THE CALCULATION OF DOMESTIC RESOURCE COST AND NET SOCIAL PROFITABILITY

by

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I. Introduction

A principal goal of the cotton project is the provision of an integrated economic efficiency analysis of cotton production, ginning, marketing and yarn manufacture. Such an analysis is essential both to understand the impacts of current policies on the Egyptian cotton economy and to estimate the potential impact of new policies on income growth, government revenue and foreign exchange generation. Particular attention of this project will focus on the issues of choice of staple length and choice of technology in production and processing. This paper is intended to provide a detailed description of the methodology and data requirements needed for an efficiency analysis of these issues.

Domestic resource costs (DRC) and net social profitability (NSP) are the two measures of principal interest in the analysis of production efficiency. The two measures initially differed from one another in their measurement of the cost of domestic factors of production. Bruno's (1967) initial development of the domestic resource cost measure utilized actual market prices in the evaluation of domestic factor costs. Outputs and tradable inputs were evaluated at fob or cif prices in order to determine value-added at world prices. The ratio between domestic factor costs and value-added determined the domestic resource cost of earning foreign exchange. Net social profitability measures were evaluated at shadow rather than market prices, with the shadow prices determined by Little-Mirrlees (1974) or similar methods. Like the DRC, fob or cif prices were used in the measurement of output and tradable input prices. NSP was then calculated as value-added at world prices minus total domestic factor costs. Gradually, users of the DRC measure also adopted the shadow price approach to the evaluation of domestic factor costs, and the two measures became essentially equivalent (Pearson, 1976).

Substantial confusion and controversy continues to surround the empirical application of the NSP and DRC measures. Empirical application of the DRC and NSP methods varies substantially among practitioners of the method, particularly with regard to the estimation of domestic factor prices. As a result, studies vary widely in their collection and treatment of data, and no comprehensive summary of data collection methods is available. In addition, recent theoretical criticisms have arisen (Bertrand, 1979; Bhagwati and Wan, 1979; Srinivasan and Bhagwati, 1978), suggesting that the calculation of shadow prices is not empirically practical or possible.

This paper attempts to clarify the rationale and methods of DRC and NSP calculation. The justification for the use of world prices in the evaluation of outputs and intermediate inputs is described in Section II. The use of world prices is then shown to imply a set of shadow prices for factors, a result well-known from linear programming analysis. Section III discusses the relevance of recent theoretical criticisms of the DRC and NSP methods, specifically problems with the indeterminacy of shadow prices, the role of nontraded goods, the problem of input substitution and seasonality in input use. Section IV describes the methods of collection and treatment of the required data. Specific lists of data requirements, sample budgets and an accounting framework for the estimation of the DRC and NSP measures are provided in Appendices.

The emphasis in this paper is placed exclusively on economic efficiency analysis, but does not intend to imply that such considerations are the only factors relevant to an analysis of cotton policy. Consideration of institutional and macroeconomic objectives of inflation, employment and income distribution are also essential for policy evaluation. Indeed, it is the tradeoffs between efficiency and non-efficiency objectives which compose the truly difficult problems of policy choice. The identification of an optimal policy is a moot problem when all objectives point to the same policy. While consideration of non-efficiency objectives is an essential complement to

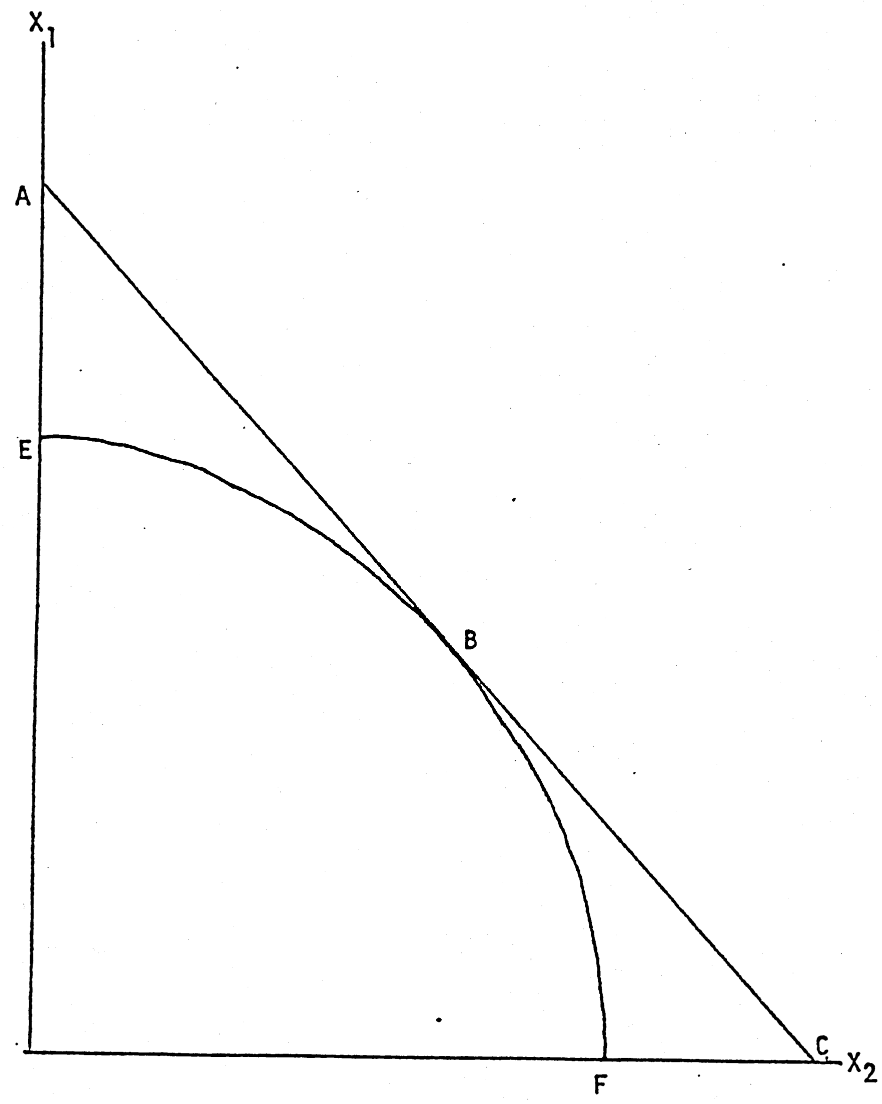


Figure 1. The Consumption Possibilities Frontier under Free Trade

efficiency analysis, from an analytical perspective such objectives may be considered independently of an efficiency analysis. Income distributional concerns, for example, may reduce the desirability of a policy dictated by efficiency considerations. Such concerns do not alter the verity of positivistic results, but merely reduce their desirability as exclusive criteria for the normative problem of optimal policy choice. In short, non-efficiency concerns are regarded as essential and separable complements to the efficiency analysis described in this paper.

II. The Theoretical Basis for DRC and NSP Estimation

The simple two-good, two-factor model of international trade theory is sufficient to demonstrate the theoretical basis for the use of the DRC and NSP measures. The country is assumed too small to influence world prices. Two goods, X_1 and X_2, are produced under linear homogeneous production functions, thus yielding a production possibilities surface concave to the origin. Only two factors, L_1 and L_2, are utilized. Input supplies are fixed and full employment prevails.

The optimality of world prices follows because production at world prices leads to the maximum consumption possibilities frontier (Samuelson, 1962). The result is demonstrated in Figure 1. The world price ratio (P_2/P_1) is represented by the slope of line ABC. Domestic production possibilities are represented by EBF, with actual production represented by point B. The line ABC thus represents the consumption possibilities frontier, and is a maximum opportunity set. Consumption under autarky (no trade) is limited to EBF, which is inferior to all points on line ABC except B. Production at prices other than world prices will result in an output mix somewhere along the sections EB or BF of the production possibilities surface. Allowing free trade given some production distortion can be represented graphically by drawing lines parallel to ABC, passing through the chosen point on the production possibilities frontier. The resultant consumption possibilities frontier is necessarily inside ABC, and thus inferior. The optimality of world prices in production also follows when countries are sufficiently large to influence world prices.

The results of the simple two good, two factor model extend to the general n x n case (Samuelson, 1967). National purchasing power is maximized at world prices. If a domestically-produced good is sold for less than the world price, export demand will expand until the price increases to world levels, which in turn bids up the prices of domestic factors of production and thus increases the incomes of consumers. If the domestic price exceeds the world price of a good, consumers will demand increased imports of the good and thus increase their purchasing power. Demand for domestic production declines until domestic prices fall to world levels.

The determination of the optimum consumption point along the consumption possibilities frontier is a more difficult problem. Community indifference maps can be added to Figure 1 only if non-distorting lump-sum transfers are plausible, so that individual marginal utilities of income are equal everywhere along each indifference surface (Samuelson, 1956). In this case, the optimum consumption pattern can be determined by the tangency of an indifference surface with the line ABC. World prices are unequivocally optimal. Diamond and Mirrlees (1971) have strengthened this result by showing that second-best optima (when lump-sum transfers are impossible) for an individualistic social welfare function are attained by taxes on consumption rather than on production. The necessary assumption for this result involves complete separability of consumption and production. While this may be a weaker assumption than that of lump-sum transfers, neither assumption appears useful in the context of a developing economy. The ability of a government to maintain a set of consumer prices different from producer prices may be only marginally greater than its ability to effect lump-sum transfers.

It is the inapplicability of these assumptions which gives income distributional considerations an influence in the determination of the welfare optimum. Production at world prices represents an efficiency maximum in the sense that, for any quantity consumed of one of the goods, aggregate consumption of the other good is maximized when production occurs at point B. But the point B may represent a distribution of factor incomes which is not satisfactory to society, and it is possible that other points on or within the production possibilities surface result in a socially preferrable distribution of purchasing power. An analysis of the movement from an existing production point to point B must consider the resultant impact on income distribution before the change can be deemed welfare-increasing. Thus, potential tradeoffs between production efficiency cost and income distribution must be considered in the evaluation of new economic policies.1/

Activity analysis provides the basis for a mathematical description of the production optimum. Perfect competition and linear homogeneity of production functions ensures that

$$\underset{(1\times m)}{[W_1{*} \ldots W_i{*} \ldots W_m{*}]} \underset{(m\times n)}{\begin{bmatrix} a_{11}{*} \ldots a_{1j}{*} \ldots a_{1n}{*} \\ \vdots \qquad \vdots \qquad \vdots \\ a_{i1}{*} \ldots a_{ij}{*} \ldots a_{in}{*} \\ \vdots \qquad \vdots \qquad \vdots \\ a_{m1}{*} \ldots a_{mj}{*} \ldots a_{mn}{*} \end{bmatrix}} = \underset{(1\times n)}{[P_1{*} \ldots P_j{*} \ldots P_n{*}]} \qquad (1)$$

where W_i = price of the i^{th} factor (L_i),

a_{ij} = the input-output coefficient (L_i/X_j),

and P_j = the price of the j^{th} output (X_j).

The * is used to denote the values of the various parameters under world prices.

The presence of intermediate inputs (such as fuel and fertilzer) allows a reduction in the size of the matrices. Since intermediate inputs are also produced outputs, world prices are optimal for intermediate inputs, and equation (1) can be rewritten, for the case of Z intermediate inputs, as

$$[W_1^* \ldots W_{m-Z}^*] \begin{bmatrix} a_{11}^* \ldots a_{1,n-Z}^* \\ \\ a_{m-Z,1}^* \ldots a_{m-Z,n-Z}^* \end{bmatrix} = [WVA_1^* \ldots WVA_{n-Z}^*] \qquad (1')$$

$(1 \times (m-Z))$ $((m-Z) \times (n-Z))$ $(1 \times (n-Z))$

where $WVA_j = P_j - \sum_Z a_{Zj} W_Z$, or value-added at world prices. Intermediate inputs which have world prices are termed tradable inputs, and are at least potentially importable or exportable. The remaining inputs are not available on world markets, and are defined as nontradable inputs. Thus equation (1') comprises Z tradable inputs, (m-Z) nontradable inputs and (n-Z) tradable final outputs.

Equation (1') is the basis for the calculation of the DRC and NSP. Shadow prices, or opportunity costs, of inputs for use in an activity are defined as the marginal value product of the input in its alternative uses. Given world prices for outputs and input-output coefficients, the shadow prices for domestic factors of production are calculated by post-multiplication of both sides of equation (1') with the inverse of the ((m-Z) x (n-Z)) input-output matrix, or

$$[W^*] = [WVA^*][A^*]^{-1}. \qquad (2)$$

This transformation is possible only if the input-output matrix is invertible. This condition requires that the determinant of the input-output matrix is non-zero, and that the number of tradable final outputs equal the number of nontradable inputs, (m-Z) = (n-Z).

The DRC and NSP of a new or existing production activity is thus determined by comparing value-added with the total cost of nontradable inputs evaluated at their shadow prices. These shadow prices are calculated by excluding the activity from the estimation matrices of equation (1'). Denoting the input-output coefficients for the h^{th} activity by b_{ih}, $i = 1, \ldots, (m-Z)$, the efficiency measures are calculated as

$$NSP_h = WVA_h - \sum_{i=1}^{m-Z} b_{ih} W_i, \tag{3}$$

and

$$DRC_h = \sum_{i=1}^{m-Z} b_{ih} W_i / WVA_h, \tag{4}$$

where

$$h \notin \{1, \ldots (n-Z)\}.$$

If $NSP_h \geq 0$ and $DRC \leq 1$ (equivalent conditions), a comparative advantage is indicated for h, where the h^{th} activity may be defined either as an output or as a particular technology utilized in the production of an output. The finding of comparative advantage does not necessarily imply exportation, but only that domestic production of the good will be non-zero in the face of international competition. In addition, if the strict inequalities hold true ($NSP > 0$ and $DRC < 1$), adoption of activity h will increase national income. Initially, excess profits will accrue to h, but under competition these profits will be eliminated as output expands and domestic factor prices $(W_1, \ldots, W_{m-Z})$ increase. In terms of Figure 1, comparative advantage in activity h implies that adoption of the activity results in an outward shift of the production possibilities curve.

III. Criticisms of DRC and NSP Estimation Methods

A number of recent papers have identified flaws in this method of estimating shadow prices. These criticisms have focussed on four principal problems: the possible nonstationarity or indeterminacy of shadow prices, the possible inability of the estimation methods to provide shadow prices for nontradable outputs, the problem of input substitution and the lack of empirical information on free-trade input-output coefficients, and finally, the failure of the technique to explicitly introduce time and seasonality considerations into the methodology. All of these criticisms can be discussed in the context of equations (1), (1') and (2).

A. Indeterminacy of Factor Prices

As noted in equation (2), use of the input-output coefficients and world prices (or value-added in world prices) yields a determinate set of shadow prices only when the number of tradable outputs $(n-\bar{z})$ equals the number of domestic factor inputs$(m-\bar{z})$. Bhagwati and Wan (1979) and Bertrand (1979) argue that this case is special, and in the empirically prevalent case when the number of outputs does not equal the number of inputs, shadow prices are either indeterminate, non-stationary or non-existent. Bertrand suggests, for example, that "it is in general possible to define a feasible factor price for each and every factor anywhere from $+\infty$ to $-\infty$..."(p.902). The price indeterminacy problem is formally identical to the factor price equalization problem (Samuelson, 1953; 1967), and much of that discussion is relevant to the shadow pricing problem.

The first possibility of indeterminacy of shadow prices (not considered by Bertrand or Bhagwati and Wan) arises if $[a_{ij}]$ is a square matrix, but there exist multiple combinations of $[a_{ij}]$ and $[W_i]$ which equal $[P_j]$. Gale and Nikaidô (1965) have developed sufficiency conditions for a univalent correspondence between factor and output prices which require that all principal minors of the Jacobian of $[a_{ij}]$ be positive. It remains to demonstrate that these conditions have a straightforward economic interpretation.

In general, all positive minors are expected only for the matrix of second derivatives of an unconstrained minimization problem. The problem of minimizing the total cost of production in the economy can be written as

$$\min\sum_j C_j(W_1, W_2 \ldots, W_m) = \sum_j\sum_i W_{ij}L_{ij}. \quad \frac{\partial C}{\partial W_{ij}} = a_{ij} \text{ at the optimum}$$

and therefore $\dfrac{\partial^2 C}{\partial W_{ij}\partial W_{kh}} = \dfrac{\partial a_{ij}}{\partial_{kh}}$.

The matrix of second derivatives of the aggregate cost function can thus be written as an m x mn matrix

$$\begin{bmatrix} \frac{\partial a_{11}}{\partial W_1} & \frac{\partial a_{12}}{\partial W_1} \cdots \frac{\partial a_{1n}}{\partial W_1} & \frac{\partial a_{11}}{\partial W_2} \cdots \frac{\partial a_{1n}}{\partial W_2} \cdots \frac{\partial a_{11}}{\partial W_m} \cdots \frac{\partial a_{1n}}{\partial W_m} \\ \\ \frac{\partial a_{m1}}{\partial W_1} & \frac{\partial a_{m2}}{\partial W_1} \cdots \frac{\partial a_{mn}}{\partial W_1} & \frac{\partial a_{m1}}{\partial W_2} \cdots \frac{\partial a_{mn}}{\partial W_2} \cdots \frac{\partial a_{m1}}{\partial W_m} \cdots \frac{\partial a_{mn}}{\partial W_m} \end{bmatrix}$$

This matrix can be reduced to a (mxn) basis of the following form:

$$\begin{bmatrix} \frac{\partial a_{11}}{\partial W_1} & \frac{\partial a_{12}}{\partial W_2} & \cdots & \frac{\partial a_{1j}}{\partial W_i} & \cdots & \frac{\partial a_{1n}}{\partial W_m} \\ \vdots & \vdots & & \vdots & & \vdots \\ \frac{\partial a_{i1}}{\partial W_1} & \frac{\partial a_{i2}}{\partial W_2} & \cdots & \frac{\partial a_{ij}}{\partial W_i} & \cdots & \frac{\partial a_{in}}{\partial W_m} \\ \vdots & \vdots & & \vdots & & \vdots \\ \frac{\partial a_{m1}}{\partial W_1} & \frac{\partial a_{m2}}{\partial W_2} & \cdots & \frac{\partial a_{mj}}{\partial W_i} & \cdots & \frac{\partial a_{mn}}{\partial W_m} \end{bmatrix}$$

Positive values for all minors of the above matrix represent the standard second-order condition for cost minimization applied across all goods produced in the economy. Since the above matrix is precisely the Jacobian of the a_{ij} matrix of equation (1), the standard second-order sufficiency conditions for cost minimization are equivalent to the Gale-Nikaidô conditions. To criticize DRC or NSP estimation on the grounds that sufficiency conditions are not necessary amounts to a criticism of the use of optimum principles in neoclassical economics, and thus does not represent an interesting topic for the viability of DRC and NSP estimation.

A case of greater interest for empirical estimation is the presence of inequality between numbers of goods and domestic factors. Empirically, it is a difficult task to identify the number of domestic factors of production, as land, labor and capital may be divided into an arbitrarily large number of distinct types. In most cases, however, at most several categories of each domestic factor are recognized. Thus the variety of goods produced in the economy frequently appears to exceed the number of domestic factors engaged in their production. Since the input-output matrix is not a square matrix, a unique solution for factor shadow prices appears impossible.

Two principal arguments refute the claim of shadow price indeterminacy for the case in which outputs outnumber inputs ($n > m$). First, the process of competition will lead to the elimination of any activities which offer each factor less than its marginal value product which prevails at the maximum income for the entire economy (Samuelson, 1953, pp.895-96). Second, for the remaining activities it is possible that multiple equilibria exist, but this is of no consequence for factor price determination. More than one combination of outputs may correspond to the same maximum level of production income. But these maximum positions are differentiated by the quantity produced of each output rather than by different output prices (which are fixed numbers for the small economy). Since output prices are given, identical values of national income ($\sum_j p_j q_j$) can be attained only through variation of the quantity components (q_j's). It is well known that in the international trade model of fixed factor supplies, factor prices depend only on output prices and are independent of quantity.

Equation (2) can be used to show that excess goods imply redundant information, rather than indeterminacy. Each member of the inverted A_{ij} matrix can be written as

$$A_{ij}^{-1} = \frac{-1^{(i+j)}}{||[A_{ij}]||} (A_{ji}*),$$ and the matrix will contain n rows and m columns. Thus n-m rows of the inverted matrix must be linear combinations of the other m rows. Each A_{ij}^{-1} in the m to n^{th} row can be written as

$$A_{iZ}^{-1} = \sum_{j=1}^{m} k_j A_{ij}^{-1}.$$

The price of the i^{th} factor in the Z^{th} activity is

$$W_i* = P_Z*(A_{iZ}^{-1}) = \sum_{j=1}^{m} P_j* \, k_j (A_{ij}^{-1}).$$

Factor mobility results in equality of the i^{th} factor price in all production activities, so that $P_Z(A_{iZ}^{-1}) = P_j(A_{ij}^{-1})$, for all j=1,...,m, and thus $k_j = \frac{1}{m}$, for all j.

This result means that any m equations can be used to identify the shadow prices of factors, with the choice of the m components to make $[A_{ij}]$ a square matrix of no significance. Rather than prevent the calculation of shadow prices, the presence of more goods than factors at the optimum indicates the presence of redundant information. Thus the existence of more goods than factors is a benefit rather than a bane for the empirical estimation of shadow prices. Where data for some outputs are difficult to obtain or particularly unreliable, these goods can be considered redundant and disregarded in the calculation of shadow prices.[2/]

B. Nontraded Goods

The preceding results are particularly useful in evaluating the class of goods which are not traded on international markets. Goods may be nontradable by virtue of high transportation costs, impossibility of storage, or a lack of demand outside the country. Hence, world prices are unavailable and it is impossible to estimate the world value-added for the right-hand side of equation (1'). Since policies may have resulted in substantial price distortions in the nontraded goods sector through direct policies (subsidy/tax mechanisms) and indirect effects of other policies (such as balance of payments policies), uncertainty arises as to the appropriate price for nontraded goods. If the input-output coefficients are available, however, the task is straightforward. The nontraded goods may be considered as redundant, with $P_n = \sum_i a_{in} W_i$. The price of the nontraded good must adjust to the opportunity cost of its factors of production. These opportunity costs are determined by the tradable goods produced in the economy.

C. Input Substitution

The next problem for DRC and NSP estimation involves the use of input-output coefficients. Equation (2) indicates that the coefficients required for the estimation are those which prevail under free-trade, general equilibrium conditions,(A_{ij}*). Empirical data ($\hat{A}_{ij}$) are obtained from farm and industry surveys, and are observed under distorted market conditions. The $\hat{A}_{ij}$ may differ from the A_{ij}* due to substitution effects induced by distortions. Findlay and Wellisz (1976) and Srinivasan and Bhagwati (1978) have argued that the problem of input substitution can lead to inappropriate and misleading calculations of shadow prices, and hence an erroneous estimate of NSP and DRC.

The effect of output price distortions on input substitution and shadow price calculations has been discussed elsewhere (Monke, 1981). Errors in factor-price estimates caused by output price distortions are second-order smalls. With a limited amount of information on alternative production technologies, individual errors in the calculated factor prices will be less than 16 percent of the relative change in the factor price ($\Delta W/W$), where ΔW represents the difference between the calculated shadow price and the observed market price. Second, in the presence of multiple output price distortions, the input substitution effects are likely to be offsetting unless output distortions are concentrated on either labor- or capital-intensive goods. Given the empirical realities of shadow price estimation, the differences between $\hat{\hat{A}}_{ij}$ and A_{ij}* due to output price distortions are of little concern.

The impact of input-price distortions on input substitution is a more difficult problem for shadow-price estimation. Taxes and subsidies on inputs may have significant effects on the choice of technique within a country. Imperfect transmission of technical knowledge across countries and the invention of new technologies may also affect the comparative advantage of production. Moreover, the identification of appropriate technologies and potential input substitution in the production of a given output is one of the principal goals of DRC and NSP estimation (see, for example, Pearson, Stryker and Humphries, 1981).

If substitution possibilities are considered important, they can be incorporated in DRC and NSP estimation through the techniques of process analysis and mixed integer programming (cf. Duloy and Hazell, 1975). This procedure yields a linear approximation of the theoretically smooth production isoquant, and the computation process compares the alternative production techniques on a pairwise basis to identify the most efficient technique. Such information is usually taken from observation of production practices in other countries or from pilot project results within the country. This approach towards potential factor substitution seems particularly appropriate to empirical comparative advantage analysis because substitution possibilities are specifically defined. The alternative approach, which assumes a smooth isoquant and an elasticity of substitution, may not identify empirically plausible input combinations. (Nor can the existence of a strictly convex isoquant be confirmed by empirical observation, as n observations along an isoquant define at most n+1 linear segments.) Complete replacement of an existing technique of production will, of course, result in a new matrix of input-output coefficients, and factor prices calculated in the future will differ from those in the present.

In sum, the difference between $\hat{A}_{ij}$ and A_{ij}^* is not a significant empirical problem. The real difficulty for empirical estimation is to find reliable observations of the input-output relationships, $\hat{A}_{ij}$. Coefficients are usually determined from field surveys, which may vary enormously in sample size, design and enumerator ability. A number of efforts can be made to minimize the uncertainty of data quality. Multiple surveys, both within and across countries, can be examined. Expert observers can frequently provide important evaluations of survey data. Private profitability calculations (at existing market prices) also provide a useful check of data viability. Finally, the data can be disaggregated among geographical areas and technologies to reflect variations in input-output relationships. Geographical area is particularly important in the evaluation of agricultural production, as location influences both yields and potential substitute crops. Technologies may vary significantly with respect to firm size, equipment vintage and the type of inputs utilized.

D. Seasonality[3/]

Equations (1) and (2) make no mention of the time period applicable to the shadow pricing exercise. Shadow prices are commonly evaluated on the basis of annual data for input-output coefficients and world prices. While this procedure is reasonable for industrial activity, it is frequently misleading in the evaluation of agricultural activities because of the seasonal variability in resource demands. In terms of equation (1), this variation means that the alternatives for resource use are time-dependent. Hence, the opportunity costs of domestic factors and the DRC and NSP will also be time-dependent.

Nowhere is the importance of seasonality more evident than in Egyptian agriculture, where constraints on feasible crop rotations and multiple cropping make resource opportunity costs highly variable over the calendar year. The obvious solution to the seasonality issue is to define alternative activities (and thus equation (1)) for a specified time period. The principal alternative to cotton, for example, may be two final cuts of berseem plus a crop of maize or rice. Where alternatives are restricted by rotation requirements, opportunity costs must be estimated on the basis of a multi-year usage of resources. If one crop of cotton necessarily implies two subsequent crops of maize or rice, the alternative uses of the domestic land, labor and capital must consider alternative crops and input requirements over a three-summer period.

Seasonality in resource use points to the critical importance of knowledge of cropping calendar for the determination of shadow prices and subsequent estimation of DRC and NSP. While seasonality may appear to make the calculations more complex, this is not necessarily the case. Recognition of time-specific production possibilities may provide a significant reduction in the number of alternative uses of domestic resources. A focus on cotton, for example, needs to consider winter crops only in terms of their overlap with portions of the cotton production calendar. Fewer alternative uses imply a smaller (m-Z) x (n-Z) matrix for equation (1'). Thus increased knowledge of the farm system can partially substitute for information on input-output requirements.

IV. Collection and Presentation of Data[4/]

In summary, DRC and NSP estimation can be viewed as an attempt to identify the most efficient allocation of nontradable factors, whose prices are necessarily domestically determined. The optimal allocation among outputs depends on their nontradable input requirements and the value-added in world prices available in their production. The necessary data for DRC and NSP estimation thus comprise the set of world prices for tradable outputs and inputs, and input-output coefficients of the production processes. These data allow calculation of the WVA and a_{ij} parameters of equation (1'). Since the prices of tradable goods may be defined in terms of any currency (£E or $US, for example), the shadow price of foreign exchange is irrelevant information. The shadow price of domestic factors will be estimated in whatever currency is used to evaluate world value-added, with the result that NSP and DRC calculations are independent of currency valuation.

Even without the shadow price of foreign exchange, however, the data requirements and practical complications of NSP and DRC estimation are substantial. This section attempts to provide further discussion of the methods of collection and organization of the price and input-output data. The required price and input-output data are described in Appendix 1. Where possible, time series data are desirable, in order to avoid the use of observations which are influenced by the vagaries of a particular year and are thus clearly inappropriate to a comparative static analysis.

A. Input-Output Coefficients

Input-output coefficients for existing technologies are based on survey data. Given the variation in survey methodologies, careful evaluation of a maximum number of surveys is generally necessary to allow preparation of a "representative" budget. Aggregation of implied input requirements at the national level and estimations of private profitability may provide useful tests of the reliability of budgets. The description of new technologies must rely on data from experimental project areas, feasibility studies, or performance in other countries. Such data must frequently be adjusted to allow for differences between experimental and actual on-site performance, particularly for expected yields and capital utilization times. These data are inherently less reliable than survey data, and the importance of sensitivity analysis of the results cannot be underemphasized.

B. Prices

Two sets of price data are collected -- world prices and domestic market prices. Domestic market prices are collected for all inputs and outputs. World prices are collected for all tradable inputs and outputs. If the good is imported, the world price is defined as the cif price plus delivery costs to the point of final use. If the good is exported, the world price is defined as the fob export price.

The shadow prices for domestic factors and the world-price equivalent for nontradable inputs and outputs are calculated from the results of equation (2). For practical reasons, separate estimations are made for agricultural production and industrial sector activities (processing and marketing). This procedure implicitly assumes that agricultural resources are in fixed supply and not transferrable to the industrial sector. This distinction is obviously incorrect in a dynamic growth context, and highlights the comparative static nature of the calculations. Alternative approaches await the development of dynamic models of comparative advantage.

Labor, land and all capital goods (imported as well as nontradable goods) are nontradable inputs, with the number of input categories an arbitrary empirical decision. The criteria to identify distinct categories of inputs involve considerations of alternative use. If labor can be readily substituted among maize, rice and cotton production, then a single category of unskilled labor is sufficient. Machinery operators can not be readily developed from farm labor, however, and thus must be considered as a separate labor input. Computational constraints also influence the number of categories of nontradable inputs, as each additional input requires the addition of an output activity to allow the solution of equation (2).

The classification of capital inputs presumes that all incremental domestic investment comes from domestic earnings, and thus implies that the access to foreign markets for investment capital is fixed. The shadow price for capital calculated from equation (2) is depreciation plus the rate of return to capital in its best alternative use, but problems with physical measurement of capital make such concepts impossible to implement. As a result, capital is considered homogeneous, and the price of capital is estimated on the basis of outside estimates and examination of the supply and demand prices of financial capital for investment purposes. Sensitivity analysis of the results is utilized to determine the impact of alternative capital prices upon the NSP and DRC.

Utilization of the value marginal product of capital at world prices as a measure of the shadow price of capital ignores the social rate of time preference. It is straightforward to show that consideration of the social time preference rate will normally have no impact on the shadow price of capital. Arguments in support of the use of an interest rate lower than the value marginal product of capital suggest that, for various reasons (such as insufficient consideration of future generations), consumption is "too large" and investment is "too small". But such arguments are concerned with macroeconomic rather than microeconomic allocations of resources, and equations (1) - (2) show that changes in the aggregate supply of capital will normally have no effect whatsoever on the rate of return to capital. When world prices for outputs are fixed, changes in the supply of domestic resources affect only the quantity produced of various outputs and have nothing to do with input or output prices. This result is an illustration of the Rybczynski Theorem. As noted in the previous section (and fn.2), the only circumstance in which the social rate of time preference could influence the price of capital arises when the output adjustments are so large that the production of a large number of outputs is eliminated. Specifically, the number of outputs produced must become less than the number of factors, so that increases in output of capital-intensive goods and the complete elimination of at least (n-m-1) of the relatively labor-intensive outputs. Unless the latter case can be argued as empirically likely, there is no basis to the argument that the shadow price of capital should be lower than the rate of return to capital at world prices.[5/]

C. Tradable and Nontradable Goods

All tradable inputs in the production process are immediately moved to the right-hand side of equation (1'), and become a component of value-added at world prices. If nontradable, however, the input is decomposed into its domestic labor, land, capital and tradable input requirements. This process continues in an iterative fashion until all goods are ultimately disaggregated into domestic and tradable resource requirements. Examples of goods which are obviously nontradable and utilize tradable inputs include electricity, local construction services, commercial margins and transportation services.

The classification of goods as tradable or nontradable is not always obvious. In theory, tradable outputs and inputs are defined to include all goods that would be traded if the government were following optimal trade policies, while a good is nontradable if its internal price lies between its export and import parity prices under optimal trade policies. Unfortunately, optimal trade policies are rarely in effect, and in their absence there exists no theoretical criterion for identifying any good as either tradable or nontradable.

However, as a practical consideration, a generally applicable and systematic framework for the treatment of inputs and outputs as either tradable or nontradables must be developed so that consistent estimates of the efficiency and policy indicators can be calculated. Three categories of goods and services are considered. These categories refer to the economy under existing trade policies and include (1) fully imported and partially or fully exported goods (2) locally produced, fully traded goods, and (3) locally produced, nonfully traded goods. Fully imported goods include only those goods that are totally supplied through imports with no domestic production taking place. Exported goods refer to goods which are domestically produced and sold abroad in part or entirely.

The other two categories, fully and nonfully traded goods, are based on concepts first developed by Joshi (1972). An input is considered to be fully traded if any incremental local demand is entirely met by imports. Similarly, with fully-traded outputs any additional domestic production could be exported. Hence, a fully traded good is characterized by the fact that increases in domestic demand or supply only affect the foreign balance, and domestic prices remain unaffected. Alternatively, nonfully traded inputs are goods for which increases in demand are entirely met by increased domestic supply, while nonfully traded outputs occur when additional domestic supply is entirely consumed locally. In these instances, changes in domestic supply and demand affect domestic prices.

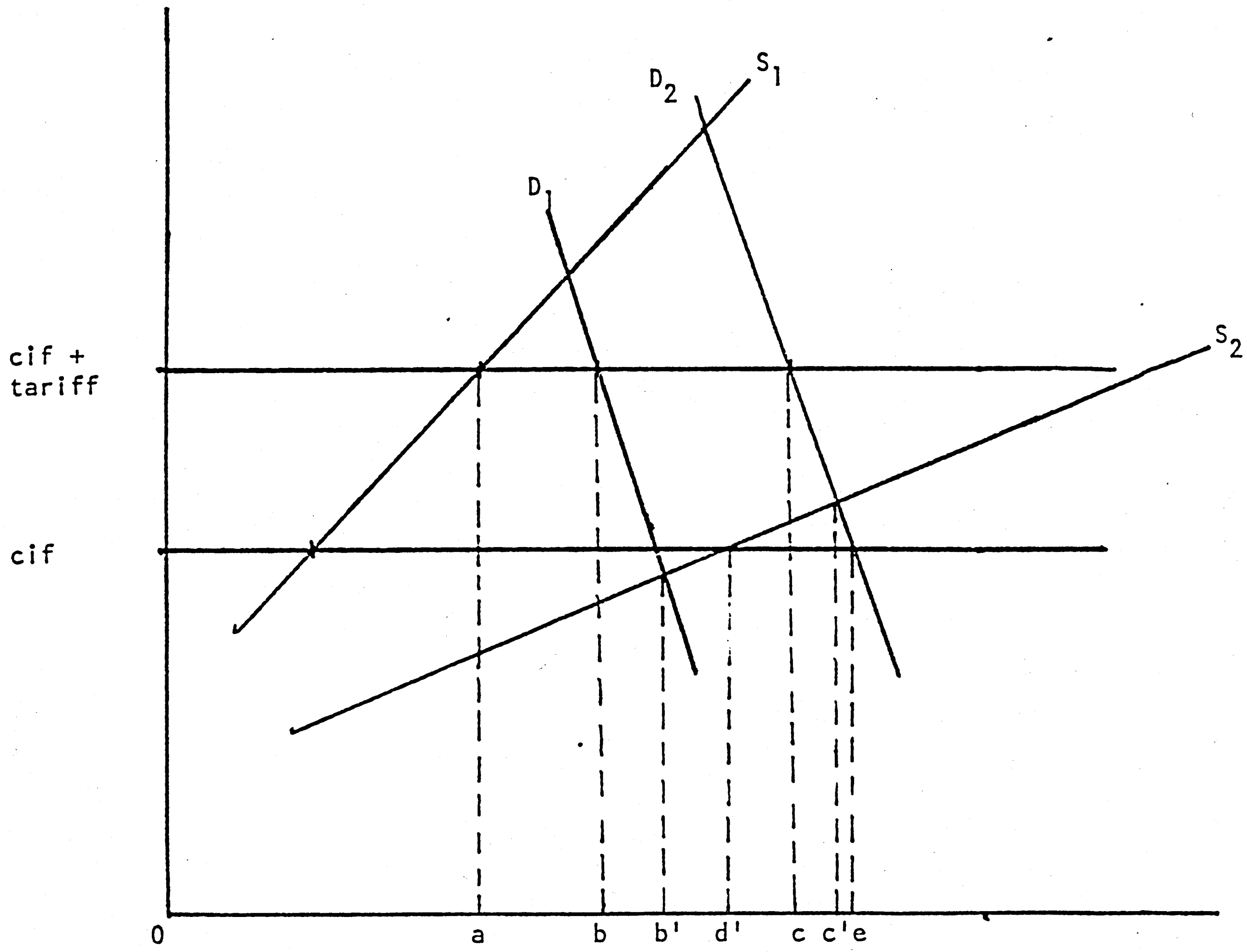
These concepts of fully and nonfully traded goods are illustrated in Figure 2 for the case of inputs subject to increased domestic demand. Input S_1 is considered to be fully traded because an outward shift in demand is met solely by increased imports (bc) and the domestic price remains at the cif price plus the nonoptimal tariff. Input S_2 represents the other extreme. Under the existing tariff structure, the domestic producers of input S_2 are totally protected, incremental demand for S_2 will be met by increased domestic production (b'c'), and the good is considered to be nonfully traded.

Utilizing these three categories of goods under existing nonoptimal trade conditions, the framework for treatment of goods as tradable or nontradable within the context of optimal trade policies can be developed.

All goods that fall in both the fully imported or exported categories and in the fully traded

Figure 2.

Fully and Nonfully Traded Inputs



0a = amount of S_1 produced domestically with import tariffs in effect

ab = amount of S_1 imported with import tariff

bc = additional imports of S_1 due to a shift in demand (D_1 to D_2)

b'c' = additional domestic production of S_2 due to a shift in demand with import tariffs in effect

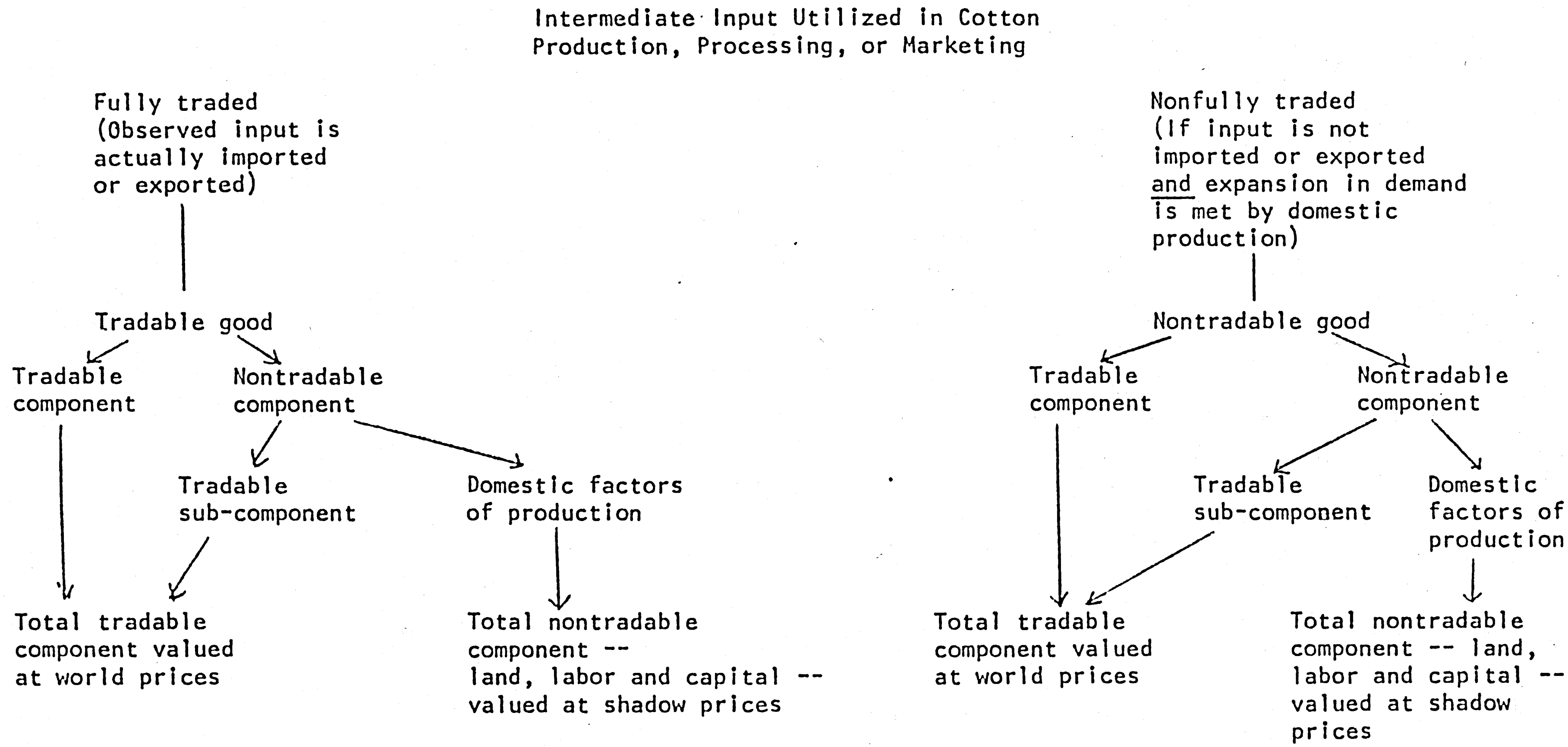
d'e' = imports of S_2 due to a shift in demand, with free trade category will be treated as tradables under the assumption that the move from nonoptimal to optimal trade policies will not affect local supply and demand conditions to such an extent that trade in the good would no longer continue. The nonfully traded category is likely to include both tradable as well as nontradable goods because certain goods not traded under existing nonoptimal policy would likely be traded if policy were changed to reflect optimal conditions. However, it is impossible to identify these types of goods as tradable and, thus, all goods within the nonfully traded category will be treated as nontradables.

This framework is illustrated in Figure 3. At the field level each input will be classified according to its origin, i.e., either domestically produced or imported. Those inputs that are imported are automatically treated as tradables because they fall within the fully imported or fully traded categories.

Observed inputs which are of domestic origin are further divided into two categories. The first contains inputs that are not directly imported for use in the activity under analysis but which are imported for use elsewhere in the economy. These goods will also be classified as fully traded inputs and will be treated as tradables. The second category consists of inputs that are not imported at all under existing trade policy and would not likely be imported in response to a shift in domestic demand. This type of input is a nonfully traded good and will be treated as a nontradable input in this study.

Once a good has been classified as nontradable, it will be broken down into its tradable and nontradable components and its primary domestic factors. The tradable components will then be valued at world prices, and the nontradable component further broken down into tradable and nontradable

Figure 3. Classification System for Tradable and Nontradable Inputs



categories. This process will continue until the nontradable input is totally broken down into tradable components and the domestically supplied primary factors of production, labor, capital and land. The tradable components are all valued at world prices while the shadow pricing techniques are applied to the factors of production.

Additionally, all goods that are treated as tradables will likely contain a nontradable component reflecting the costs of such things as transportation or handling charges. These nontradable components are handled in the same manner as nontradable goods with the tradable portions broken down and valued at world prices and the primary factors of production identified and shadow priced.

The use of this framework introduces the possibility of biased estimates of NSP and DRC due to improper input classification. By referring back to Figure 2, it can be seen that in the face of existing nonoptimal trade policy (reflected by the cif plus tariff price), increased demand for input S_2 is met fully by increased domestic production. Hence, the good is classified as nonfully traded and treated as a nontradable. However, under optimal trade policy (reflected by the cif price) S_2 would in fact be tradable because increased demand is partially met by imports (quantity d'e' is imported). Hence, it is clear that the framework developed for the treatment of goods as tradable or nontradable may lead to the erroneous treatment of some goods as nontradable which should in theory be treated as tradable. To the extent that tradable input costs are erroneously counted as domestic factor costs or <u>vice versa</u>, a systematic bias will be introduced into the calculations of the efficiency indicators. The extent of the bias in the DRC and NSP estimation has been investigated by Bruno (1967). DRC estimates will be biased toward one and NSP estimates will be unbiased. This is a fortunate result, as it implies estimated values will never overstate the degree of comparative advantage and that inefficient activities will not be mistakenly identified as efficient (or vice versa).

D. Accounting Framework for DRC and NSP Estimation

The data for world, domestic market and domestic factor shadow prices are applied to the input-output coefficients to allow the calculation of private and social costs of production for the activity of interest. These calculations are summarized in budget form, and sample budgets are provided in Appendix B. Data for domestic market and world prices for the output allow subsequent calculation of both private and social profitability. A second organizational framework, useful for summarizing the impact of government tax/subsidy policies and imperfections in domestic factor markets, is provided in Appendix C.

The private cost and profitability calculations have two important uses. First, domestic market price data allows a useful test of the validity of input-output data. A finding of negative private profitability concomitant with rapidly expanding cash-cropping, for example, suggests that some data are seriously under- or over-estimated. Second, domestic market prices help to identify the impact of market imperfections and government policies on economic efficiency. While NSP and DRC calculations are largely independent of domestic market prices, exclusive concentration on shadow prices and comparative advantage is of limited value for policy-makers. Of greater interest is the explanation of causes for differences between shadow prices and market prices. This process serves to identify the specific policies or market imperfections which prevent the realization of comparative advantage (or opportunities to earn foreign exchange) and thus allows identification of specific new policies which can achieve efficiency-related goals.[6] Thus the goal of DRC and NSP analysis is not only to identify an optimal production technology or output, but to explain in detail why the optimum is not realized. If the producer price for fertilizer exceeds the cif price plus delivery costs to the farmgate, DRC and NSP analysis must also explain the causes for this difference, such as monopolization of domestic marketing, quantitative restrictions on fertilizer imports, or import tariffs.

V. Concluding Comments

The discussion of the preceding section makes clear that the calculations of DRC and NSP involve some degree of arbitrariness. The system of distortions of world prices is not likely to be fully known. The iterative process of nontradable goods disaggregation into domestic factor and tradable good components is rarely conducted for more than one or two iterations. Identification of the number of technologies, regions and factors of production is necessarily arbitrary, and often influenced by data availability.

But arbitrariness is present in all applications of economic theory, and the criticism of cost-benefit analyses such as the DRC and NSP on the basis of weak data amount to claims that input-output coefficients and price data utilized in the DRC and NSP are less reliable than data used in other methods of analysis. But the data utilized by the DRC and NSP are not uniquely utilized by cost-benefit analyses. Almost all economic analyses utilize price data, and their reliability is an issue which can be resolved only at the individual country level. Input-output coefficients represent averages of yields and input uses, but are frequently based on similar input and output information utilized in supply analyses. Whereas supply response estimates the shape of the response curve, NSP analysis identifies its location in price-quantity space. Thus with respect to input-output data, NSP and DRC estimates will be no less reliable than the results of supply analysis. To the extent that observational errors are offseting, estimations of the "average" input-output relationships will be more reliable than estimates of marginal response. As with price information, data reliability is a country-specific issue rather than a problem inherent to the technique.

While the DRC or NSP can make no claims to being a single decision criteria comprising all economically relevant information, there can be little doubt that the issues addressed by DRC and NSP estimation are of critical importance for economic policy. Identification of the specific instruments which have determined the economic status of a commodity -- government distortions of output and input prices, promotion and restriction of alternative technologies, and market imperfections -- is clearly an advance beyond the casual empiricism which pervades much economic policy analysis. Second, the method allows a focus on the government revenue impacts of the various instruments, a factor which has proven important in both understanding the reasons for current policies and developing viable new policies. Finally, the estimates allow calculation of the aggregate real income gains or costs which result from changes in policy. These quantitative estimates can then be weighed against non-efficiency parameters, such as income distribution or government revenue generation. Without the detailed examination of policy instruments and the quantitative estimates provided DRC and NSP analysis, the importance of economic efficiency in policy will continue to risk domination by more readily observable political and administrative considerations.

Footnotes

1/ It is possible to combine the income-distributional and production efficiency effects of policies into a single measure (Boadway, 1976). However, without cardinal utility functions for both individuals and society, estimation of the "value" of income distributional shifts is beyond the capacity of empirical analysis, and thus only obscures the tradeoff between production efficiency (absolute income levels) and income distribution (relative income levels). Description of the income distributional impacts of new technologies and policies is as much information as the empirical economist can provide, and nothing is lost by maintaining analystical separability between income distribution and production efficiency (See also Harberger, 1978).

2/ The case in which the number of factors exceeds the number of outputs is not likely to be empirically significant. Factor price determination in this case has been considered by Samuelson (1953) and Bertrand (1979), and requires the addition of information about factor supplies, specifically

$$L_i = \sum_j a_{ij} X_j \quad , \qquad i=1,\ldots m$$

These relations comprise m equations in n unknowns (X_j's). A determinate equilibrium is formed since the factor price equations comprise mn equations and the production functions comprise n equations. The total number of unknowns (a_{ij}, W_i and X_j) equals mn + m + n.

3/ I am indebted to Carl Gotsch for demonstrating the importance of this topic.

4/ This section draws liberally from material presented in V. Roy Southworth, Eric Monke and Scott R. Pearson, "Methodological Notes for Calculating Social and Private Profitability", mimeograph, Food Research Institute, Stanford University, 1976.

5/ As Baumol (1968) points out, the restraint of current consumption to allow increased investment and future consumption becomes a "Robin Hood activity stood on its head" when the economy grows at a positive rate. Under these conditions, reduction of interest rates to encourage increased investment for the benefit of future generations amounts to a transfer from today's poor to tomorrow's wealthy. Irreversibilities, such as the construction of dams or the utilization of a finite nonrenewable resource, may represent exceptions to the above assumption. But such considerations may be incorporated as justifications for tax/subsidies to a particular project rather than arbitrary adjustments to the interest rate. Such factors represent potential rationales for the acceptance of activities with apparently negative net social profitability.

The approach described in the text implicitly assumes that any risk premium present in private sector rates of return should also be included in the evaluation of public sector investment. In developing countries where the number of investment projects is relatively small, such an assumption may be reasonable. Furthermore, truly riskless investment alternatives either do not exist due to the limited size of financial markets or are apparently offered at rates of return well below the market rate less the risk premium, as they do not attract a significant amount of financial capital. Thus the risk premium is unobservable. In cases where risk permia are believed important, but are unknown, ex post simulation of results under alternative interest rates appears as the only viable method of analysis.

6/ To reiterate a point made in the introduction, the desirability of new policies depends also on their impact on non-efficiency objectives, such as income distribution and government revenue generation.

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APPENDICES

Appendix A. Data Requirements for DRC and NSP Estimation

Outline of Economic Data Requirements for Project

Analysis Paper - Production

Note: One set of data should be provided for each technique. Unless otherwise indicated, costs should apply to 1979-80 year.

I. Outputs

A. Producer prices, seed cotton, 1960-80

1. By variety

2. What are discounts and premiums paid for different qualities (e.g. different qualities of Giza 67)

B. Producer prices, berseem, 1960-80

This time series may be difficult to find. If not available, is it possible to relate the price of berseem to other series such as the price of meat, or to the costs of animal rental.

C. Producer prices, rice, 1960-80

D. Producer prices, maize, 1960-80

II. Intermediate Inputs - On Farm

A. Seed prices, 1960-80

B. Fertilizers and insecticides, 1960-80

1. Farmer prices from co-op

2. Prices for purchases from private market

3. cif prices

4. Import or export tariffs

C. Mechanical equipment costs

1. Farmer rental rates (e.g. co-operative charges/feddan for land preparation)

2. cif prices for equipment (e.g. tractors, plows, groundsprayers, airplanes)

3. Maintenance and repair charges (this can be an average number)

4. Operating costs

   a. Fuel consumption/hr

   b. Driver costs

5. Import tariffs on mechanical equipment

D. Irrigation system

1. Maintenance equipment

   a. Government charges to farmer

   b. Cost of equipment to government (Is any of equipment imported? Is any of equipment subject to tariffs?)

2. Pumping costs

   a. Animal-power (rental rates for animal power)

   b. Pumps

      1. Farmer initial cost and usualbe life.

      2. cif cost of pumps, or tariff rates on imported pumps

3. Skilled labor costs (e.g. machinery operator charges)

E. Hand tools

1. Purchase price (1979), usuable life of tools

2. cif prices (if relevant), or tariff rates on tool imports

III. Primary Inputs

A. Skilled labor

1. Costs, by task

2. Source of skilled labor (e.g. provided by cooperative, hired at custom rates)

B. Unskilled labor

1. Daily wage rates, male adults, 1970-80, by season. (These might be available in Master's or Ph.D. Theses on Farm Management topics)

2. Average number of hours/day

3. Wage rate differentials by sex and age

4. In-kind payments (meals, etc.)

C. Capital

1. Interest rates on long-term loans, 1970-80 (e.g. for purchases of tractors or pumps)

   a. Rates from government institutions

   b. Rates from private sector lenders

2. Interest rates on short-term loans, 1970-80 (e.g. seasonal loans on operating expenditures)

   a. Government rates

   b. Private sector rates

D. Land, rental rates, 1970-80

IV Farm-to-Gin Costs

1. Price of sacks

2. Transportation charges/km

3. Cost of storage facilities used by village co-op

Outline of Economic Data Requirements for Project

Analysis Paper - Ginning

Note: One set of data should be provided for each technique. Unless indicated otherwise, costs should be given for 1979 - 80.

I. Outputs

A. Seeds

1. Price/kg by enduse (e.g., next year's seed, processing)

2. Proportions of seed output in different end-uses.

B. Scerto

1. Price/kg, 1970-80

2. Enduses of scerto

C. Lint cotton, by quality

1. Prices for domestic spinning mills, 1960-80.

2. Prices for exporting firms, 1960-80 (if relevant)

II. Imput costs at Gin

A. Equipment (gins, equipment for transporting sacks, and unprocessed cotton, balers, ovens, etc.)

1. Purchase price and date of purchase

2. Usuable life of equipment

3. Import tariffs on equipment

B. Buildings

1. Construction costs, and date of construction

2. Usuable life

3. Import or export taxes on major construction inputs (e.g., cement)

C. Storage Facilities

1. Costs and date of construction

2. Usuable life

D. Skilled labor, annual costs by task (e.g. administration, equipment operators, drivers, etc.)

E. Unskilled labor, costs by task

   1. Daily wage rates, by task, by shift (e.g., does a night-shift pay a higher wage than day shift)

   2. Annual wage bill, by task

F. Fuel costs, annual

G. Oil

   1. Annual costs

   2. f.o.b. export values/gallon, 1970-80

H. Electricity, annual

I. Maintenance and Repair Expenditures

   1. Buildings

   2. Machinery

   3. Import tariffs on principal items

J. Sacks and Packaging Materials

   1. Purchase price

K. Vehicles

   1. Age and purchase price

   2. Usuable life

   3. Import tariffs

L. Other tolls and equipment (e.g. scales, hand tools)

   1. Purchase price

   2. Import tariffs

N. Other charges (e.g. land rental, etc.)

III. Input costs, transportation from gin to mill or port

A. Transportation

1. Charge/km

2. Capacity of vehicle (cantars of lint cotton)

B. Skilled labor (driver) cost

C. Unskilled labor costs (loading and unloading)

Outline of Economic Data Requirements for Project

Analysis Paper - Spinning Mills

Note: One set of data should be provided for each technique.

I. Outputs

   A. Yarn prices, by count, 1960-80.

      1. Prices for domestic weaving industry

      2. f.o.b. export prices (if relevant)

II. Input costs

   A. Lint cotton costs, 1960-80

   B. Equipment (carding and spinning)

      1. Costs and date of purchase

      2. Are tariffs applied to imported equipment?

   C. Building costs

      1. Production

      2. Storage

      3. Office

      4. Housing

      5. Tariff rates on imports or exports of principal building materials (e.g. cement)

   D. Skilled labor, annual costs by task (e.g. administrative, equipment supervision)

   E. Unskilled labor, costs by task

      1. Daily wage rates, by task, by shift

      2. Annual wage bill, by task

         a. Permanent employees

         b. Temporary employees

F. Fuel, annual cost

G. Oil

1. Annual costs

2. f.o.b. export values/gallon, 1970-80

H. Electricity, annual costs

I. Maintenance and repair expenditures

1. Buildings

2. Equipment

3. Tariff rates on imports or exports

J. Packaging materials

1. Purchase price

2. Import or export tariffs

K. Vehicles

1. Purchase prices and usuable life

2. Import tariffs

L. Other tools and equipment costs

1. Purchase price

2. Import tariffs

M. Administrative overhead (e.g. office supplies)

N. Other charges (land rents?)

III. Input costs, transportation from spinning mill to weaving mill or port

A. Transportation

1. Charge/km

2. Capacity of vehicle

B. Skilled labor cost (driver)

C. Unskilled labor costs (loading and unloading)

Appendix B. Sample Budgets for Private Profitability, DRC and NSP Calculation for Rice.

Table A.--Production budget for farming

(name of technique)

Units: (local currency)/ha

Inputs	Unskilled labor: Man-days	Unskilled labor: Market value	Skilled labor	Capital	Land	Tradable inputs	Taxes and subsidies: Tradables	Taxes and subsidies: Nontradables	Total market value
1. Direct labor									
A. Land preparation									
B. Seeding									
C. Chemical application									
D. Weeding									
E. Pest control									
F. Irrigation									
G. Harvesting									
H. Threshing									
I. Transport									
2. Seed									
3. Fertilizer									
4. Insecticides, etc.									
5. Interest and depreciation									
A. Small tools									
B. Animals									
C. Animal implements									
D. Mechanical equipment									
E. Land improvement									
6. Operation and maintenance									
A. Animals									
B. Animal implements									
C. Mechanical equipment									
D. Land improvements									
7. Extension services									
8. Fixed charges									
9. Land cost									
10. Other costs									
Total costs									

Yield ______; market price farm gate ______; ratios of shadow price to market price for: unskilled labor ______, skilled labor ______, capital ______, land ______; total social cost per hectare ______; per metric ton milled product equivalent

Table B.--Budget for Collection

(name of technique)

Units: (local currency)/kg paddy

Inputs	Unskilled labor	Skilled labor	Capital	Land	Tradable inputs	Taxes and subsidies Tradables	Taxes and subsidies Nontradables	Total market value
1. Sacks								
2. Handling								
3. Transport								
4. Commissions								
5. Capital charges								
6. Storage								
7. Other								
Total								

Price received at mill ______; ratios of shadow price to market price for: unskilled labor ______, skilled labor ______, capital ______, land ______; total social cost per kilogram paddy ______, per metric ton milled product equivalent ______, ______.

Table C.--Budget for Milling

(name of technique)

Units: (local currency)/kg milled rice

Inputs	Unskilled labor	Skilled labor	Capital	Land	Tradable inputs	Taxes and subsidies: Tradables	Taxes and subsidies: Nontradables	Total market value
1. Direct labor								
2. Fuel								
3. Oil								
4. Electricity								
5. Rent								
6. Interest and depreciation								
A. Building								
B. Equipment								
7. Maintenance and repair								
A. Building								
B. Equipment								
8. Capital charges								
9. Insurance								
10. Other								
Total								

Yield ______; percentage brokens ______; price received ex-mill ______; ratios of shadow price to market price for: unskilled labor ______, skilled labor ______, capital ______, land ______; total social cost per kilogram milled rice ______, per metric ton milled rice ______, ______.

Table D.--Budget for Distribution

(name of technique)

Units: (local currency)/kg milled rice

Inputs	Unskilled labor	Skilled labor	Capital	Land	Tradable inputs	Taxes and subsidies Tradables	Taxes and subsidies Nontradables	Total market value
1. Sacks								
2. Handling								
3. Transport								
4. Commissions								
5. Capital charges								
6. Storage								
7. Other								
Total								

Price received from wholesalers in consumption center ______; border price of comparable rice ______; ratios of shadow price to market price for: unskilled labor ______, skilled labor ______, capital ______, land ______; total social cost per kilogram milled rice ______, per metric ton milled rice ______, ______.

Appendix C. Accounting Framework for the Estimation of the Efficiency and Policy Indicators

The accounting framework presented here will be useful in clarifying further the concepts and data requirements underlying the efficiency and policy indicators. This framework is presented as the "Table of 18" and appears in Table 1. The eighteen items in the table are either cost and return data or one of the indicators. These items appear as rows in the accounting framework. The column headings include Countries/Areas/Techniques --in other words, the cotton producing activity being evaluated. As an example, a column might involve cotton production at the national or regional level, or production with a specific technology. Each item will be discussed below in terms of cotton production.

Item One. Gross output, at domestic prices or at government support prices.

The important thing to recognize about this entry is that it is not necessarily the domestic market price. If, for example, a government purchasing agency subsidizes domestic production by buying from producers at one price and reselling to consumers or processors at a lower price, then the market price is not the relevant price. The market price does not adequately describe the production incentives for farmers or the cost of the good to the domestic economy. The relevant price for DRC analysis is the subsidized price or, equivalently, the per unit market price plus the per unit subsidy. Taxes on output should be treated as negative subsidies.

Table 1. Accounting Framework for the Estimation of the Efficiency and Policy Indicators

Cost and Return Data and Indicators

(1) Gross Output, at domestic prices or at government support prices (inclusive of government subsidies to domestic production)

(2) Tradable Inputs, at domestic prices (list separately)

(3) Value Added, in domestic prices ((1)-(2))

(4) Factor Costs, other than capital, at domestic prices (list separately)

(5) Indirect Taxes (Subsidies can be entered as a negative tax)

(6) Private Profitability ((3)-(4)-(5))

(7) Gross Output, at world market prices

(8) Tradable Inputs, at world market prices (list separately)

(9) Value Added in world market prices ((7)-(8))

(10) Domestic Resource Costs, other than capital, at opportunity costs (list separately)

(11) Social Profitability ((9)-(10))

(12) Domestic Capital Costs, at opportunity costs

(13) Nominal Protective Coefficient on Output (NPCO) ((1)÷(7))

(14) Nominal Protective Coefficient on Tradable Inputs (NPCI) ((2)÷(8))

(15) Effective Protective Coefficient on Value Added (EPC) ((3)÷(9))

(16) Net Social Profitability, at official exchange rate ((11)-(12))

(17) Domestic Resource Cost Coefficient (DRC) ([(10)÷(12)]÷(9))

(18) Excess Cost of Domestic Factor Coefficient ([(3)-[(10)÷(12)]]/(9) or (15)-(17)

(a) Excess Cost of Capital

(b) Excess Cost of Land

(c) Excess Cost of Unskilled Labor

$$\frac{\text{Price of Gross Output}}{\text{kg. lint cotton}} = \frac{\text{Market Price}}{\text{kg. lint cotton}} + \frac{\text{Subsidy}}{\text{kg. lint cotton}}$$

It is important to be careful about the units involved in assessing subsidies. If a tax/subsidy is implemented on seed cotton, i.e., the government buys seed cotton from farmers and then resells the lint to consumers, adding up per unit market prices plus per unit subsidies will not yield an appropriate output price because the subsidies will be paid per unit of seed cotton while the market price is in terms of lint cotton. This problem can be dealt with by using conversion ratios -- the efficiency with which seed cotton is converted to lint cotton. The milling ratio will vary depending on processing technologies and the type of cotton produced. A subsidy on cotton at the farm gate level would thus be handled as follows:

$$\frac{\text{Price of Gross Output}}{\text{kg. lint cotton}} = \frac{\text{Market Price}}{\text{kg. lint cotton}} + \left[\frac{\text{Subsidy}}{\text{kg. lint cotton}} \times \frac{\text{a kgs. seed cotton}}{\text{b kgs. lint cotton}}\right]$$

where a/b - conversion ratio.

Clearly, there is no single market price for cotton. Cotton prices may vary according to market location and according to the quality of cotton. Since a comparison will be made between domestic prices and world prices, the relevant domestic market price is the price that prevails at the major point of importation/exportation. All data (world prices, domestic production costs, processing costs) should be framed in terms of the same grade of cotton.

Finally, it may be impossible to collect market prices at all. In this case it may be necessary to use cost of production data in pricing the output:

cost of production or price at the farm gate plus the cost of processing and transporting the cotton to the point of importation/exportation. Again, the estimates should be consistent and prices should be framed in terms of a common denominator (preferably, kilograms of lint cotton).

Data for item 1: Conversion ratio, market prices of a particular grade (at the point of importation/exportation), subsidized prices.

Item 2: Inputs traded as tradable goods at domestic prices. The relevant cost to use for each tradable input is the farm gate cost of the input (or the portion of the input treated as tradable) plus indirect taxes which will be netted out later. In view of the fact that these prices will be utilized in calculations of private profitability, they are inclusive of government subsidies on inputs and tariffs.

A prototype calculation is presented below for fertilizer. Assume that fertilizer has a cif price of \$500/ton; the government maintains a subsidy on fertilizer consumption of \$100/ton; there is a transportation cost of \$50/ton for transportation of the fertilizer from the port; there is a tariff of \$30/ton; and there is a domestic sales tax of \$10/ton.

Cost of input = cif + tariff + taxes - subsidy

\$440 = 500 + 30 + 10 - 100.

Note that this price differs from the cost to the farmer by an amount equal to the transportation costs which are treated as nontradable costs since they are nonfully traded. The cost to the farmer is equal to

cif + tariff + taxes - subsidy + transportation costs, or

490 = 500 + 30 + 10 - 100 + 50 = cost to farmer.

Data for Item 2: Farm gate prices, tariff rates, domestic tax rates, government subsidies, nonfully traded component of input, cif prices.

Item 3: Value added in domestic prices. This item is derived by subtracting item 2 from item 1 and will be used in calculating the effective protection coefficient.

Item 4: Factor costs, other than capital, at domestic prices. This category refers to the market prices for labor and land. For land the prevailing rental rate should be used, if available. For rent-free land that was not previously cultivated, the discounted cost of land preparation will be the relevant variable. The market wage for hired labor should be imputed to all labor used in farm production. This category includes all direct and indirect labor and land costs.

Data for Item 4: Prices of inputs, share of labor and land in inputs and input components treated as nontradables.

Item 5: Indirect taxes. This category includes all domestic non-income taxes.

Data for Item 5: Indirect tax rates on inputs.

Item 6: Private profitability. This entry is derived from the above items. Private profitability = value added in actual market prices (3) - factor costs, other than capital, at actual market prices (4) - indirect taxes (5). Private profitability within this framework is defined as the return to capital.

Item 7: Gross output at world market prices. This item is the border price of rice, the fob export price or the cif import price depending on whether expanded domestic cotton production would be exported or serve as an import substitute, exclusive of tariffs and domestic taxes. As a per unit price, it should be consistent with item (1), the domestic price of cotton.

Data for item 7: cif or fob price of cotton, tariff and domestic tax rates on cotton.

Item 8: Inputs treated as tradable goods, at world market prices. The desired items in this category are cif prices of inputs treated as tradable goods net of tariffs. If cif prices are not directly available, they must be calculated by indirect procedures, working back from farm gate prices to net out the cif price. This procedure is not simple, and two general cases are described below:

1) Calculation of the cif price with a government subsidy on the production of domestic fertilizer.

The farm gate cost of imported fertilizer is assumed to be the sum of the cif price, tariffs, transport costs and indirect taxes.

farm gate price = cif price + tariff + transport costs + indirect taxes

Assuming competitive conditions, the farm gate price plus any government subsidy also equals the cost of domestically produced fertilizer.

cost of domestic fertilizer production = cif price + tariff + transport costs + indirect taxes + government subsidy, or

cost of domestic fertilizer production - government subsidy = cif price + tariff + indirect taxes + transport costs

The cif price is found by redefining and rearranging terms.

$$\text{farm gate price} = X + [t \cdot X] + bX + [T \cdot X] = (1 + t + b + T] \cdot X$$

where X = cif price;

T = transport costs as a percent of cif price;

t = tariff rate; and

b = tax rate.

2) Calculation of the cif price with a government subsidy on fertilizer consumption by in this instance farmers,

farm gate price + government subsidy = cif + tariff + transport cost + indirect taxes, or

$$\text{farm gate price} + \text{government subsidy} = X + (t \cdot X) + (b \cdot X) + (T \cdot X) = [1 + t + b + T]\ X$$

Data for Item 8: Same as for Item 2.

Item 9: Value added in world market prices. Value added in world market prices = gross output, at world market price (7) - inputs treated as tradables, at world market prices (8).

Item 10: Domestic resource costs, other than capital, at opportunity costs. This item includes the social opportunity cost of land and labor. The calculations for this item involve applying the shadow prices for land and labor discussed previously.

Data for Item 10: Shadow price for labor and shadow price for land. As discussed earlier, these shadow prices will likely be derived from the cost structure of the best alternatives for cotton, yields, and price of output of best alternatives, amount and types of labor inputs and allocation of labor time over the course of a year.

Item 11: Social profitability. This counterpart to private profitability is calculated using world prices and social opportunity costs as shadow prices. Social profitability = value added in world market prices (9) - domestic resource costs, other than capital, at opportunity costs (10).

Item 12: Domestic capital costs at opportunity costs. This item includes the capital costs of input components that are nonfully traded as well as capital services used directly. These capital costs are derived with reference to the shadow price of capital.

Data for Item 12: Capital components of all items treated as nontradable, shadow price of capital.

The remaining six items in the Table of 18 are incentive indicators, and involve rearrangement of the above items.

Item 13: Nominal protection coefficient (NPCO) on output.

The nominal protection coefficient is the ratio of the domestic producer price of a good to its world price (cif for imports or fob for exports). This ratio incorporates the effects of quantitative restrictions, tariffs, and price controls on the price received by a particular producer of import substitutes. For exports the measure displays the effects of export taxes or subsidies and is equal to one minus (or plus) the ad valorem equivalent of any export tax (or subsidy).

Item 14: Nominal protective coefficient on inputs (NPCI). This term is used analogously to the NPCO.

Item 15: Effective protection coefficient on value added (EPC)

This coefficient is a ratio of the difference between product price and the cost of material inputs, both measured in domestic currency, and the difference between the border price of the product and the border prices of tradable inputs. In other words, this ratio compares domestic value added with value added in world market prices and essentially combines the NPCO and NPCI measures. Hence, it measures the degree to which protection causes actual value added to diverge from the value added that would have prevailed in the absence of protection. An EPC ratio greater than one implies that a particular product is receiving positive incentives through protection at the existing exchange rate while a value of less than one indicates disincentives at this rate. Finally, negative EPCs imply that value added in world prices is negative which means that more foreign exchange is used to produce the product in question than would be required to import it.

Item 16: Net social profitability, at official exchange rate. This equation is the difference between value added at world market prices and all domestic factor costs, including capital, at shadow prices. NSP at official exchange rate = social profitability (9)-(10) - domestic capital costs, at opportunity costs (12) = value added at world market prices - domestic factors of production at opportunity costs.

<u>Item 17</u>: Domestic Resource Cost Coefficient, at official exchange rate.

The DRC is simply an alternative means of presenting the net social profitability measure.

<u>Item 18</u>: Excess Cost of Domestic Factors

This term represents the impact on factor prices of market imperfections which are not represented by government price policies, and are the final category of market distortions which cause shadow prices to differ from observed market prices.