated in decimal terms; the capitalized value
is then entered in the first year of the project's financial accounts. The appropriate rate of interest actually
would be the economic rate of return (see chapter 9), but this may well involve repetitive computations.
Some analysts prefer to use the opportunity cost of capital (also discussed in chapter 9). If this rate were,
say, 12 percent and the going rental rate were Rs525 a hectare, then the capital value of a hectare would be
Rs4,375 (525 - 0.12 = 4,375). If we were using the conversion factor approach to allow for the foreign
exchange premium, this capitalized value would be, in turn, multiplied by a conversion factor. If the stan-
dard conversion factor were 0.909, for instance, the land would then have an economic value of Rs3,977
(4,375 x 0.909 = 3,977). At the end of the project, the same value of the land could be credited to the
project as a residual value.

Inevitably, however, there will be instances in which neither the purchase price nor the rental value is a
good estimate; we then will have to make a direct estimate of the productive capability of the land. Such a
direct estimate is not difficult if idle land is to be used for a settlement project. In the projects financed by
the World Bank in the Amazon basin at Alto Bene in Brazil and in the Caqueta region of Colombia, the
land without the project would in effect have produced no economically valuable output at all. Hence, the
net value of production forgone was clearly zero, and no value for the land was entered in the project eco-
nomic accounts. If settlers were required to pay the government a purchase price, either all at once or in
installments, the farm budgets at market prices in the financial analysis would have to show those pay-
ments as a cost. When these financial farm budgets were converted to economic values, however, there
would be no cost entered for the land because there was no reduction in national income as a result of shift-
ing its use from jungle to farmland. (Of course, the cost of clearing jungle land should be reflected some-
where in the project costs.)

In other cases it will not be so simple. The analyst will have to make a direct estimate of the net value of
production forgone for bringing the land into the project. A straightforward approach is to take the gross
value of the land's output at market prices and deduct from that all the costs of production—including allow-
ances for hired and family labor and for the interest on the capital engaged, again all at market prices. The
analyst can assign the residual as the contribution of the land to the production of the output and take that as the opportunity cost of the land in financial terms. This set of computations can then be converted to economic terms by using economic values for each of the input and output entries. For those familiar with the technique, estimating a production function would provide a much more accurate estimate of the contribution of the land to the value of the output than the direct method described here and thus is a preferable approach.

Valuing Labor

Wage rates for labor in many developing countries may not accurately reflect the opportunity cost of shifting labor from its without-project occupation to its with-project use.

The price of labor in a perfectly competitive market, like other prices in that impossible place, would be determined by its marginal value product. That is, the wage would be equal to the value of the additional product that one additional laborer could produce. It would pay a farmer to hire an additional laborer-for harvesting, for example-so long as that extra worker increased total output by a value more than the wage the farmer had to pay him.

Even in labor-abundant societies, there are probably peak seasons at planting and harvesting when most rural workers can find employment. At those seasons, the market wage paid rural labor is probably a pretty good estimate of its opportunity cost and its marginal value product; therefore, we could accept the market wage as the economic value of the rural labor.

The problem of course is that, except for the peak seasons, in many crowded countries the addition of one more laborer may add very little to the total production-in an extreme instance, nothing at all. That is, if there is a surplus of agricultural workers, there may be very little or virtually no productive outlet for their energies in the off-season. In technical language, we may say that the marginal value product of such labor-the amount such labor adds to the national income-is very close to zero. Because the marginal value product of labor is also the opportunity cost of labor in the economic accounts, we may make another statement: if we take a laborer away from a farm community where he is producing very little or nothing and put him to work productively in an agricultural project that produces something of value, we do not have to forgo very much to use this labor to realize new production. This being the case, we can consider the cost of the laborer to be very low-some economists would say even zero. By this line of reasoning, the proper value to enter in the economic (not financial) account as the cost of labor would be very small, perhaps only a fraction of the going market wage. If the opportunity cost of labor in an agricultural project is properly priced at a very small amount, then it is likely that the rate of return on the project will look very favorable in comparison, say, with a capital-intensive alternative project that uses labor-saving tractors or expensive imported harvesting machinery.

Note that the validity of this reasoning is not changed by the fact that agricultural labor is, in fact, paid a wage well above its opportunity cost. A common example of a "wage" paid, even though little productive work is available on the margin, is found in the case of family labor. Older children and the farmer's wife will be entitled to a share of the family income even if the family farm is too small to give them an opportunity to be productive. In this instance, if an older son were to find productive employment elsewhere, the total production on the farm might be reduced by very little or none at all. Yet, because the older son is entitled to a share of the total family income, he would accept new employment far away from his home only if he were offered a wage in excess of his share-and that might be well above what his marginal value product would be and the reduction in farm output that would occur if he were to leave.
Rural wages may be above the marginal value product because of a traditional concept of a "proper" wage or because of social pressure on the more prosperous farmers in a community to share their wealth with their less fortunate neighbors. In parts of Java, for example, social custom prevents even quite small farmers from harvesting their own rice. Instead, they permit landless laborers to do the work, even though the farmer himself may well have the time to do it. This is explicitly seen by the community as a means of providing at least something for the poorest agricultural laborers. Unfortunately, increasing economic pressures on small farmers and continued population growth are leading to a break-down of this system.

Virtually all economists now agree that the marginal value product of agricultural labor on an annual basis worldwide is more than zero, so that in every instance our opportunity cost of labor, at least in some season or another, will be positive—though it may still be very low. [A more detailed discussion of the marginal value product of agricultural labor can be found in McDiarmid (1977) and in Barnum and Squire (1979).]

To begin our discussion of how actually to determine an economic value for labor, we can take the easiest case. In most instances, skilled labor in developing countries is considered to be in rather short supply and would most likely be fully employed even without the project being considered. Hence, the wages paid workers such as mechanics, foremen, or project managers are in general assumed to represent the true marginal value product of these workers, and the wages are entered at their market values in the economic accounts. The rationale here is that, if those skills are in such scarce supply that they would be worth more than the going wage, then someone in the society would be prepared to pay more, and the skilled worker would then move to where he could earn that higher wage, thus establishing a new equilibrium. This convention of accepting market wages as good estimates of economic value may substantially undervalue skilled labor or the management skills of such top civil servants as extension specialists and project managers or project analysts!

Note too that, as we consider the opportunity cost of labor and how to estimate it, if we set the financial accounts so they correctly show the situations with and without the project, then the opportunity cost of family labor will be appropriately priced in financial terms. Suppose that, in the dry season without the project, a farmer along the north coast of Java could find essentially no gainful employment. With the advent of the Jatiluhur Irrigation Project he now is able to produce a second crop of rice, and his net benefit rises accordingly. When we subtract his without-project net benefit (which would be essentially only what the family could earn for a rainy-season rice crop) from the with-project net benefit (which will include earnings from two crops), the incremental net benefit will correctly show the labor return the family had to give up during the dry season (essentially nothing) to participate in the project and produce a second crop of rice. Shifting the financial prices in the farm budget to economic values also automatically converts the opportunity cost of family labor to economic values.

To make our farm budgets work this way, we must remember to include any off-farm earnings in the accounts. Suppose we assume that the farmer from the north coast of Java goes to Jakarta and finds employment in the construction industry during the dry season, as many such farmers do. The without-project net benefit will thus be increased by the amount of the farmer's off-farm earnings. If he wishes to use Jatiluhur irrigation water to produce a second crop of rice, he must now give up the construction wages he could otherwise have earned in the dry season. In turn, when we subtract the without-project net benefit from the with-project net benefit, which includes the returns from two crops of rice, the incremental net benefit will be smaller by the amount of the opportunity cost of labor at the market wage, that is, by the amount of construction earnings the farmer must forgo. We may proceed to convert these financial accounts to economic terms by revaluing the appropriate entries at their shadow prices. In doing so, however, we must remember that one shadow price will be the shadow wage rate for the construction earnings the farmer had to forgo. It is to estimating this shadow wage rate that we now may turn.
In most discussions of the marginal value product of labor—hence, of its economic opportunity cost—the standard is the productivity of the marginal agricultural laborer. This is true not only for agricultural projects but also for projects in other sectors, since it is assumed that additional manufacturing employment, for example, will tend to reduce the number of unemployed agricultural laborers. This would be true even if it is urban workers drawn from some other urban occupation who actually take the new factory jobs, since it is assumed the jobs they vacate will, in turn, be filled by workers drawn from agriculture.

Cast in this form, our estimate of the shadow wage rate must now focus on how to estimate the marginal value product of agricultural labor without the project. We can begin by noting that in most agricultural communities there is usually a season when virtually everyone who wants work can find it. Even unemployed urban laborers may return to their home villages in these peak seasons to help their families or to work as hired laborers. This happens at harvest time in Java, and may happen at the peak planting time in other areas where transplanted rice is grown. Thus, we may reasonably assume that this peak season labor market is a relatively competitive one, that labor is in relatively short supply at this period, and that the daily wage at this period is a good indicator of the daily marginal value product of the labor engaged.

With this accepted, a good estimate of the annual shadow wage for agricultural labor is the number of days in the year when most rural labor can expect to find employment, multiplied by the daily wage rate at such times, and reduced by a conversion factor if appropriate. If an agricultural worker’s daily wage at harvest were Rs7.50, and during harvest and other peak seasons most people in the rural work force could find employment for 90 days, then his annual shadow wage might be Rs675 if we are using the shadow exchange rate approach to allow for the foreign exchange premium (7.50 x 90 = 675), or Rs614 if we are using the conversion factor approach and the factor is 0.909 (7.50 x 90 x 0.909 = 614). Now if we wanted to hire an agricultural laborer to work in our project for 250 days a year, all the society would give up in production—the opportunity cost—would be Rs675 if we are using the shadow exchange rate approach, or Rs614 if we are using the conversion factor approach. This opportunity cost is the economic value of the annual earnings of the laborer without the project. Note that we surely would have to expect to pay a wage much greater than this amount, and thus our financial accounts at market prices would have quite a different cost for this same agricultural laborer. It is possible, for instance, that the hired laborer would expect a wage of Rs7.50 a day for all 250 days he worked during the year, or an annual wage of Rs1,875 (7.50 x 250 = 1,875). More probably, he would be willing to work for rather less a day outside the harvest season—say, Rs5.00 a day. Thus, his annual wage might be something more on the order of Rs675 for 90 days and Rs5.00 a day for the remaining 160 days, or an annual total wage of Rs1,475 [(7.50 x 90) + (5.00 x 160) = 1,475]. The project analyst would clearly have to form a judgment of the shadow wage of hired labor on the best basis he could, just as he must for every other price estimate he makes.

Of course, in many agricultural projects labor is not engaged on a year-round basis. Rather, the work is quite seasonal, and we must consider in which particular season hired labor would be engaged. If our new cropping pattern calls for work to be done during the peak season, then we will have to consider that the peak season market wage is probably a good estimate of the marginal value product, and we could not justify using a lower wage as the basis for our shadow wage rate, even though there might be considerable unemployment in the off-season. In Egypt, for example, a common rotation calls for both rice and cotton to be harvested in October. If we were to propose a project incorporating these crops—or another crop requiring hired labor at this period—then the going wage (in 1975 about E£0.30 a day; the symbol for Egyptian pounds is E£) would be paid. Since even in a country as populous as Egypt most rural labor can find employment at this peak season, the use of a shadow wage rate derived from a basis less than the market wage would be unjustified. But suppose our project called for growing maize, which is planted in May when there is little other agricultural work available and harvested in August before the peak harvest season for rice and cotton. Then we might find that, on the margin, many agricultural laborers were either...
unemployed or not very productively engaged at that season and that to draw them into maize planting might entail an opportunity cost considerably less than the going wage, although it would perhaps not be zero. Thus, we might estimate that at this season the combination of being able to work only two or three days a week on the average, and then at jobs of rather low productivity, would justify taking a shadow wage rate based on half the going market rate. This would mean the equivalent of E^0.15 in 1975 if we are using the shadow foreign exchange rate approach (0.30 - 2 = 0.15), or E^0.14 if we are using the conversion factor approach and the conversion factor is 0.909 (0.30 - 2 x 0.909 = 0.14), even though our farm budget at market prices would continue to show a wage for hired labor of E^0.30.

All of these considerations will have to be adapted to fit the circumstances of any given project. For example, in India nationwide we might expect a shadow wage rate for agricultural labor rather less than the going wage rate. But using a nationwide shadow wage rate in particular projects might underestimate the true opportunity cost of the labor actually engaged in a project. The peak season in the Punjab, for instance, finds virtually all agricultural labor fully engaged, but in the neighboring state of Haryana the marginal labor in agriculture is not fully engaged. While many laborers from Haryana do migrate in search of peak season employment in the Punjab, not enough do so to meet the demand for labor completely. Using a very low shadow wage rate for a project in the Punjab might be unjustified because at the peak season the project would have to bid labor away from harvesting. Thus, although the shadow wage rate might not be as high as the harvest wage (but it might), neither would it be as low as conditions in neighboring Haryana might otherwise indicate.

This discussion of how to value labor applies whether labor is to be paid a money wage or is to be compensated in kind. The discussion so far has emphasized that it is the opportunity cost that determines the value of labor in the system of economic analysis we have adopted. The value of the payment actually made to labor—whether in money or in kind—is not the issue. If we shadow-price labor, we already are acknowledging that the wage the labor receives is different from the benefit forgone by using that labor in the project instead of in its next best alternative use without the project. It is the opportunity cost of the labor, not the form of payment, that sets the economic value of labor. Hence, it is irrelevant in a determination of the economic value of labor whether labor is paid a money wage or is compensated in kind—for example, in food grain, even though the food grain may be a tradable commodity and even though the food grain itself might need to be shadow-priced if it is to be valued.

Excess Capacity

In some projects, a domestically produced input may come from a plant that is not operating at its full capacity. If that is the case, then the opportunity cost of using the input in a new project is only the marginal variable cost of producing the input, and no allowance need be made for the fixed capital cost of the plant itself. If the national cement industry is operating at less than its full capacity and it is proposed to line irrigation canals with cement, then the cost of the cement for the canals would be only the marginal variable cost of producing the cement. This would be less than the average cost of cement production, which would include some allowance for fixed costs of production.

Situations such as these are more common in industrial projects than in agricultural projects. When they do occur, however, they may influence the timing of projects. A canal-lining project might be quite attractive if it is begun soon, while there is excess cement-manufacturing capacity, but much less attractive later, when demand has caught up with the cement industry's capacity. To supply cement for canal lining later, after demand has picked up, would entail constructing an additional cement plant. At that time, new fixed as well as variable costs would be incurred, and the analyst would include all costs, both fixed and variable, plus an estimate of the "normal" profit in calculating the cost of cement.
TRADABLE BUT NONTRADED ITEMS. In the system of project analysis presented here, we lay out the economic accounts as best we can to reflect the real resource costs and benefits of the proposed project. The project will be carried out within a framework of economic policies set by the government. The project analyst must make the best judgment about what those policies are and will be, not just what they ought to be, and work the economic analysis accordingly. This can lead to difficult choices when the analyst must evaluate the real effects on resources of a project that involves items that could be traded but probably will not be because of government regulation. These items, which are "tradable but non-traded" across national boundaries, are valued as nontraded.

Such items would usually be imported were it not for an import quota or an outright ban that is enforced against them. Their domestic price may well rise high above the prevailing price on the world market. The import restriction might be enforced to protect domestic industries, even though the imported item may be preferred by consumers. Import of foreign engines for tubewells, for example, may be forbidden so that domestic manufacture might be encouraged. Yet, the domestic equivalent may not be as efficient or as durable as the imported engine and may cost more to produce. The domestic engine clearly could not compete on the world market, and it would therefore be a nontraded item. For those few imported engines allowed to enter the country, the price may rise quite high. This indicates that to some buyer the imported item is worth more than its domestic equivalent. If our project will use one of these engines, the economic value is not a price based on the world market as if the engines could be relatively freely traded. Rather, it is the higher domestic market price of the imported engine, which indicates its high opportunity cost. Upon reexamination, of course, we might consider changing the project design to use the domestic engine-for example, we might do so if we find the domestic engine to be less costly when valued at shadow prices.

For the domestic equivalent of an imported item, the market price usually will closely approximate the real resource use that went into producing it. But if there is a shortage and the price is bid up, in the absence of additional imports the market price will rise above the cost of production. In this case, the opportunity cost of the item will not be determined by the resources used to produce it but by its marginal value product in its best alternative use. If the price is higher than is justified by the resources used to produce the item, it may well be because to someone that high price for the domestic engine is worth it-for this buyer's purposes, the marginal value product of the scarce engine at least equals the market price. If we wish to bid that engine away for use in our project, we are denying its use to the other potential buyer. If we use the engine in our project, the economy must forgo the productive contribution of the engine in the alternative use the other potential buyer had in mind-our standard concept of opportunity cost. Again, in this instance the opportunity cost is most likely well estimated by the market price; if it were not, other buyers would not have bid the price up so high for the limited number of engines available.

If there is an import ban on an imported final good or service, then we will base the economic valuation on the criterion of willingness to pay and accept the market price as a good indicator of the economic value of the product-provided that we expect the trade ban to remain in force throughout the life of the project. Earlier we cited the example of a ban on sugar imports that would force the domestic price of sugar above its border price. If the ban on imports will continue, then the higher price of sugar indicates a willingness to pay that, in turn, is an indicator of the economic value set on sugar by the consumers. In the project analysis, we would accept this market price as the economic value, not a border price as if the sugar were being traded.

For both kinds of import substitutes we have cited, the analyst may want to prepare an analysis that will indicate the effect on the proposed project of lifting the import ban. We will discuss this topic further below, and value each separately. Take locally assembled tractors, for example. We may be told that the
market price of Rs65,000 includes a 30 percent local component (in other words, 30 percent of the market price represents domestic value added) and that 70 percent of the market price represents the imported component, which includes a 15 percent tariff. Thus, the local component will amount to Rs19,500 (65,000 x 0.3 = 19,500), and the imported component including the tariff will amount to Rs45,500 (65,000 x 0.7 = 45,500). The domestic value added will most likely arise from sources such as wages paid domestic skilled labor and domestically manufactured items that use mainly domestic raw materials. If so, we probably can accept the market price as a good indicator of the opportunity cost to the economy of these items.

To determine the economic value of the imported component of the tractor, the tariff must first be eliminated. This may be done by dividing the value of the imported component including the tariff by 1 plus the percentage of the tariff stated in decimal terms; this calculation gives a value for the imported component without the tariff of Rs39,565 (45,500 / 1.15 = 39,565). This is, of course, the c.i.f. price converted to its domestic equivalent at the official exchange rate.

Now, if we are using the shadow exchange rate to allow for the foreign exchange premium, we will want to revalue the imported component of the indirect import (after the tariff has been eliminated) to reflect the distortion in the prices of traded goods. To do this, we can take the c.i.f. price converted at the official exchange rate and multiply it by 1 plus the foreign exchange premium stated in decimal terms. If the official exchange rate is Rs10 = US$1 and the foreign exchange premium is 20 percent, then for the imported component of the tractor we derive a value of Rs47,478 (39,565 x 1.2 = 47,478). (We could, of course, have taken the c.i.f. price in foreign exchange and converted it to its domestic equivalent by the shadow exchange rate; this would have given the identical result.) The shadow price of the tractor is now the market price of the domestic component, which we calculated to be Rs19,500, plus the shadow-priced value of the imported component of Rs47,478-or a total economic value of Rs66,978 (19,500 + 47,478 = 66,978).

If we are using the conversion factor to allow for the foreign exchange premium, the economic value of the imported component will be the c.i.f. price converted to the domestic currency equivalent at the official exchange rate after eliminating the tariff, or Rs39,565. To obtain the economic value of the domestic component, we will need to multiply it by the conversion factor. For efficiency prices, we would use the standard conversion factor of 1 divided by 1 plus the foreign exchange premium stated in decimal terms. In this instance, the foreign exchange premium is 20 percent, so the standard conversion factor becomes 0.833 (1 / 1.2 = 0.833). Applying this to the domestic component of the tractor, estimated to be Rs19,500 at market prices, gives us an economic value of Rs16,244 (19,500 x 0.833 = 16,244). The shadow price of the tractor now becomes the sum of the imported component valued at c.i.f. converted at the official exchange rate and the shadow price for the domestic component, or Rs55,809 (39,565 + 16,244) = 55,809).

In some agricultural projects, electricity is an important cost that may raise valuation problems. Electricity is usually thought of as a nontraded commodity. In reality, part of the value of electricity in most developing countries arises from the imported generating and transmission equipment and, perhaps, from imported fuel. Thus, in our system of project analysis, electricity might be an indirectly traded item. The first difficulty is that the price charged for electricity is not competitively set, since there is no competition in electricity. Rather, electricity rates are administered prices, and electricity prices thus may bear little relation to marginal value product or to opportunity cost. No easy means exists to resolve this problem. Some average rate, or perhaps some weighted average rate, will probably have to suffice as an estimate of opportunity cost at market prices. Once a rate is accepted, an estimate will have to be made of the domestic and imported components, and the components revalued using the shadow exchange rate or a conversion factor as appropriate, just as for any other indirectly imported item (and as we illustrated earlier by the example of tractors assembled from imported components). These calculations would usually not be undertaken by agricultural project analysts. The planning office should estimate a shadow price for electricity and other utilities to be used in all project analyses.
For some agricultural projects, new generating facilities will be required. In the simplest case, we might think of a project remote from the electric grid, such as a settlement project, in which a diesel generating unit might be included as a cost of the project. In that instance, there would be no particular problem of valuation. When new generating facilities would be needed to meet the demand on the power grid arising from an irrigation project, however, the problem would not be so simple. Here, the best approach would probably be to ask the electricity authority for an estimate of the additional cost the authority would incur for this particular project, and then to treat that cost-properly shadow-priced to allow for the imported component—as the opportunity cost. The cost of the additional facilities needed for the project will probably have to be reduced to a kilowatt-hour basis (using, perhaps, the capital recovery factor to estimate the annual charge for the new facilities).

We have contrasted use of a shadow exchange rate and a conversion factor to correct for price distortions caused by import and export tariffs and subsidies, and we have noted that the same correction can be realized whichever approach is used. This is illustrated in table 7-1, in which an economic account for a hypothetical project is drawn up using both a shadow exchange rate and a standard conversion factor.

When indirectly traded items will be used repeatedly in projects, it may be convenient to have specific conversion factors that, once they are derived, can be directly applied to the same class of indirectly traded items. This is the approach both Little and Mirrlees (1974) and Squire

**Table 7-1. Use of Shadow Exchange Rate and Standard Conversion Factor Compared**

<table>
<thead>
<tr>
<th>Item</th>
<th>Financial values</th>
<th>Economic Value (Rs)</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Rs</td>
<td>Using shadow exchange rate</td>
<td>Using standard conversion factor</td>
</tr>
<tr>
<td><strong>Inflow</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Gross value of wheat produced</td>
<td>1,750</td>
<td>175</td>
<td>2,100</td>
</tr>
<tr>
<td>Total</td>
<td>1,750</td>
<td>175</td>
<td>2,100</td>
</tr>
<tr>
<td><strong>Outflow</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Unskilled labor (shadow wage rate= 50% market wage)</td>
<td>600</td>
<td>60</td>
<td>300</td>
</tr>
<tr>
<td>Imported fertilizer</td>
<td>200</td>
<td>20</td>
<td>240</td>
</tr>
<tr>
<td>Tractor services</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>75% imported component</td>
<td>90</td>
<td>9</td>
<td>108</td>
</tr>
</tbody>
</table>
Rs = Indian rupees; US$ = U.S. dollars.

a. The official exchange rate is assumed to be Rs10 = US$1. Financial prices are converted by this official exchange rate.

b. The foreign exchange premium is assumed to be 20 percent. As in note a, the official exchange rate is assumed to be Rs10 = US$1.

c. The shadow exchange rate is the official exchange rate of Rs 10 multiplied by 1 plus the percentage of the foreign exchange premium stated in decimal terms, or Rs12 (10 x 1.2 = 12), so that Rs12 = US$ 1. Foreign exchange prices are converted into domestic currency values by multiplying the foreign currency price by Rs12.

d. The standard conversion factor is the reciprocal of 1 plus the foreign exchange premium stated in decimal terms, or 0.833 (1 - 1.2 = 0.833). Foreign currency prices are converted into decimal currency values at the official exchange rate. Domestic currency prices are multiplied by the standard conversion factor of 0.833.

and van der Tak (1975) suggest, and both sets of authors recommend that some central agency prepare specific conversion factors for project analysts to use. It is possible in a parallel manner to derive "specific shadow exchange rates" that may then be applied repeatedly, although in practice this has rarely been done. Instead, when the shadow exchange rate approach is followed, nontraded items are decomposed into their traded and nontraded elements and each is valued separately. Use of a specific conversion factor can be illustrated by referring to table 7-1. Suppose we planned a number of projects in which tractor services would be important and we wanted a specific conversion factor for tractor services. Once we had the conversion factor in hand, we could multiply the domestic market price of items in each project by the same specific conversion factor to obtain the various economic values. In table 7-1, in the column illustrating use of the standard conversion factor, we have a value for the imported component of the tractor services of Rs90, which was converted at the official exchange rate. The domestic component was multiplied by the standard conversion factor to obtain an economic value of Rs25. If we accept this as a good estimate of the value of the domestic component, then by adding the two we reach an economic value for the tractor services of Rs15. If we divide this economic value by the domestic price, we obtain a specific conversion factor of 0.958 (115 - 120 = 0.958). In the future, we can simply multiply the market price of tractor services by the specific conversion factor to obtain the economic value directly.

### Economic export and import parity values

The economic value of a traded item—either an export or an import—at the farm gate or project boundary is its export or import parity value. These values are derived by adjusting the c.i.f. (cost, insurance, and freight) or f.o.b. (free-on-board) prices (converted to economic values) by all the relevant charges (again

<table>
<thead>
<tr>
<th>25% domestic component</th>
<th>30</th>
<th>3</th>
<th>30</th>
<th>25</th>
<th>Indirectly traded item</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total</td>
<td>920</td>
<td>92</td>
<td>678</td>
<td>565</td>
<td></td>
</tr>
<tr>
<td>Net benefit</td>
<td>830</td>
<td>83</td>
<td>1,422</td>
<td>1,185</td>
<td></td>
</tr>
<tr>
<td>Ratio of inflow to outflow</td>
<td>1.90</td>
<td>1.90</td>
<td>3.10</td>
<td>3.10</td>
<td></td>
</tr>
</tbody>
</table>
converted to economic values) between the farm gate or project boundary and the point where the c.i.f. or f.o.b. price is quoted. The general method of calculating export and import parity prices was discussed in the last section of chapter 3. When these financial prices are adjusted to derive their economic equivalent, both traded and nontraded elements must be valued simultaneously.

The methods for deriving import and export parity values are parallel. Thus, it is unnecessary to discuss the method for both; instead, we will discuss only derivation of the import parity price as an example because import parity values tend to be a bit more complicated to derive.

We may return to the example of the imported combine harvester used earlier in the chapter to illustrate economic valuation of a traded item. In our financial accounts, the c.i.f. price of US$45,000 was converted to its domestic currency equivalent at the official exchange rate of Rs 10 = US$1, to which we would add, say, a 10 percent duty, Rs 1,500 in domestic handling and marketing charges, and Rs 2,250 in internal transport costs to the project site—for an import parity price at the farmgate of Rs 498,750 \[ (45,000 \times 10) + (45,000 \times 10 \times 0.10) + 1,500 + 2,250 = 498,750 \].

To obtain the economic import parity value at the farm gate or project boundary when using the shadow exchange rate to allow for the foreign exchange premium, we would make the same computations except that we would use the shadow exchange rate and omit the tariff, which is a transfer payment. In the illustration of valuing traded items, we assumed that the foreign exchange premium on the imported combine was 20 percent, and so we assumed a shadow exchange rate of Rs 12 = US$1 (10 \times 1.2 = 12). Now, to obtain the import parity value of the harvester, we would convert the c.i.f. price to its domestic equivalent using the shadow exchange rate, omit the tariff, and then add the value of the nontraded domestic items. To simplify matters, we will assume that all costs of moving the combine to the project site reflect only nontraded items—although that might not be acceptable if, say, the transport costs included significant amounts of petroleum fuel. We now reach an economic import parity value of Rs 543,750 \[ (45,000 \times 12) + 1,500 + 2,250 = 543,750 \].

If we are using the conversion factor to allow for the foreign exchange premium, the foreign exchange would be converted to its domestic currency equivalent in the economic accounts by using the official exchange rate, and every nontraded item would be reduced by the conversion factor. Recalling that the standard conversion factor is 1 divided by 1 plus the foreign exchange premium stated in decimal terms, we obtain a standard conversion factor of 0.833 \((1 - 1.2 = 0.833)\). Now, to obtain the economic import parity value of the harvester at the farm gate or project boundary, we convert all foreign exchange costs to domestic currency at the official exchange rate and reduce all prices of nontraded items by applying the standard conversion factor. Again, we will assume that the transport costs are predominantly made up of nontraded items. As before, we will omit the tariff because it is a transfer payment. The economic import parity price thus becomes Rs 453,124 \[ (45,000 \times 10) + (1,500 \times 0.833) + (2,250 \times 0.833) = 453,124 \].

In certain instances, the value in local currency of an imported item at the project site will be known, as will the rate of tariff and local transport charges from the point of import to the project site. If this is the case, to determine the economic value it is necessary to determine the c.i.f. price, take out the tariff, and allow for the cost of domestic transport. Using our previous values, we may know, for example, that a combine harvester delivered to the project site costs Rs 498,750, that the tariff on imported harvesters is 10 percent, and that local transport and domestic handling from the point of import to the project site costs Rs 3,750. We know that the official exchange rate is Rs 10 = US$1 and that the foreign exchange premium is 20 percent, so the shadow exchange rate would be Rs 12 = US$1 (10 \times 1.2 = 12) and the standard conversion factor 0.833 \((1 - 1.2 = 0.833)\). We deduct the cost of local transport to obtain a financial value of Rs 495,000 at the point of entry, which includes the c.i.f. price plus the duty \((498,750 - 3,750 = 495,000)\). To take out the duty, we divide by 1 plus the percentage of the duty stated in decimal terms to obtain
Rs450,000 \( (495,000 - 1.1 = 450,000) \). This is the c.i.f. value at the official exchange rate. We can then divide by the official exchange rate to obtain the c.i.f. value in foreign exchange of US$45,000 \( (450,000 - 10 = 45,000) \). If we are using the shadow exchange rate to allow for the foreign exchange premium, we can obtain our c.i.f. economic value by multiplying by the shadow exchange rate of Rs12 = US$1 to obtain a value of Rs540,000 \( (45,000 \times 12 = 540,000) \). Then, to obtain the economic value at the project site, we would add the cost of transport from the point of entry to the project site; this yields an economic import parity value for the harvester at the farm gate or project boundary of Rs543,750 \( (540,000 + 3,750 = 543,750) \). If we are using the conversion factor to allow for the foreign exchange premium, the economic value of the combine at the port will be the c.i.f. foreign exchange price converted at the official exchange rate, or Rs450,000 \( (45,000 \times 10 = 450,000) \). To obtain the economic import parity value at the farm gate or project boundary, we would add to this c.i.f. value the cost of domestic transport and domestic handling, reduced by the standard conversion factor, to obtain an economic import parity value of Rs453,124 \[ 450,000 + (3,750 \times 0.833) \_ 453,124 \].

It is clear that to derive the import and export parity values in the economic analysis we must omit transfer payments, allow for the foreign exchange premium, and use shadow prices for those domestic goods and services for which prices are inaccurate indicators of opportunity cost. The same examples from the Sudanese and Nigerian projects used to illustrate the discussion of import and export parity prices in chapter 3 (tables 3-3 and 3-4) are used again in tables 7-2 and 7-3 to show economic parity values using both the shadow exchange rate and the conversion factor to allow for the foreign exchange premium.

**Trade Policy Signals from Project Analysis**

Up to this point, we have been discussing an analytical system that estimates the contribution of a proposed project to national income within a policy framework that the project analyst considers will exist during the life of the project. We have assumed that the project analyst has very little influence on trade policies, for this is true in the agriculture sector in most countries. Questions often arise, however, about the effects on a proposed project if trade policies were to change, and about whether changes in trade policies should be recommended. Unfortunately, when assessing the effects on a project of policies that would lift or impose a ban on trade, the analytical issues become very complex, and the analysis of a single project is of limited usefulness. The limitations of project analysis in influencing policy arise from the partial nature of project analysis and from the assumption that the project investment does not significantly change price relations in the economy as a whole.

Two important cases involving trade policy often arise that cause soul-searching among project analysts. The first is when a quota or prohibitive tariff prevents entry of a crucial input—perhaps fertilizer—

<table>
<thead>
<tr>
<th>Table 7-2. Economic Export Parity Value of Cotton, Rahad Irrigation Project, Sudan (1980 forecast prices)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Steps in the calculation</strong></td>
</tr>
<tr>
<td>-----------------------------------------</td>
</tr>
<tr>
<td><strong>Lint</strong></td>
</tr>
<tr>
<td><strong>Seed</strong></td>
</tr>
<tr>
<td><strong>Scarto</strong></td>
</tr>
<tr>
<td>Description</td>
</tr>
<tr>
<td>-----------------------------------------------------------------------------</td>
</tr>
<tr>
<td>C.i.f. at point of entry</td>
</tr>
<tr>
<td>Deduct unloading at point of import</td>
</tr>
<tr>
<td>Deduct freight to point of import</td>
</tr>
<tr>
<td>Deduct insurance</td>
</tr>
<tr>
<td>Equals f.o.b. at point of export</td>
</tr>
<tr>
<td>Converted at shadow exchange rate</td>
</tr>
<tr>
<td>Port handling cost</td>
</tr>
<tr>
<td>Deduct local port charges</td>
</tr>
<tr>
<td>Deduct local transport and marketing at LSd6.782 per ton</td>
</tr>
<tr>
<td>Export parity</td>
</tr>
<tr>
<td>Export parity value at project boundary site</td>
</tr>
<tr>
<td>Conversion allowance</td>
</tr>
<tr>
<td>Convert to seed cotton</td>
</tr>
<tr>
<td>^Sd217.336 x 0.4</td>
</tr>
<tr>
<td>^Sd21.834 x 0.59</td>
</tr>
<tr>
<td>^Sd110.200 x 0.01</td>
</tr>
<tr>
<td>Deduct local storage, ginning, baling, and</td>
</tr>
</tbody>
</table>
Table 7-2 (continued)

<table>
<thead>
<tr>
<th>Steps in the calculation</th>
<th>Relevant steps in the Sudanese example</th>
<th>Value Lint per ton</th>
<th>Seed</th>
<th>Scar toa</th>
</tr>
</thead>
<tbody>
<tr>
<td>transport, and</td>
<td>storage (Sd15.229)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>marketing costs (if not</td>
<td>per ton)</td>
<td>- 15.229</td>
<td></td>
<td></td>
</tr>
<tr>
<td>part of project cost)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Collection and internal</td>
<td>transfer (Sd1.064)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>per ton)</td>
<td>- 1.064</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Equals</strong> export parity</td>
<td>Export parity value</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>value at farm gate</td>
<td>at farm gate</td>
<td>Sd84.625</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Using conversion factors</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>C.i.f. at point of entry</td>
<td>C.i.f. Liverpool (taken as estimate for all European ports)</td>
<td>US$639.3 3</td>
<td>US$103.39</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><em>Deduct</em> unloading at point of import</td>
<td>Freight and</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Deduct freight to point of import</td>
<td>- 39.63</td>
<td>- 24.73</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Deduct insurance</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Equals</strong> f.o.b. at point of export</td>
<td>F.o.b. Port Sudan</td>
<td>US$599.7 0</td>
<td>US$78.66</td>
<td></td>
</tr>
<tr>
<td>Convert foreign currency</td>
<td>Converted at official exchange rate of at official exchange</td>
<td>Sd1.000 = US$2.8726</td>
<td>Sc1208.8 09</td>
<td>Sd27.389</td>
</tr>
<tr>
<td>to domestic currency</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

*(Table continues on the following pages.)*

*Table 7-2 (continued)*
Convert nontraded goods | Converted using to equivalent domestic standard conversion value using conversion factor of 0.909

**Deduct** local port charges | Port handling cost
Lint: ^Sd5.564 per ton | 5.058
Seed: ^Sd1.510 per ton | 1.373

**Deduct** local transport and marketing costs from project to point of export (if not part of project cost)

| Lint: ^Sd6.782 per ton | 6.165 - 6.165

Equals export parity Export parity value

| Export parity value at gin at project boundary site | ^Sd197.586 | ^Sd19.851 - 1

Conversion allowance

| Convert to seed cotton | 79.034 | 11.712 | 1.00

if necessary

| (^Sd197.586 x 0.4) | 1 |
| + ^Sd19.851 x 0.59 | |
| + ^Sd110.200 x 0.909 | ^Sd91.748 |

**Deduct** local storage, transport, and marketing costs (if not part of project cost)
Collection and internal transfer per ton

Equals export parity Export parity value

| Ginning, baling, and storage (^Sd15.229) |  |
| per ton | - 13.843 |
| Collection and internal transfer (^Sd1.064) |  |
| per ton | - 0.967 |
LSD = Sudanese pounds.


a. Scarto is a by-product of very short, soiled fibers not suitable for export and is sold locally at a price of LSD110.20 per ton.

b. For purposes of illustration, there is assumed to be a foreign exchange premium of 10 percent. Thus, the dollar value of the Sudanese pound at the official exchange rate of LSD1.000 = US$2.872 has been divided by 1.1 to give an assumed shadow exchange rate of LSD1.000 = US$2.611 (2.872 - 1.1 = 2.611), whereas the standard conversion factor is divided by 1 plus the foreign exchange premium, or 0.909 (1 - 1.1 = 0.909). In the appraisal report that is the source of this table, no foreign exchange premium was assumed.

c. Seed cotton is converted to lint, seed, and scarto assuming that a ton of seed cotton yields 400 kilograms lint, 590 kilograms seed, and 10 kilograms scarto.

and this forces use of a more costly domestic alternative and thus greatly reduces the contribution of the project to national income. The second is when an import quota imposed on products that compete with the project's output makes the contribution of the project investment to national income high, even though the cost of production per unit of output from the project is higher than the cost of competing imports.

When the domestic cost of an important project input is higher than the world market price because of a quota or prohibitive tariff, the potential contribution of the proposed investment to national income is

| Table 7-3. Economic Import Parity Value of Early Crop Maize, Central Agricultural Development Projects, Nigeria |
|---|---|
| 1985 forecast prices in 1976 constant terms |

Steps in the calculation

Relevant steps in

the Nigerian example

Value

perton

F.o.b. at point of export

Add local transport and marketing costs to relevant market

Equals value at market

Conversion allowance if necessary

Deduct transport

and marketing costs to relevant market

F.o.b. at point of export

Add freight to point of import

Add unloading at point

of import

Add insurance

Equals c.i.f. at point of import

Convert foreign currency
to domestic currency at shadow exchange rate

*Add local port charges*

*Using shadow exchange rate* F.o.b. U.S. Gulf ports No. 2 U.S. yellow corn in bulk US$116

Freight and insurance 31

(Included in freight estimate)

C.i.f. Lagos or Apapa US$147 Converted at an assumed shadow exchange rate of 4q1 =

US$1.47

X100 Landing and port charges (including cost of bags)

22 Transport (based on a 350-kilometer average)

10

Wholesale value x#132 (Not necessary)

Primary marketing (includes assembly, cost of bags, and intermediary margins) -12 Transport (based on a 350-kilometer average)

-10 Storage loss (10 percent of harvested weight)

-9

*Deduct* local storage, transport, and marketing costs (if not part of project cost) *Equals* import parity value at farm gate

*Add* freight to point of import *Add* unloading at point

*Add* insurance *Equals* c.i.f. at point of import *Convert* foreign currency to domestic currency at official exchange rate

Import parity value

at farm gate x#101 *Using conversion factors*

F.o.b. U.S. Gulf ports

No. 2 U.S. yellow corn in bulk US$116

Freight and insurance 31 (Included in freight estimate)

C.i.f. Lagos or Apapa US$147 Converted at official exchange rate of
Table 7-3 (continued) Steps in the calculation

<table>
<thead>
<tr>
<th>Steps in the calculation</th>
<th>Relevant steps in Valuethed Nigerian example</th>
</tr>
</thead>
<tbody>
<tr>
<td>Convert nontraded goods</td>
<td>Converted using standard</td>
</tr>
<tr>
<td>to equivalent domestic</td>
<td>conversion factor of 0.909b</td>
</tr>
<tr>
<td>value using conversion</td>
<td></td>
</tr>
<tr>
<td>factors</td>
<td></td>
</tr>
<tr>
<td>Add local port charges</td>
<td>Landing and port charges (including cost of bags, X22) 20</td>
</tr>
<tr>
<td>Add local transport</td>
<td>Transport (based on a 350-kilometer average, X10) 9</td>
</tr>
<tr>
<td>and marketing costs</td>
<td></td>
</tr>
<tr>
<td>to relevant market</td>
<td></td>
</tr>
<tr>
<td>Equals value at market</td>
<td>Wholesale value X120</td>
</tr>
<tr>
<td>Conversion allowance</td>
<td></td>
</tr>
<tr>
<td>if necessary</td>
<td>(Not necessary)</td>
</tr>
<tr>
<td>Deduct transport</td>
<td>Primary marketing (includes assembly, cost of bags, and intermediary margins, *12) - 11</td>
</tr>
<tr>
<td>and marketing costs</td>
<td></td>
</tr>
<tr>
<td>to relevant market</td>
<td></td>
</tr>
<tr>
<td>Deduct local storage, transport, and marketing costs</td>
<td>Storage loss (10 percent of harvested weight) - 8</td>
</tr>
<tr>
<td>(if not part of project cost)</td>
<td></td>
</tr>
<tr>
<td>Equals import parity value</td>
<td>Import parity value at farm gate x#92</td>
</tr>
</tbody>
</table>

Nigerian naira.


b. For purposes of illustration, there is assumed to be a foreign exchange premium of 10 percent. Thus, the dollar value of the naira at the official exchange rate of $1 = USS1.62 has been divided by 1.1 to give an assumed shadow exchange rate of $1 = USS1.47 (1.62 - 1.1 = 1.47), whereas the standard conversion factor is 1 divided by 1 plus the foreign exchange premium, or 0.909 ($1 - 1.1 = 0.909). In the appraisal report that is the source of this table, no foreign exchange premium was assumed.

c. Shadow prices were assumed for transport and for primary marketing because in the financial analysis the market wage overvalued the opportunity cost of unskilled labor. The value given is the opportunity cost in naira (before applying the standard conversion factor).

will be reduced by the tariff or quota. Given the policy prevailing, the project analysis will be an accurate indicator of the project's worth. Take fertilizer, for instance. If it is expensive to produce domestically, this is an indication that fertilizer production uses a large amount of scarce domestic resources relative to the resources necessary to produce some other product that could be exported to earn the foreign exchange needed to import the fertilizer from a foreign supplier. But if the domestic fertilizer must, in fact, be used for the project to move forward, then it will take a lot of domestic resources to produce the project's agricultural output, and the project will not, accordingly, make as much of a contribution to the national income as it could be imported fertilizer available. If the quota or prohibitive tariff against the input were removed, then the project investment would look quite different. A change in trade policy, however, will have implications ranging far beyond the boundary of the project itself, implications for both efficiencies in the economy and for noneconomic objectives. A change in trade policy may bring a wide range of changes in other prices in the economy as well as in the price of fertilizer used on nonproject farms, and to be valid an investment analysis would have to be run with the new price relations and include nonproject farms. Predicting these changes could be very difficult if the change in trade policy were significant. At best, the project analyst could run his analysis again using a c.i.f. price for fertilizer and making a broad guess about what the changes might be in the rest of the economy both within and outside agriculture. He could then turn to those responsible for trade policy and say that his project analysis signaled a need to consider with care removing the quota against fertilizer. But note that the project analysis is only a signal, not a criterion for decision; much, much more must go into a reevaluation of trade policy than the analysis of one project.

The other important case in which a change in a quota proves very difficult for the project analyst is that of a quota against imports that would compete with the output of a proposed project. If the imports are prohibited, the output of the project will sell for more in the protected market, and what otherwise might not be a very attractive project may now make a sufficient contribution to national income to be justified. Again, if policies are not going to be changed, this is an accurate indicator of the contribution to the national income. But if the domestic cost per unit of project output—say, apples—valued at shadow prices is greater than the c.i.f. cost of imported apples, then this is an indication that it would be more efficient from the standpoint of the economy as a whole for the project to produce something else, export it to earn foreign exchange, and then use the foreign exchange to import apples. Under the circumstances, the project analyst may want to run his analysis again using an import parity price and perhaps also adjusting some of the other price relations in the direction he thinks might prevail under a change in trade policy. He may find that domestic production would not make enough of a contribution to national income at these prices to justify the investment required. He might also want to determine the domestic resource cost of the import substitute along the lines discussed in the section of chapter 10 devoted to that topic; this will show that it costs more to save a unit of foreign exchange by producing apples domestically than the shadow exchange rate indicates the foreign exchange to be worth. His analysis has now signaled that trade policies should perhaps be reviewed. Again, it is only a signal; the analysis of this one project does not itself provide a complete decision criterion. The trade policy change will have many other effects that will be felt far beyond the boundary of the project itself.
Valuing Intangible Costs and Benefits

The methodology outlined for converting financial prices to economic values is one that is most appropriate for tangible costs and benefits. When intangible costs or benefits enter into investment considerations, they raise difficult issues of valuation.

Intangible factors have come up frequently in earlier discussions of identifying costs and benefits and of valuing them. They comprise a whole range of considerations-economic considerations such as income distribution, number of jobs created, or regional development; national considerations such as national integration or national security; and environmental considerations that can be both ecological and aesthetic, such as the preservation of productive ecosystems, recreation benefits, or famous spots of scenic beauty. [Lee (1982) discusses ecological considerations to be kept in mind when designing agricultural projects for tropical regions.]

The question of how to treat intangible factors most often arises when we are considering the benefits of a project. Many development projects are undertaken primarily to secure intangible benefits--education projects, domestic water supply projects, and health projects are a few common ones. Intangible benefits are usually not the major concern in agricultural projects, although many agricultural and rural development projects include components such as education or rural water supply from which intangible benefits are expected. Whether in agricultural projects or in other kinds of projects, intangible benefits, even though universally agreed to be valuable, are nevertheless virtually impossible to value satisfactorily in monetary terms. Yet costs for these projects are in general tangible enough, and the considerations of financial and economic valuation we have discussed earlier apply unambiguously.

Intangible costs are not uncommon, however, and prove just as difficult to bring within a valuation system as benefits. Often costs are merely the inverse of the benefits that are sought: illiteracy, disease, unemployment, or the loss of a productive environment or treasured scenic beauty.

Some costs in agricultural projects, while tangible, are very difficult to quantify and to value. Siltation, waterlogging, salinization, and soil loss are examples. These costs should not be ignored, and if they are likely to be substantial they should be treated in the project analysis in a manner analogous to intangible costs.

When considering projects in which intangible benefits or costs are important, the least the project analyst can do is to identify them: lives that will be saved, jobs created, kind of education provided, region to be developed, location of a park, ecosystem or kind of scenery to be preserved.

Very often, the analyst can also quantify intangibles: number of lives saved, number of jobs created, number of students to be enrolled, number of people expected to use a park. Even such simple quantification is often a substantial help in making an investment decision.

Economists have tried repeatedly to find means to value intangibles and thus bring them within the compass of their valuation system. The benefits of education have been valued by comparing the earnings of an educated man with those of one who is uneducated. Health and sanitation benefits have been valued in the number of hours of lost work avoided by decreasing the incidence of disease. Nutrition benefits have been valued in terms of increased productivity. Population projects have been valued by attaching a value to the births avoided. Although work in these areas continues-especially with regard to environmental impact-few applied project analyses in developing countries currently attempt to use such approaches to valuing intangible costs and benefits. For one thing, such efforts generally greatly underestimate the value of the
intangibles. The value of an education is much more than just the increase in income—ask any mullah, monk, or priest. Good health is a blessing far in excess of merely being able to work more hours. Good nutrition is desirable for more reasons than just increased productivity. Moreover, the methodological approaches used to value intangibles turn out to be unreliable and open to serious question. Finally, there may be moral issues involved—many who support population programs do so out of considerations that extend far beyond any benefit-cost calculation.

In contemporary practice of project analysis in developing countries, the only method used to any extent to deal with intangible benefits is to determine on a present worth basis the least expensive alternative combination of tangible costs that will realize essentially the same intangible benefit. This is often referred to as “least-cost combination” or “cost effectiveness” (for an application of the method to sanitation projects, see Kalbermatten, Julius, and Gunnerson 1982, chapter 3). If the same education benefits can be provided by centralized schools that realize economies of scale but require buses or by more expensive smaller schools to which students can walk, which schools are cheaper? Can the same health benefits be provided at less cost by constructing fewer large hospitals but more clinics manned by paramedical personnel? By constructing a waterborne sewerage system or by installing low-cost household sanitation facilities that do not require sewers? Can the same number of lives be saved more cheaply by buying up all the property rights in a flood plain and moving people out than by constructing dykes and levees? Given two park sites that would give similar recreation benefits—perhaps one that would require buying warehouse sites and another that would require extensive filling and flood control along a river—which would be cheaper? Once it is determined that the least expensive alternative has been identified and its costs valued, then the subjective question can be more readily addressed: is it worth it?

Interestingly enough, electricity projects are customarily analyzed using least-cost combination. The marginal value product of electricity is in general considered greatly understated by the administered price charged; in any event, much electricity is used for home lighting that is very difficult to value. In practice, most power projects simply compare alternative means of producing the same amount of power: steam generating stations versus a hydroelectric dam; a large generator with transmission costs and several years of idle capacity versus a series of smaller stations close to the demand centers.

A variation of the least-cost combination method can be used to deal with intangibles in multipurpose projects. From the total cost of the project are deducted all those costs that can be directly attributed to tangible benefits—flood damage avoided, irrigation, navigation, and the like. These costs are compared with their associated benefits to determine if the purpose is worthwhile at all. Is the flood damage avoided worth the direct costs incurred? Finally, the residual costs for the project are compared with the residual, intangible benefits. Is the number of lives saved by the project worth the residual cost that must be incurred? (A method of allocating residuals was outlined in the section on joint cost allocation in chapter 6.)

The problems with valuing intangibles are more common and more difficult to deal with in sectors other than agriculture. In agricultural projects, most of the benefits usually are tangible and can be valued. The costs and benefits can be compared directly to choose the highest-yielding alternative. There are, however, several aspects of intangible benefits that are frequently encountered in agricultural projects. Agricultural extension services, for example, are sometimes considered to give an intangible benefit in greater farmer education. For the most part, it is best to treat such costs that may give rise partly to intangible benefits—or, at least, the incremental amount of such costs—within a project if the total, tangible benefits are to be realized. If a dairy production project requires helping farmers to learn better sanitation procedures, then the extension agents who teach the procedures are essential to the success of the project, and the benefit of their effort is the tangible one of more and better milk.
In rural development projects, there are often components that are hardly essential to the main production objectives and that produce generally intangible benefits. This is the case when village schools, rural water supplies, rural clinics, or even agricultural research costs are included in a project. If these components are relatively small in comparison with total project costs, as they often are, then the problem of valuing the benefits may be ignored. But if such components form a significant part of total project cost, they probably should be separated out and treated on a least-cost combination basis. This procedure was followed in the analysis for the Korea Rural Infrastructure Project. The project included irrigation, feeder roads, community fuelwood plots, rural domestic water supply, and rural electrification. The irrigation, feeder roads, and community fuelwood components were analyzed by

![Decision Tree for Determining Economic Values: Major Steps](image)

![Decision Tree for Determining Economic Values: Direct Transfer Payments](image)
comparing their tangible costs with their tangible benefits, but the components for rural domestic water supply and rural electrification were each dealt with separately on a least-cost combination basis.
Finally, if the proposed project is one in which the output is wholly intangible, a least-cost combination approach is appropriate. This would probably be the case for agricultural projects in which the major investment is in extension, agricultural education, rural water supply, rural health improvement, or research.

**Decision Tree for Determining Economic Values**

A "decision tree" for determining economic values is given in figure 7-1, parts A-D. Most issues of economic valuation in agricultural projects are covered by this diagram. The decision tree is used by taking an item to be valued in an agricultural project and tracing through the tree, following each alternative as it applies to the item until the end of the tree is reached, where a suggestion about how to value the item will be found.

To illustrate, we may trace through a few common elements in agricultural projects. Take fertilizer to be used in an irrigation project that will produce cotton. The fertilizer is tangible, involves real resource use, is traded, is a project input, and would be imported without the project. Therefore, it is valued at the import parity price. Or take agricultural labor to be used to apply the fertilizer. It is tangible, involves real resource use, is nontraded, is a project input, is nonproduced, is labor, and would be underemployed without the project. Therefore, it is valued by taking the marginal value product of the labor in its without-project employment. (Note that labor is defined as a tangible item, a possible source of confusion in using the decision tree.) Or take a tax on the fertilizer. It is tangible, is a direct transfer payment, is a payment to or from government, and is a tax. Therefore, it is omitted from the project economic account. Or, finally, take the cotton to be produced in the project. It is tangible, involves real resource use, is traded, is a project output, and will be an export. Therefore, it is valued at the export parity price.