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June 4, 1974

ECONOMIC ANALYSIS OF PROJECTS

STAFF REVIEW

Attached is a memorandum dated May 31 from Mr. van der Tak entitled Economic Analysis of Projects and the supporting papers. A meeting will be held on Wednesday, June 19, 1974 at 3:30 p.m. in Conference Room D-556. The discussion will center on the issues raised in the memorandum rather than on the supporting papers themselves.

Please inform this office if you cannot attend; and, as scheduled attendance is rather large, all additional or substitute attendance should be cleared with this office.

Frank Vibert
Secretary
Policy Review Committee

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IBRD Directors
Program Coordinators

REVISED DRAFT
May 31, 1974

ECONOMIC ANALYSIS OF PROJECTS

SUMMARY TABLE OF CONTENTS

Prepared by: LSquire/JLinn/HGvanderTak
Office of the Vice President, Projects Staff

ECONOMIC ANALYSIS OF PROJECTS

Table of Contents

Page

Economic Analysis of Projects

Introduction

1. This memorandum is concerned with the basic approach to be followed by the Bank for assessing the economic merit of projects. It describes how to measure costs and benefits in terms of a common unit of account, and discusses the criterion which should be used to select projects. Throughout, the perspective is economic, and not financial or technical. The memorandum reflects the evolution of Bank appraisal methods, as well as the advances in analytical techniques which have occurred in the last decade. While it provides guidelines for some particular problems, it is not an exhaustive treatment of the subject. In particular, it does not deal with sector-specific issues.

2. Part I of the memorandum discusses in broad terms the basic ideas behind cost-benefit analysis and introduces some of the concepts which will be developed in later sections. Part II identifies the types of costs and benefits of projects which are relevant for their economic appraisal, whilst Part III discusses in general qualitative terms how such costs and benefits should be valued and in what circumstances shadow prices will be appropriate. Specific quantitative guidelines for the derivation of shadow prices are given in an Annex, with three Appendices. Appendix I supplements the Annex, providing further technical details on derivation, Appendix II discusses methods of estimation and Appendix III illustrates the approach with a case study.[1/] Part IV shows how costs and benefits may be compared so that a meaningful decision can be made about the value of the project to the country. Finally, Part V examines how to take account of the considerable risk elements and uncertainties that are commonly involved in undertaking a project.

1/ The space devoted to shadow pricing should not be interpreted as a measure of its importance: shadow pricing represents only one of the many facets that need to be considered in project analysis.

Part I - General Context of Project Analysis

3. All countries, but particularly the developing countries, are faced with the basic economic problem of allocating limited resources, such as labor at all levels of skill, management and administrative capacity, capital, land and other natural resources, and foreign exchange, to many different uses, such as current production of consumer goods and public services or investment in infrastructure, industry, agriculture, education, etc. These different uses of resources, however, are not the final aim of the allocative process: rather they are the means by which an economy can marshall its resources in the pursuit of more fundamental objectives such as the removal of poverty, the promotion of growth and the reduction of income inequalities. Using limited resources in one direction (e.g. investment in industry) reduces the resources available for use in another direction (e.g. investment in agriculture). Pursuit of one objective, say, better income distribution, may involve a sacrifice in terms of other objectives, say, rapid growth. Thus there are clearly trade-offs: the country can have more of some things and less of others, but not more of everything. A choice has therefore to be made among competing uses of resources in terms of the extent to which they help the country achieve its fundamental objectives. If the country consistently chooses allocations of resources which achieve most in terms of these objectives, it ensures that its limited resources are put to their best possible use.

4. Project analysis is a method of presenting this choice between competing uses of resources in a convenient and comprehensible fashion. In essence, project analysis assesses the benefits and costs of a project and reduces them to a common denominator. If benefits exceed costs (both expressed in terms of the common denominator) the project is acceptable: if not, the project should be rejected.

As such, project analysis may appear divorced from both the fundamental objectives of the economy and the possible alternative uses of resources in other projects. The definition of benefits and costs, however, is such that these factors play an integral part in the acceptance/rejection decision. Benefits are defined in terms of their effect on the fundamental objectives: costs are defined in terms of their opportunity cost which is the benefit foregone by not using these resources in the best of the available alternative investments. The foregone benefits are in turn defined in terms of their effect on the fundamental objectives. By defining costs and benefits in this fashion we try to ensure that acceptance of a project implies that there is no alternative use for the resources "consumed" by this project which would secure a better result in terms of the country's objectives.

5. Economic analysis of projects is similar in form to financial analysis in that they both assess the "profit" of an investment. The concept of financial profit, however, is not the same as the social profit of economic analysis. The financial analysis of a project identifies the money profit accruing to the project-operating entity, whereas social profit measures the effect of the project on the fundamental objectives of the whole economy. These different concepts of profit are reflected in the different items considered to be costs and benefits and in their valuation.[1/] Thus, a money payment made by the project-operating entity for, say, wages is by definition a financial cost. But it will only be an economic cost to

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1/ It should be noted that "financial analysis" as used here is only one of several concepts of financial analysis, all of which have their specific purposes.

the extent that the use of labor in this project implies some sacrifice elsewhere in the economy with respect to the country's objectives. Conversely, an economic cost of the project may not cause a money outflow from the project entity in which case it is not a financial cost. The two types of cost need not coincide. Similar comments apply to economic and financial benefits. Economic costs and benefits are measured by "shadow prices" which may well differ from the market prices appropriate for financial costs and benefits.

6. Shadow prices are determined by the interaction of the fundamental policy objectives and the basic resource-availabilities. If a particular resource is very scarce (i.e. there are many alternative uses competing for that resource), then its opportunity cost (i.e. the foregone benefit in the best available alternative) will tend to be high. If the supply of this resource were greater, however, the demand arising from the next best uses could be satisfied in decreasing order of importance and its opportunity cost (or shadow price) would fall. Frequently, market prices will correctly reflect this scarcity but there is good reason to believe that in less developed countries imperfect markets may cause a divergence between market and shadow prices. Three important resources (labor, capital and foreign exchange) are generally considered to fall in this category, and Part III will be largely concerned with the appropriate shadow-pricing of these resources.

7. Resource availabilities, however, need not be the only constraints operating in the economy. Political and social constraints may be equally binding. These non-economic constraints can limit the alternatives open to the government in pursuing its development objectives to a narrower range than that implied by the basic resource availabilities. If the tools of general economic policy (i.e. fiscal and monetary policy) cannot successfully break these constraints, project analysis

should take account of them by means of appropriate adjustments in shadow prices. For example, if the government is unable to secure a desired redistribution of income through taxation, then the allocation of investment resources can be used as an alternative method of redistributing income. By attaching higher values to increases in income accruing to the poorer sections of society in project appraisal, investment will be biased in their favor. This merely reflects the fact that all available policy tools should be working jointly towards the same goals. If one particular instrument is inoperative or blunted, other instruments may be used to achieve the same end.

8. Project analysis is designed to permit decentralized decision-making on the appropriate choices between competing uses of resources, costs and benefits being defined and valued, in principle, so as to measure their impact on the development objectives of the country. In many cases, however, a more direct link is necessary with the sector and economy as a whole: for example, the merit of a project characterized by economies to scale cannot be judged without making an estimate of the demand for its output, and this in turn requires placing the project in its sector and country context.

9. Furthermore, in practice, many shadow prices (for land and natural resources for example) are hard to determine independently of the project appraisal process, because they depend on the alternative projects which have been rejected. This is the basic reason why a systematic scrutiny of plausible alternatives is at the heart of the appraisal process: it is not sufficient in practice to select "acceptable" projects whose benefits appear to exceed costs; it is necessary to search for alternatives with a larger surplus of benefits over identified costs. If such projects are found, it means that the opportunity cost of using, say, land in the project originally considered acceptable has been underestimated or wholly neglected.

10. Consideration of alternatives is the single most important feature of proper project analysis throughout the project cycle, from the sector development plan through identification and preparation to appraisal. Many of the more important choices are made at early stages when decisions are taken concerning the alternatives which are to be rejected or retained for further more detailed study. For economic analysis to make a maximum contribution to trying to ensure that scarce resources are used to best advantage for the country, it should start at the earliest phases of this process of successive sifting and narrowing down of options that are open to the country. Use of shadow prices reflecting basic policy objectives and resource constraints tends to be mainly "cosmetics" if only employed in the final stage of appraisal when most of the essential choices with respect to types of project and project design have already been made. To be an effective aid in decision-making shadow prices should also be used in framing sector strategies, in identifying promising project possibilities, and in designing their major features.

Part II - Identifying Relevant Costs and Benefits

11. The implementation of a project will reduce the supply of inputs ("consumed" by the project) and increase the supply of outputs (produced by the project). Without the project, the supply of these inputs and outputs to the rest of the economy would have been different. Examining this difference between the availabilities of inputs and outputs with and without the project is the basic method of identifying its costs and benefits. In many cases the "without" situation is not simply a continuation of the status quo ante, but rather the situation that is expected to exist if the project is not undertaken, because some increases in output, and costs, are often expected to occur anyway. Furthermore, some projects (e.g. modernization projects and land-conservation projects) have as their primary

aim the prevention of future cost increases or benefit decreases. The without situation must then include these cost increases or benefit decreases in order to fully reflect the improvement engendered by the project. An accurate description of the situation "with", as also that "without", the project may involve difficult judgments.

12. Frequently, the projected financial statement of the project entity will be a good starting place for identifying economic costs and benefits. In general, two types of adjustment must be made to the financial calculation in order that it should reflect economic concepts: firstly, it may be necessary to include (exclude) some costs and benefits which have been excluded from (included in) the financial analysis; and secondly, some inputs and outputs may have to be revalued if their shadow and market prices differ. Only the former adjustmemt is considered here, the latter being the subject matter of Part III.

Transfer Payments

13. Some payments which appear in the cost streams of the financial analysis do not represent direct claims on the country's resources but merely reflect a transfer of the control over resource allocation from one member or section of society to another. For example, the payment of interest by the project entity on a domestic loan merely transfers purchasing power from the project entity to the lender. The purchasing power of the interest payment does reflect control over resources but its transfer does not use up real resources and is, to that extent, not an economic cost. Similarly, the loan itself and its repayment are financial transfers. However, the investment, or other expenditure which the loan finances, involves real economic costs. The financial cost of the loan occurs when the loan is repaid;

but the economic cost occurs when the loan is spent.[1] The economic analysis does not, in general, need to concern itself with the financing of the investment, i.e. the sources of funds and how they are repaid. Again, depreciation allowances may not correspond to actual use of resources, and should therefore be excluded from the cost stream. The economic cost of using an asset is fully reflected in the initial investment cost less its discounted terminal value. Finally, taxes are also transfer payments and as such do not constitute a resource cost.

14. The preceding "rule" is subject to one very important exception. Although transfer payments such as taxes and interest, etc. are not a resource cost, they do have an impact on the distribution of income and possibly on savings. And, if the government wishes to use project selection as a means of improving income distribution or increasing savings, then this should be taken into account when determining the costs and benefits of a project, and be reflected in the shadow prices of factor inputs and incomes.

Contingencies

15. Contingency allowances are determined by engineering and financial considerations which are beyond the scope of this memorandum, but it is important to examine the treatment of contingency allowances in the economic appraisal. To the extent that the physical contingency allowance is a part of the expected value[2] of the project's costs, it should be included in the economic analysis. Any allowance beyond this should be excluded from the basic data but should be examined in the sensitivity or risk analysis. The project evaluator will require the assistance of the engineer in determining the nature of physical contingency

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1/ These points also apply to foreign loans, unless the loan is "tied" to the project in which case its economic cost is the stream of associated repayments. Bank loans are not considered tied. Note, however, that a country should not borrow beyond the point where the real cost of the debt service exceeds the return on the marginal project.

2/ The concept of "expected value" is discussed further in paras. 64-65 which deal with risk.

allowances. With regard to the price contingency, to the extent that it covers expected increases in relative prices of project items, it should be included in the economic analysis. Any price contingency for domestic and foreign inflation of the general price level should be excluded, provided that differential rates of inflation in supplier countries are offset by currency realignments. If not, the part of the price contingency covering "excess" inflation beyond that in the numeraire currency should be included.

Sunk Costs

16. Sunk costs are defined as all those costs incurred on the project prior to appraisal and which, therefore, can no longer be avoided even if they are considered utterly wasteful. They should be excluded from the cost of the project for the purpose of reaching a decision as to whether to proceed further with the project; only costs which can still be avoided matter in this regard; bygones are bygones. For example, the economic merit of a project designed to complete a project started earlier and left unfinished, does not depend on the costs already incurred but only on the costs of completion. (Similarly, the benefits from the new project are only those arising over and above those that may flow from the old, uncompleted works.) This treatment of sunk costs may result in a high return on the investment in completing the project, but this is then as it should be. In addition to this calculation of the return on the incremental investment, it is usually of interest to show the return on the total project, including sunk costs, to throw light on the question whether, in hindsight, the original decision to proceed with the project was well-founded.

Externalities and Linkages

17. There are some effects of the project which do not impose a cost or confer a benefit within the confines of the project itself. If these effects (known as

externalities) affect the achievement of the country's objectives (either positively or negatively) they should be included in the economic analysis. Unfortunately, externalities are sometimes difficult to identify and nearly always difficult to measure. On the benefit side, demonstration and training effects are often cited as externalities, but these are not amenable to quantification at present. Various forms of pollution and congestion, use of water affecting yields of wells elsewhere, side effects from irrigation schemes on health or fisheries, are some of the standard examples of external costs and, if they are significant and measurable, should be counted as economic costs. Whether or not externalities can be quantified, they should at least be discussed in qualitative terms.

18. Price effects caused by the project are also often included in the definition of externalities. The project may lead to higher prices for the inputs which it requires and lower prices for the outputs which it produces. The project may also result in lower demand and prices for competing products or services, or higher demand and prices for complementary ones. So-called forward linkage effects may thus occur in industries which use or process a project's output, and backward linkages in industries which supply its inputs, in that such industries are encouraged or stimulated by increased demand and higher prices for their output or lower prices for their inputs. Conversely, other producers may lose because they now face increased competition, and other users of inputs used by the project may have to pay higher prices. The project may have wide-ranging repercussions on demands of inputs and outputs and cause gains and losses for producers and consumers other than those involved in the project itself.

19. Such external costs and benefits may or may not have to be added to the more direct costs and benefits of the project. The direct social profit is a comprehensive measure of all economic gains and losses of the project provided

that two conditions are met. First, the government should be indifferent as to who gains and who loses as a result of the project. If it attaches different weights to gains and losses depending on the person or region affected, the direct social profit on the output from the project is not a full measure of all its positive and negative effects on the country's social/economic objectives. There is then no remedy but to trace as best one can the repercussions on the rest of the economy. Whether this is a serious qualification in practice depends on the extent to which the project results in price changes. If induced price changes are minor, or income distribution weights of affected groups are approximately the same, it may be a reasonable approximation to exclude such external price effects from the economic analysis of the project.

20. Second, and perhaps more serious, the direct costs and benefits of the project, in terms of its own output and inputs, do not provide a complete measure of its social profit in cases where other producers, whose output is affected by the project, do not sell in perfect markets where price equals social marginal costs. In such cases - which are of course normal - there will be gains and losses not measured by the social profit on direct output from the project. For example, if an improved road diverts traffic from a railway which charges rates below marginal cost, this diversion entails a social gain on reduced rail traffic (because the previous social loss on this traffic is no longer incurred) in addition to the social profit on road traffic as usually measured (in terms of changes in the area between its demand and supply curve). In practice, it is not feasible to trace all externalities arising from such market imperfections: the analyst can only hope to capture the grosser distortions on more immediately affected changes in output.

21. Externalities of various kinds are thus clearly troublesome, and there is no altogether satisfactory way to deal with them. However, this is no reason simply to ignore them: an attempt should always be made to identify them, and, if they appear significant, to measure them. In some cases it is helpful to "internalize" externalities by considering a "package" of closely related activities as one project. This procedure is also convenient in cases where strictly speaking externalities play no role, but where it is difficult, if not impossible, to estimate demand, and hence the social value of the output from the project, without closely linking it to related activities. A standard example is the analysis of irrigation projects in which benefits are measured in terms of agricultural output rather than water.

Multiplier Effects

22. In an economy suffering from general excess capacity, project investment may cause a further increase in income as the additional rounds of spending following the investment reduce the excess capacity. General excess capacity however is not the situation in which LDC's typically find themselves. If it were otherwise, development would be a far easier task and could be furthered simply by spending more. This does not deny the existence of secondary expenditure effects. As will be discussed in Part III these effects may be important and should be measured by examining the pattern of consumption expenditure induced by the project. Different patterns of second round expenditure out of incomes generated by the project will have different economic impacts, especially when viewed in a regional context.

International Effects

23. Some external effects of a project may extend beyond the borders of the country concerned. For example, a project's output may increase exports or substitute for imports, and thus tend to reduce world prices, thereby benefiting

other importing countries but harming other exporting countries. Or the increase in demand, and possibly prices, for inputs into the project may affect other countries, favorably or adversely. Or a project in one country may influence the environment of a neighboring country by, for example, diverting or polluting a river common to both countries. All such external effects on other countries are similar in nature to the externalities discussed above (paras. 17 - 21), and raise similar problems: The crucial issue in this case is whether one should take account of benefits accruing to, or costs imposed on, other countries - which may be developed countries or other developing countries, may be poorer or better off than the country concerned and may be politically close or otherwise. This clearly depends on value judgments. The Bank's policy is to take account of physical externalities, as in international rivers, and expect agreement between the countries concerned on the sharing of water and appropriate compensation for any untoward effects. Thus far, however, it has not taken into account external price effects on other countries caused by the projects it finances, and normally evaluates investment projects from the point of view of the country where the project is to be undertaken. 1/ This means that costs borne by foreign countries, or foreign participants in the project, and benefits accruing to them, are excluded from the economic analysis of the project. Some implications of this are discussed further in Part III below.

Double Counting

24. While all relevant costs and benefits should be included when evaluating a project, it is necessary to ensure that benefits and costs are not recorded twice. Double counting may arise on two scores. First, as noted above, external benefits

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1/ But the Bank is currently examining a recommendation that appraisals of primary commodity projects should take account of their effect on export prices of other developing countries; problems of implementation and other aspects are still being considered.

and costs may be included (erroneously) even though they are already fully accounted for in the social profit measure of the project. For example, increases in agricultural output may mistakenly be claimed as additional benefits of, say, a road project when such benefits are already reflected in the usual measure of the social surplus gained on the transport services to be provided. Second, benefits may be claimed for employment, or foreign exchange earnings, in addition to the estimated social profit of the project. Provided that labor inputs into the project, and its foreign exchange costs and savings, have been evaluated in terms of shadow prices which are a comprehensive measure of their value to the economy, any such employment or foreign exchange effects have already been taken into account, and should not be added as separate benefits. The contributions of increased employment and foreign exchange earnings to the social/economic objectives of the government have then been given their full and proper weight in deriving the social surplus of the project. This does not mean that employment and foreign exchange effects should not be discussed in the report; but it does mean that any discussion must be consistent with the assumptions underlying the economic evaluation of the project.

Part III - Valuation and Shadow Prices

25. Every project uses up resources (inputs) and produces outputs. Part II above discussed which inputs (costs) and which outputs (benefits) are to be included in the economic analysis of the project. This Part considers what are the values of the costs and benefits thus identified to the economy. These values depend on the value judgments of the government, as well as on technical and behavioral parameters, and on resource and policy constraints. Value judgments of the government determine the weight to be given to future consumption relative to present consumption, i.e. to growth (depending on savings and investments) versus

consumption; to benefits for different classes of income recipients (or regions); to future employment relative to present employment; and to other possible objectives such as national independence, or modernization. Policy constraints of an institutional/administrative or political nature may limit the choice of path that the economy can follow in pursuing its development objectives to a narrower range than that imposed by the technical and behavioral parameters and resource availabilities in the economy.

26. Shadow prices are defined in the generally accepted theory of resource allocation as the values of inputs and outputs associated with the optimal development program, given the weights attached to the basic social/economic objectives (objective function) and given all the various constraints which limit the extent to which these objectives can be achieved. The costs and benefits of the project to the economy should thus be valued in terms of shadow prices reflecting, as best one can, these objectives and constraints. Any changes in objectives or constraints affect the optimal development program that is feasible, and hence the shadow prices and the costs and benefits of any given project.

27. Two points should be noted about this definition of shadow prices. Firstly, these prices relate to an economic environment in which distortions may be expected to persist: they are not the equilibrium prices which would prevail in a distortion-free economy. However, this should not be interpreted as a passive acceptance of existing distortions; in fact, the estimation of (second best) shadow prices supplies important information which can be used as a basis for designing policies to remove the distortions. Secondly, the Bank should try to arrive at some common understanding with the government concerning the social/economic goals to be pursued in the country's development policy. The development objectives of most countries will probably be consistent with the Bank's own general views of development priorities, but if views diverge, for example, with respect to the

desired distribution of the gains from development, the Bank should ensure that project lending is not used for purposes which run counter to its own conception of basic development objectives. In extreme cases of discord, the Bank might prefer to cease operations in the country.

1. The Shadow Rate of Interest

28. In the absence of policy constraints arising from political feasibility, administrative costs and repercussions on incentives, the government could ensure through its fiscal policy that, at the margin, additional savings (and future consumption) are in its view as valuable as additional present consumption. In that case project analysis does not need to concern itself with the impact of a project on consumption or savings, but should concentrate on the impact on income, irrespective of its use for consumption or savings, since both are worth the same. The opportunity cost of capital, which measures the rate at which additional savings (investment) in the current period are transformed into output in the next period, does then equal the "consumption rate of interest" which measures the discount attached to having additional consumption in the next period rather than now. There is in that case no need to distinguish between savings and consumption when assessing costs and benefits.

29. However, in some cases the government might prefer more rapid growth, and higher savings and investments, at the expense of current consumption, but it judges the administrative and political obstacles to the fiscal measures necessary to bring this about insurmountable. Savings are then at a premium (or, equivalently, consumption at a discount), and the opportunity cost of capital exceeds the consumption rate of interest. The correct choice of discount rate then depends on the chosen numéraire (the common yardstick used for expressing savings and consumption), because the discount rate is defined as the rate at which the value of

the numéraire falls over time. For example, if consumption is chosen as numéraire, then savings should be valued at their higher consumption equivalent, and benefits and costs in different time periods should be discounted by the "consumption rate of interest". The approach can be further refined by distinguishing different types of consumption and different types of saving. Thus, the consumption of the rich may be considered less valuable than that of the poor; or public sector saving may be considered more valuable than private sector saving. Such refinements require a careful specification of the numéraire but the principle remains the same as in the savings/consumption case. Moreover, the choice of numéraire does not affect project analysis because the selection of projects depends only on relative prices, whereas the numéraire only determines the absolute price level.

30. It is recommended that the Bank use as numéraire uncommitted public income measured in terms of foreign exchange. The units of foreign exchange need not be dollars or any other foreign unit of account; the recommended unit of account is the domestic currency equivalent of any foreign currency at the official exchange rate. This is considered a suitable numéraire because most Bank loans are to the public sector and involve large amounts of foreign exchange. Such loans are, therefore, already measured in terms of our numéraire. Accordingly, the Bank discount rate, described as the "accounting rate of interest", should be defined as the rate of fall over time in the value of uncommitted public income measured in terms of foreign exchange.

31. In the traditional Bank approach, the discount rate is interpreted as the opportunity cost of capital, i.e. the marginal productivity of additional investment in the best alternative uses. The precise relationship between the opportunity cost of capital, the accounting rate of interest and the consumption rate of interest is outlined in the Annex, but it may be noted here that the traditional

Bank procedure essentially implies a judgment that there is no significant imbalance between the value attached to current consumption and future growth (current savings). Appraisal reports, in fact, seldom differentiate between consumption and savings in assessing the costs and benefits of a project, and implicitly treat both as of equal value. This approach may not always be appropriate, as noted above. In cases where growth rates are considered too low, because of insufficient savings rather than inefficient use of resources, and greater fiscal efforts are ruled out by overriding constraints, project appraisals should take account of the greater value which then attaches to savings than to consumption. A further breakdown of consumption may be warranted, if the government wishes to use project selection to influence the current distribution of consumption. The assumptions employed in such cases should be specified in the appraisal report. Guidelines for estimating the shadow rate of interest are given in the Annex.

2. Shadow Wage Rates

32. Similar considerations apply to the concept of the shadow wage rate. The appropriate values, and the interpretation of what the shadow wage rate represents, will differ depending on the value judgments and policy constraints that are considered applicable. The value judgments should be consistent with those underlying the estimates of other shadow prices. If, for example, savings and growth are considered at a premium, this should be reflected in both the shadow rate of interest, as argued above, and the shadow wage rate. Shadow prices are interdependent: changes in assumptions determining one, also affect others.

33. In the simplest case, the shadow wage rate does not aim at measuring anything more than the opportunity cost of labor, i.e. the marginal output of labor foregone elsewhere because of its use in the project. In case of severe unemployment which is expected to persist even when the development program is implemented, the

shadow wage would then be zero, and not whatever market wage is actually being paid. However, such factors as seasonal fluctuations in demand for labor and varying degrees of labor mobility should caution against any hasty conclusion, even in that case, that the opportunity cost of labor and the shadow wage rate are zero. Furthermore, the creation of one additional urban-sector job may induce several rural-sector workers to migrate to the town so that the foregone output is then some multiple of one worker's marginal product. It is also likely that there is not one shadow wage rate in a country but rather a whole set of rates, for different skills and different times and locations.

34. The shadow wage rates thus measured may not be the total cost to society of using labor on the project. Labor incomes will tend to be higher than they otherwise would be, because project wages may exceed subsistence incomes, or because projects may induce more productive self-employment. This is likely to give rise to higher consumption at the expense of savings. If, consumption is considered, at the margin, less valuable than savings, this should be reflected in the shadow wage rate. An increase in consumption out of labor income is, in that case, to some extent a cost that should be added to the shadow wage. The effect of this upward adjustment in the shadow wage rate will be to sacrifice some current employment and output in order to obtain faster growth, in line with the relevant value judgment.

35. There are other complications. If the project provides additional employment to the unemployed or to subsistence farmers, it is likely to give higher incomes to some of the poorest groups in society. If poverty redressal is considered important - and, of course, this is based again on a value judgment that the income distribution is not what it is desired to be, and a policy judgment that it cannot be corrected effectively through fiscal means - this should be reflected by adjusting the shadow wage rate downward. Thus the growth objective,

may require an upward adjustment, as argued in the previous paragraph, while the income distribution objective may require a downward adjustment in whatever level of the shadow wage rate would otherwise have been appropriate. This is not a contradiction, but a straightforward reflection of the trade-off between current output and employment, growth and income distribution objectives.

36. Even in cases where growth (savings) and income distribution considerations play no role, a shadow wage rate based on the marginal productivity of labor in alternative uses may be considered overly simple. People may prefer being unemployed to arduous work at low pay. This depends on their income situation while unemployed, the value of "leisure" and leisure time activities such as fishing or fixing the roof, and the unpleasantness of the job. There is some "reservation" wage below which they would prefer being unemployed rather than take the job. Should the government simply ignore this preference in its economic planning and decision making? If not, the shadow wage rate may need to be higher than indicated by a more narrow interpretation of opporutnity cost of labor. Consequently, there will tend to be more (voluntary) unemployment than if society did not attach any value to leisure and to the possible disutility of at least certain kinds of work.

37. Traditional Bank practice in shadow pricing labor focuses on the output of labor foregone in alternative uses. This approach implies a judgment that there is no significant reason for attaching a greater value, at the margin, to savings (growth) than to consumption; that the value attached to income distribution (or possibly to expanding employment per se) does not require a reduction in the shadow wage rate below the marginal productivity of labor; and that preference for work and leisure can reasonably be ignored. (It might also reflect a judgment that any adjustments on these scores roughly cancel out.) In such cases it is good practice to make these judgments explicit. In many cases, however, it may be more appropriate

to allow for these other factors in the determination of the shadow wage rate, and adjustments should be made, upward or downward, as discussed earlier, in the rate established in terms solely of the marginal output of labor in alternative uses.[1/] The basis for the adjustments and the judgments underlying them should always be indicated in the economic analysis of projects. Guidelines for estimating shadow wage rates on various assumptions as to the value of key parameters are given in the Annex.

3. Foreign and Domestic Values/Traded and Non-traded Goods

38. Some inputs of the project are directly imported or, though bought locally, lead to additional imports since any domestic production of this input has reached capacity constraints. The cost of such goods to the economy is the c.i.f. import price prevailing at the time the input is required. Similarly, the value to the economy of any output from the project which substitutes for imports is measured by the c.i.f. import price. Conversely, output that is directly exported or, though physically sold in the home market, leads to additional exports because domestic demand is fully met from existing supplies, has a value to the economy measured by the f.o.b. export price. And, similarly again, for any input used in the project that would otherwise have been exported, the cost to the economy is the f.o.b. price.[2/] In all such cases the c.i.f. or f.o.b. (border) prices should, of course, be adjusted for internal transport or other costs in order to arrive at the value of the commodities ex-factory or farm gate. This account assumes that the supply of imports or demand for exports is perfectly elastic, so that the

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1/ The accounting rate of interest should then be adjusted to reflect the same judgments.

2/ Such prices should be expressed in terms of the domestic currency as explained in the discussion of the numéraire in para. 30.

project does not affect import or export prices. The border prices should then not be adjusted for any import duties or export taxes that may be levied: the import supply and export demand prices are the appropriate prices for project analysis. However, if import prices rise or export prices fall on account of the project, the value to the economy of additional imports or exports is approximated by the marginal import cost or export revenue (see Annex).

39. Any output or input of which the value to the economy cannot be measured in terms of f.o.b. or c.i.f. border prices should, as a first approximation, be assessed in terms of its price in the home market. This applies to obviously "non-traded" commodities such as electricity or transport, as well as to all commodities, usually those with high transport costs, of which the domestic supply price, at the given level of local demand, is below the c.i.f. price of imports, but above the f.o.b. price of exports. It also applies in cases where government policy isolates commodities from foreign markets through import (export) prohibitions or quotas. This price in the home market depends on local supply/demand conditions, including market imperfections: for example, monopolistic pricing affects, say, power rates; so does an import quota on fuel imports; and, more indirectly, general trade policies affect it through their impact on factor prices such as wages.

40. As a result of market imperfections, or indirect taxes, the marginal value (demand price) of non-traded inputs or outputs may differ from their marginal cost (supply price). The shadow prices of such goods may be the demand price, the supply price or somewhere in between depending on whether project inputs or outputs affect the supply to other users, the supply from other producers, or both. If an input used in the project reduces the supply to other users, its shadow price should be based on the demand price; if the input is supplied from new production, its shadow price should be based on the supply price. If the input is supplied

from both sources, affecting other uses as well as calling forth new output, the shadow price is a weighted average of the demand price and supply price, the weights being determined by the elasticities of supply and demand (see Annex). The shadow price of output is determined similarly in terms of its demand or supply price, depending on whether additional output increases supply, reduces output from other producers, or both. If at the margin supply is perfectly elastic or demand perfectly inelastic, the supply price is the shadow price. If at the margin supply is perfectly inelastic or demand perfectly elastic, the demand price should be used.[1/]

41. In some cases indirect taxes (or subsidies) are designed to compensate for external costs (or benefits). If the tax (subsidy) corresponds exactly to the external cost (benefit) of an input, the shadow price of the input should include the tax (subsidy). Conversely, the shadow price of an output should in that case exclude the tax (subsidy). In other words, the cost of an input should be increased, and the value of an output reduced, by the amount of the external cost (tax). Similarly, subsidies which reflect external benefits should reduce the cost of inputs and increase the value of outputs. However, the taxes or subsidies may provide only partial compensation or create other distortions. It may often be preferable therefore to treat such compensating taxes or subsidies as market distortions and allow separately for any externalities.

Conversion Factor and Shadow Exchange Rate

42. Thus, with the qualifications noted above, the value to the economy of traded goods is measured by border prices (in local currency); that of non-traded

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1/ This corresponds to the border price discussion for traded goods in para. 38.

goods is measured by domestic prices (in local currency). The final step is to convert border prices into domestic prices or vice versa. What is the rationale for this conversion? Consider, for example, that a project increases demand for a non-traded commodity which is met in part by expanding its output and in part by a shift in consumption away from other uses. With respect to the former, the cost of expanding output at border prices may be determined by decomposing production into its component inputs, consisting in part of traded and in part of non-traded goods. Traded input components can then be valued directly at border prices. This process can be repeated, in principle, until all inputs consist of directly and indirectly traded goods, and of basic domestic inputs, i.e. mainly labor (and possibly some other primary resources such as land). As noted earlier, the cost of labor (or other primary factors) is, in general, made up of output foregone and of additional consumption, both of which can, in principle, be valued at border prices. With respect to the latter, if demand for a non-tradable is met by withdrawing it from other uses, one must assess at border prices the reduction in consumption or production of other goods occasioned thereby. In general, the conversion factor to be applied to non-traded goods will incorporate both the cost of an increase in supply and the cost of a reduction in alternative uses. It should be clear that the conversion factor for translating domestic prices of non-traded goods into border price equivalents will vary between different non-traded goods depending on the particular mix of traded goods required to satisfy non-traded demand. In principle, there is not one conversion factor but a large set of such factors.

43. Use of such a set of conversion factors is not always feasible in practice. We need a shortcut which provides a reasonable approximation. One shortcut is to decompose the (incremental) cost of major non-tradables for one or two rounds and apply a general conversion factor to the residual. The same general factor is

also used to convert minor non-tradable items. Similarly, differences in consumption patterns may be taken into account at least for some major income groups. These approaches imply some differentiation in conversion factors applied to various non-tradables. A more traditional approach ignores the need for differential conversion factors and simply applies one conversion factor to all non-tradables. In terms of our chosen numéraire, this conversion factor is the official exchange rate divided by the shadow exchange rate. 1/

44. The method for arriving at the standard conversion factor is already suggested by the foregoing discussion. It should measure the value to the economy, at the margin, of having additional foreign exchange which can be used for increasing consumption or production. This value depends on the trade policies being pursued by the government. For example, in the case of wide-ranging import restrictions, the official exchange rate understates the value to the economy of additional foreign exchange earnings. In other words, the shadow exchange rate of local currency per unit of foreign currency is then higher than the official rate. Note that this is not a question of "equilibrium": the official exchange rate is an equilibrium rate given the trade restrictions, but the shadow rate is higher. Export incentives have similar effects; widespread export subsidies tend to give a shadow exchange rate higher than the official rate. If trade policies are anticipated to change over time, this should be reflected in corresponding changes in the shadow exchange rates. In the event of general trade liberalization, the shadow and official exchange rates would tend to merge - not at the existing

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1/ The corresponding traditional practice converts foreign exchange at the shadow exchange rate.

official level, but at a new equilibrium level.

45. Estimates of the shadow exchange rate, and hence the standard conversion factor, are based on weighted averages of (import and export) tariffs, the weights being given by the relative importance of tradables in non-traded production and consumption. As an approximation, weights may be based on the shares of imports and exports in total trade. Traditional Bank practice normally uses the general shadow exchange rate approach. Use of specific conversion factors is encouraged in cases where greater accuracy of conversion is required. Guidelines for estimating the appropriate shadow exchange rate or conversion factors in the light of current and anticipated trade policies and other considerations are given in the Annex.

4. Miscellaneous Valuation Problems

Excess Capacity

46. In some cases the increase in demand for inputs in the project can be met by expanding output from plant working below capacity. The valuation of such inputs raises no new problems. They are valued as non-traded commodities since their supply is not met by increasing imports or reducing exports. The cost of the inputs is determined by current operating costs, with each of its elements, say fuel and labor, appropriately shadow priced; or, in other words, the relevant cost of the inputs is their short-run marginal social cost. There are no capital costs: The investment in the plant may be considered a sunk cost (cf. para. 16 above) as long as the excess capacity continues. When capacity constraints begin to impose themselves or new investments become necessary to expand output, incremental operating costs alone are no longer an appropriate measure of the value of the inputs to the economy. One should then include as costs the scarcity value or rents earned on the inputs or the cost of additional investment.

Rents

47. Factors in fixed supply, such as land, mineral resources, or sites, may earn rents reflecting their scarcity value. To shadow price primary factors in fixed supply, one must estimate the opportunity cost to the economy of using these factors to satisfy project demand. The rent earned by these factors may or may not be an adequate measure of the appropriate shadow price; distortions in the product and capital markets may have to be taken into account in order to derive the shadow rental from the market rental. Similar considerations apply to other assets, such as roads or power plants, that are temporarily in fixed supply: costs are sunk, but strong demand may give the assets a high rent value. The shadow prices of their output, say road services or power, cannot then be assessed in terms of the shadow price of their operating costs only, but should include the scarcity value of the assets.

Profits and Other Capital Incomes

48. The shadow wage rate, it will be recalled (see paras. 32 to 37 above), does not depend solely on direct opportunity cost in terms of output foregone, but also on other factors such as the impact of employment on savings and income distribution. The shadow value of rents, interest and profits may similarly have to be adjusted. This depends on who are the recipients of such payments, the extent to which they save their incomes, whether such savings are considered more valuable than consumption, and the value attached to income accruing to them as compared to income accruing to others. Traditional Bank practice does not systematically incorporate these factors in its economic analysis of projects, except, to some extent, with respect to income accruing to foreigners. The implication of this approach, and the underlying judgments on which it is based, should always be made clear. Where income distribution and savings effects are

considered relevant, they should be explicitly taken into account in the economic analysis. Shadow rates for rents, interest and profit payments are further discussed in the Annex.

Consumer Surplus

49. The project may lower price to consumers. The shadow price corresponding to the new level of output is in that case not a complete measure of the benefits to the economy: it neglects the effect of the reduction in prices. Consumers would have been willing to pay more for the quantity of the product they now buy. Consumer surplus is a measure of the difference between what a consumer is prepared to pay for a product and what he actually pays. If the project lowers the price to consumers, they gain an increase in consumer surplus. This increase should be included as part of the benefits of the project.

50. Consumer surplus, however, is a private measure of the benefit derived from a reduction in price, and does not necessarily correspond to its social value. If the government accords the same value to benefits regardless of the recipient of those benefits then the social and private measures will coincide, but, as we have seen in connection with the discussion on wages (paras. 35 and 36) and capital incomes (para. 48), the government may wish to assign a higher value to benefits accruing to poor people than to those accruing to rich, or a higher value to benefits which will be translated into savings than to those which will be consumed. Three important points should be stressed here. First, the revaluation of consumer surplus should be consistent with the assumptions relating to income distribution and growth which were incorporated in the estimate of shadow wage rates and capital incomes. Second, care should be taken to identify the real beneficiaries of the "consumer surplus" on intermediate goods: a gain in "consumer surplus" by road users, for example, may in fact be an increase in their

profits, or the profits of middlemen or shippers, or an increase in surplus for consumers of the transported goods, etc. Finally, gains in consumer surplus, like other increases in income, lead to shifts in consumption expenditures. In principle, one should take account of the costs (benefits) of increases (decreases) in consumption of other goods valued at their shadow costs.[1/] In practice, correction by a standard conversion factor may be sufficient.

Inflation

51. It follows from the foregoing discussion on shadow prices that the economic analysis of projects should not be based simply on present prices, but on the prices pertaining to each period. Thus the analyst must project changes in shadow prices, taking into account the various considerations discussed previously. This should not be misunderstood: general changes in the price level which leave relative prices unchanged, should not be taken into account. General inflation is not relevant for the economic analysis of projects. However, projected changes in relative (shadow) prices reflecting changes in the relationship between supply and demand, whether or not associated with inflation, should enter into the economic analysis. They indicate real shifts in the value of inputs and outputs to the economy. One apparent exception should be noted: any divergence between domestic and foreign inflation gives rise to a change in relative prices of traded goods (i.e. border prices) and non-traded goods (i.e. domestic prices). But this is only a real change in relative prices to the extent that differential rates of inflation are not offset by an adjustment in the exchange rate.

1/ In extreme cases, the social value of the consumer surplus could be more than offset by an increased cost of consumption.

Part IV - Comparing Costs and Benefits: Investment Criteria

52. The foregoing Parts of this paper have discussed what costs and what benefits should be included in the economic analysis of projects and how they should be valued (shadow priced). This leaves us with time streams of costs and benefits, appropriately shadow priced to reflect their value to the economy, given the government's basic objectives and the resources it has at its disposal. The remaining questions are how these costs and benefits streams are to be compared and what criteria are to be used in deciding whether a project represents a good use of resources.

53. The basic technique is to discount costs and benefits occurring in different periods and express them all in a common value at any one point of time. The relevant discount rate for this purpose has been discussed above (paras. 28 to 31). If the net present value (NPV) of the project is negative, i.e., if the discounted value of the benefits is less than the discounted value of the costs, the project should be rejected. But projects with a non-negative NPV should not necessarily be accepted, in practice, for two reasons.

54. Firstly, the shadow prices of some inputs (e.g. land or site value or mineral resources) are virtually impossible to estimate independently of the project appraisal process itself. Consequently, the opportunity cost of such inputs may be seriously underestimated because their best alternative use may not have been identified. In principle, the relevant alternative use should be determined by a careful analysis of all conceivable projects: in practice, only a few alternatives can be examined. Nevertheless, it should be borne in mind that a high NPV may reflect an inadequate search for alternative projects rather than a potentially valuable project. Secondly, there are many projects which, by their

nature, are mutually exclusive: if one is chosen, the other cannot be undertaken. This applies to different designs or sizes or timings of what is essentially the same project. It also applies, perhaps less obviously, to such cases as plants in alternative locations serving the same limited market, surface irrigation development ruling out tubewell irrigation, river development upstream instead of downstream, etc. In all such cases of mutually exclusive projects it is not sufficient to choose a project with a positive NPV but one should select the project with the highest NPV amongst the mutually exclusive alternatives. The analyst should not assume too easily that such mutually exclusive alternatives do not exist.

55. This discussion bears on the issue of ranking of projects in order of priority. This is a rather ambiguous notion. For a given investment budget, and associated shadow prices including the shadow rate of interest, projects are either acceptable in accordance with the foregoing criteria and should be included in the investment program, or they are not and should be excluded. This applies to mutually exclusive projects where only the project with the greatest NPV qualifies as well as to any other projects which only require a non-negative NPV. The only "ranking" is here between the "ins" and the "outs". A more interesting ranking question appears to be which projects should successively be excluded (included) if the investment budget were reduced (expanded). However, a change in the size of the available investment budget implies a change in the shadow rate of interest and corresponding changes in other shadow prices, which affect the size of the NPV of various projects in a differential way, depending on their time pattern and composition of inputs and outputs. Consequently, some projects with a high NPV in the origianl program may now drop out, some projects with more moderate NPV may be retained, and some projects that previously were excluded may now qualify. There is no single ranking of projects that are added or deleted from the program

in accordance with variations in its size. Changes in the investment budget tend to affect its general composition, and not simply "marginal projects".

56. Traditional Bank practice calculates the economic rate of return, i.e. the rate of discount which results in a zero Net Present Value for the project.[1/] If this rate of return exceeds the estimated shadow rate of interest, it indicates for a non-mutually exclusive project that it is acceptable; the NPV is then positive. Unfortunately, the rate of return is defective as a measure of the relative merits of mutually exclusive projects; a higher rate of return does not necessarily indicate the superior alternative. The economic rate of return thus may be misleading in comparing the economic merits of alternative projects and should not be used for this most essential function of project analysis.[2/] However, the (internal) economic return is a widely understood concept and has merit as a compact summary measure of the economic result of a project. For this purpose alone, its use should be continued.

57. Both measures, the NPV and the economic rate of return, are sometimes misinterpreted. The essential purpose of project analysis is to sort out the best of the feasible alternatives, i.e. the project which makes the greatest contribution to the basic objectives of the economy. After the selection has been made on this basis, this contribution may be expressed as a NPV or economic return

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1/ This rate is usually referred to in the literature as the internal rate of return.

2/ Benefit/cost ratios are similarly misleading as well as suffering from other ambiguities, and should not be used. This also applies to traditional business criteria such as the payback period which are wrong indicators of economic profitability. The economic rate of return criterion can provide the correct decisions if applied to the difference in net benefits between two mutually exclusive projects. But in such cases the possibility of multiple solutions to the rate of return calculation is considerably increased.

by comparing it with the situation without the project. As noted earlier, this measures the increase in rent (surplus) earned by the primary factors as compared to what they could earn without the project. It does not necessarily measure the contribution of the project in comparison with that of other (rejected) alternatives which may in fact have surpluses nearly as large as the selected projects.

Cost Minimization

58. Special variants of mutually exclusive projects are alternatives which produce the same benefits. This may be a question of choice of design, such as between hydro or thermal power generation, and rail or road transport. Whatever technical solution is chosen, the benefits are deemed to be the same. In such cases one only needs to consider costs and select the alternative with the lowest present value of cost when discounted at the appropriate rate of interest. For any given level of output and benefits, the least-cost alternative is to be preferred. But it should be clear that by itself this does not tell us anything about the economic merits of the project: even the least-cost project may have costs which exceed its benefits. The analysis should therefore not stop at a least-cost solution but consider wherever possible whether benefits are adequate. In cases where valuation of the benefits is difficult, for example improvements in health services, an assessment in terms of (least) cost per unit of physical output, such as number of beds made available, or reduction in morbidity, may be helpful.[1/] But note that differences in costs as between the least-cost design and the next best alternative are not, and should not be used as a substitute for, a proper measure of the benefits of such projects.

1/ The analyst might also compute the value which would have to be attached to, say, the benefits from hospital beds in order to make NPV zero.

First Year Return

59. An important choice of project alternatives concerns timing: when should the project be undertaken? In principle, alternative starting dates for the project, and other variations in execution such as stage construction, are subject to the normal NPV test (with all NPVs being calculated for the same base year, irrespective of the different starting dates of the projects). In some instances, however, a simpler test may suffice to determine the appropriate timing of the project. The so-called First Year Return (FYR) test involves calculating the ratio of net first year benefits to investment costs. If the ratio is below (above) the opportunity cost of capital, i.e. the shadow rate of interest, the project is premature (overdue). The test is strictly accurate only if benefits are time-dependent (and rising) rather than project-dependent, and project costs are not affected by postponement. In other words, the benefit stream must not shift depending on when the project is undertaken, and "tail-end effects" resulting from the timing of the project must be negligible. If these conditions are not fulfilled the FYR test is not applicable. Note also that this test is not a substitute for the standard requirement that the project should have a positive NPV; it is only a complementary test to determine its optimum timing.

Criteria for Public Utilities

60. As discussed earlier (para. 40), if an expansion of output increases supplies to users, its marginal value to the economy is measured by the demand price. In public utility project analysis, rates are often used as an approximation of such prices. They may or may not underestimate demand prices depending on whether or not demand for public utility service is rationed at the given rates or fully met. Furthermore, increases in public utility capacity are normally sufficiently large to reduce the market clearing rates, so that account should be

taken of gains in consumer surplus. For these reasons the revenue[1/] from additional sales is often referred to as a conservative measure of the benefits of such projects. However, the consumer surplus gains may need to be revalued to take account of their effect on income distribution and may need to be adjusted for the social costs (or benefits) of induced changes in consumption of other goods (see para. 50). In extreme cases, the social value of the consumer surplus might be negative, if the surplus accruing to the rich were counted for little and the cost of their additional consumption were high. In that case the revenue measure is not necessarily a conservative measure of benefits. On balance, additional revenues paid by the rich, as well as additional consumer surplus accruing to the poor through subsidized consumption, are likely to contribute to social gains.

Equivalent Criteria

61. As discussed earlier, the NPV and economic rate of return are two different ways of presenting the same information. The NPV is a measure of the project's value when due allowance has been made for all costs; the economic return is a measure of the project's value when due allowance has been made for all costs except the interest cost on capital. It follows that the critical point for acceptance or rejection of a project on the NPV scale is zero,[2/] while on the rate of return scale it is the accounting rate of interest.

62. Tests similar to the economic return test could be derived for factors of

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1/ Revenue must be expressed in real terms; e.g., a constant tariff in money terms is decreasing in real terms at a rate equal to the rate of inflation.

2/ This disregards the qualifications discussed in para. 54 that in practice the rent elements of cost are not normally included.

production other than capital. For example, net benefits can be related to labor inputs (or foreign exchange inputs) by netting out all costs and benefits other than labor (or foreign exchange). The critical point for acceptance or rejection becomes then the shadow wage rate (or shadow exchange rate). All such tests are equivalent, as long as the valuation of inputs and outputs remain the same, and do not provide any new information: they are simply transformations of the original NPV test. Hence, information on the employment or foreign exchange effects of a project should not be presented as a contribution (beneficial or otherwise) to the country's development objectives in addition to that measured by the NPV or economic rate of return. The weight attached to employment or foreign exchange earnings is already fully reflected in the shadow prices used in the NPV calculation.

63. Similarly, the effect of the project on investment and consumption is already adequately captured through the use of shadow prices. If the government values savings more highly than consumption, then this is reflected in the shadow wage rate and valuation of profits, and the accounting rate of interest. It is, therefore, fully taken into account in the calculation of the project's NPV. Discussion of the project's effects on saving and consumption must be consistent with the assumptions and data used in the NPV calculation. Consumption effects are, of course, closely related to employment effects.

Part V - Uncertainty, Sensitivity and Risk

64. Uncertainty is inherent in project analysis. Estimates of costs and demand, of shadow prices and the parameters underlying them, of consumer surplus and externalities, are approximate even for the present, and uncertainties increase when those estimates are projected into the future, as the analysis requires. A question therefore is how to take account of these uncertainties in the choice of projects.

65. The starting point is that the basic calculation of the NPV should incorporate the best estimates of the variables and parameters which determine the cost and benefit streams. The estimates should be the expected value obtained, in principle, by weighting each possible value by the probability of its occurrence. This ensures that the estimates are unbiased. Biased estimates, such as "conservative" estimates of costs (i.e., on the high side) and benefits (i.e. on the low side), should be avoided as much as possible since they distort the comparison of alternative projects.

66. Actual values may deviate from the most likely, expected values. It is important to investigate the impact of such deviations on the NPV of the project. A simple method is to vary the magnitude of the more important variables, singly or in combinations, by a certain percentage and see how sensitive the NPV is to such changes. Such sensitivity analysis helps in providing a better understanding of the key factors on which the outcome of the project depends. It may focus attention on the variables where a further effort should be made to firm up the estimates and narrow down the range of uncertainty. It also may aid the management of the project by indicating critical areas requiring close supervision in order to ensure the expected favorable return to the economy. The number of variables to be tested in this fashion is a matter of judgment, but care should be taken that all the plausible cases are covered. In particular, the significance of a certain sensitivity - i.e. the change in NPV resulting from, say, a 10% change in a certain variable - depends not just on its magnitude but also on the range of values which the variable is considered likely to attain; and some variables are likely to move together, or in opposite directions, in response to a common cause, or because of close interrelationships.

67. This points to the weakness of sensitivity analysis. It shows what the effect is on the NPV of a project if certain variables were to assume different values, all other things remaining equal. It does not show what the combined net effect is of changes in all variables, or the likelihood of various changes occurring together. Risk analysis (or probability analysis) is designed to throw light on these questions. It requires specifying, as best one can, probabilities for the several values that each variable entering into the project analysis may attain, as well as any covariances between the variables, i.e. the extent to which changes in one variable are correlated with changes in the other. (Specifying these covariances tends to be a stumbling block in practice.) Given these probability distributions, specific values of the underlying variables are randomly selected and combined into an estimate of the NPV of a project. Repeated application of this process produces a probability distribution of the NPV (or rate of return), i.e. the probabilities that the NPV take on certain values higher or lower than the "central" expected value calculated in the basic analysis. This gives the decision-maker a better picture of the degree of risk involved in the project than is given by a single valued calculation. It enables judgments that there is an X% chance that the project will result in a negative NPV, and a Y% chance of a surplus exceeding $N million.

68. Risk analysis provides a better basis for judging the relative merits of alternative projects. However, it does nothing to diminish the risks. It was mentioned above, in connection with sensitivity analysis, that some risks can be reduced by further investigations, for example of the technical problems and costs, or market prospects. This may or may not be worthwhile depending upon the cost of the investigation and the expected reduction in risk and the value attached

thereto. Risk may also be reduced by a flexible design of the project which leaves future options open to cope better with unexpected changes in circumstances. Such flexible design is likely to impose additional costs which may or may not be justified, in view of the anticipated uncertainties and the benefits of greater responsiveness which the flexible design makes possible.

69. In traditional Bank practice, sensitivity analysis is a standard part of project analysis, as a check on the results of a project if key variables were to differ from the estimated most likely values used in the analysis. More elaborate risk analysis is undertaken only in special cases. It should be considered for larger more complex projects or projects with exceptional risks which cannot be adequately appreciated by means of a simple sensitivity anlaysis. The advantages of further study of certain project features or variables, and of a more flexible design to cope better with future uncertainties, should be part of the normal process of project preparation and appraisal.

70. Finally, it should be noted that the use of net present expected value as a measure of a project's worth implies that the government is indifferent to risk as measured by, say, the variance of expected value. This is justifiable provided the risks of all public sector projects are pooled and spread over the country's whole population so that a change in the outcome of any single project is unlikely to have a significant impact on the income of any single group. This is not necessarily true for all projects. In some cases (e.g. agricultural projects) the risk may be borne by a relatively small section of the population; in other cases, the success or failure of the project may weigh heavily on national income. In such cases, one may wish to assess the "cost" of offsetting risk, for example, by maintaining sufficient foreign exchange reserves to offset fluctuations in export prices.

ANNEX

Table of Contents

A N N E X

DERIVATION OF SHADOW PRICES

I INTRODUCTION

1. This Annex provides a self-contained explanation of shadow pricing. It is intended to give the country/project economist an intuitive appreciation of the techniques being recommended: however, it should not be viewed as a rigorous statement of the subject nor should it be assumed that all eventualities are covered. More detailed information on the technical derivation of shadow prices is provided in Appendix I where some of the complications, omitted in this section, are also considered. Possible methods of estimation are described in Appendix II and Appendix III illustrates the approach with a case study.

Definition of Shadow Prices

2. Shadow prices are defined as the prices associated with the economy's optimal development path given the country's objectives and given all the constraints which limit the achievement of those objectives. Thus, shadow pricing presupposes that one has in mind a well-defined social welfare function (a mathematical statement of the country's objectives) and a precise understanding of the constraints, both now and in the future, which confine the country's development. The next two paragraphs consider the type of welfare function and the constraints which are thought to be most important in LDCs.

Social Welfare Function

3. Governments are making decisions every day in terms of some concept of welfare. Usually the concept of welfare is not clearly defined and as a result decisions are often contradictory. Thus, a clear statement of the welfare function

is essential to ensure consistent decision making. Countries have many so-called objectives such as better health services, efficient agriculture and so on, but one may reasonably comment that such objectives are really means to attain more fundamental objectives which usually relate to the distribution of consumption both over time and at a point of time. It is these two aspects of consumption, i.e. its intertemporal and interpersonal distribution, which form the basis of the welfare function employed in this Annex. This enables us to concentrate on the crucial trade-off between growth (i.e. a redistribution of consumption from the present to the future) and the redistribution of consumption from the rich to the poor.

Constraints

4. Constraints can take various forms. All economies are faced by the basic constraints on the availability of resources and the possibilities for their technological transformation. In some circumstances market prices will correctly reflect the scarcity value of these resources but frequently other constraints operate to divorce market prices and economic values. For example, minimum wage legislation may keep the market wage above the foregone output in other occupations. Similarly, trade taxes cause a divergence between the value of commodities at domestic and international prices which means that the official exchange rate does not reflect adequately the value of foreign exchange. To correct for such distortions the economist recommends the use of shadow prices, i.e. prices which, despite the distortion, will ensure the efficient allocation of resources. Note, however, that shadow prices as defined here do not necessarily assume the removal of the distortion. One is not trying to estimate, for example, the free trade exchange rate (unless one expects the country to adopt a free-trade policy) but an exchange rate which, given the distortion, will more accurately reflect the value of foreign exchange.

5. LDCs may also be constrained in other ways. For example, administrative costs or political pressure may limit the government's actions. Thus, the possibilities of taxing the agricultural sector may be limited by the costs of collection and administration, or the political power of the rich may be sufficient to prevent the government distributing income to the poor. Arguments of this type suggest that LDCs may also be faced by a fiscal constraint in the sense that the government cannot raise sufficient revenue to achieve its desired level of investment or its desired distribution of income. The obvious implication is that the government may wish to use project selection as an alternative, additional method of increasing public income or of redistributing income. Even within the public sector constraints may prevent the optimal use of the limited public revenue. The government may be committed to various expenditures (e.g. the payment of civil servants' salaries) so that public sector expenditure in other directions (e.g. investment) may be constrained below its optimal level.

6. If such constraints are thought to be important, the value of a project depends not only on the benefits generated by the project but also on their distribution. In other words, besides looking at the effect of the project on the allocation of resources (i.e. the efficiency effect), we must also look at the effect on the incomes of different groups in society (i.e. the distribution effect). Until recently the Bank has been interested primarily in the efficiency aspect of projects. To incorporate the distributional aspect we could adopt one of two procedures: firstly, we could price all factors of production at their efficiency price and then look at the distribution of benefits and weight accordingly; secondly, we could make use of the economic fact that the benefits of the project will accrue to the factors of production employed in the project.

We can then define the social price[1/] of a factor as

$$\text{Social Price} = \text{Efficiency Price} \pm \text{Distributional Impact} \qquad 1)$$

so that the efficiency price[1/] is adjusted to reflect the distributional impact (which could be positive or negative) of hiring an additional unit of the factor. The latter method may be useful for some factors, e.g. unskilled labor, for which it is convenient to have an all-inclusive price for purposes of decentralized decision making. For other factors this may not be particularly interesting, in which case one could use the first method. Whilst both methods may be used in any single project, they must not be used for the same factor payment because that would involve double-counting.

7. In presenting the economic analysis of a project it will be instructive to indicate the project's worth at market, efficiency and social prices. The first evaluation will correspond to the financial appraisal of the project. The second will be similar to that traditionally used in the Bank, i.e. all incomes will be considered equally valuable, there will be no premium on public income or investment, the discount rate will be the opportunity cost of capital and other factor prices will be based on opportunity cost. In other words, the evaluation at efficiency prices corrects for the distortions in factor and product markets but does not assume any constraint on the government's ability to redistribute income or invest. The final evaluation will include the project's distributional impact (see equation 1)) if it is thought that the economy does suffer from a fiscal constraint.

1/ Efficiency price is used in the traditional Bank sense of opportunity cost; social price is defined by equation 1). The terms "shadow" and "accounting" are used indiscriminately to refer to both efficiency and social prices.

Inasmuch as the main innovation is contained in this final step we will pay particular attention to the derivation of distribution weights, devoting the whole of Section II to a discussion of both interpersonal and intertemporal weights. This is not to say that the methodology ignores efficiency. To illustrate this, in Section III we combine efficiency and distributional considerations for the particular case of labor. Finally, in Section IV we examine the prices to be used for commodities, both tradable and non-tradable.

II DERIVATION OF WEIGHTS

Numéraire

8. The choice of numéraire (standard of account) is basic to the determination of the weight. One is at liberty to choose any commodity or resource as numéraire but, once it has been chosen, one must consistently express all values in terms of that numéraire. It is recommended that the Bank use as numéraire uncommitted public income measured in terms of foreign exchange. Note, however, that the units of foreign exchange need not be dollars or any other foreign currency: in general, the domestic equivalent, at the official exchange rate, of any foreign currency will be the most convenient unit of account. This numéraire is recommended because most projects are in the public sector and involve considerable amounts of foreign exchange. A unit of private consumption expressed in terms of domestic currency, therefore, has to be revalued to express it in terms of the value of foreign exchange in the hands of the government. This may appear tedious, but if one used consumption expressed in domestic currency as numéraire, one would have to go through the reverse process in order to express, say, a foreign loan to the public

sector in terms of the consumption numéraire.[1/] The choice of numéraire also has implications for intertemporal, as well as for interpersonal, weights because the discount rate is defined as the rate of fall in the value of the numéraire over time. If all values are consistently expressed in terms of the numéraire in each period, then the discount rate provides the link between different time periods and enables us to express all costs and benefits in terms of present value.

9. The choice of numéraire essentially determines the absolute value of the weights to be applied to benefits accruing to different groups of society because the weight attached to the numéraire (public income measured in terms of foreign exchange) is to be set equal to unity by definition. The social price formula (equation 1)) may then be interpreted in the following manner. Assume that, as a result of its employment in a project, a particular factor, say labor, enjoys an increase in consumption represented by C.[2/] The increased consumption will comprise various commodities or services which either directly or indirectly will reduce the quantity of foreign exchange available to the government. By examining the composition of labor's marginal consumption basket, one can ascertain the quantity of foreign exchange required to satisfy the additional demand for imports or to compensate for the reduced supply of exports which, either directly or indirectly, constitute that basket.[3/] Let β represent the ratio of the basket's value at border

1/ Note also that if one wishes to take account of the distribution of consumption the numéraire would have to be defined as the value of consumption at a particular level of consumption. The public income numéraire is used in (Little and Mirrlees, 1974) whose general format has been followed here. The consumption numéraire is used in (UNIDO, 1972). For further references to the literature see Appendix I.

2/ We treat an increase in private savings separately, i.e. for the moment we assume that there is no saving out of wages. See para. 26.

3/ The concept of direct and indirect foreign exchange requirements is discussed further in Section IV (Commodity Prices).

prices to its value at domestic prices, so that βC units of foreign exchange are required to satisfy labor's increased demand for consumer goods.[1/] Thus, the increased consumption reduces the foreign exchange available to the government by βC. This represents an additional cost incurred by the project and should, therefore, be included in the shadow price of labor. Moreover, since it is already expressed in terms of our chosen numéraire (public income measured in terms of foreign exchange) it can be immediately added to the efficiency price.[2/] However, increased consumption is one of the government's goals so that, although it is a cost in the sense that it reduces the foreign exchange available to the government, it is also a benefit in the sense that it increases welfare. Assume that a unit of private consumption valued at domestic prices is worth ω units of our numéraire, then the distributional impact of the increased consumption may be viewed as a reduction in the government's foreign exchange income of βC (which receives a weight of one) and an increase in private sector consumption of C (which receives a weight of ω). Equation 1) may now be written as

$$\text{Social Price} = \text{Efficiency Price} + C(\beta - \omega) \qquad 2)$$

where β indicates foreign exchange cost and ω indicates the social benefit of the increased consumption.

10. We can make five general points about equation 2). Firstly, if the

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1/ In general, we expect β to be less than one because import duties and export subsidies raise the domestic price above the c.i.f. and f.o.b. prices respectively.

2/ As we shall see in Section III the efficiency price will also be expressed in foreign exchange.

increase in consumption is zero then the social price equals the efficiency price. This might occur in a perfect labor market where the transfer of labor does not involve a change in income or consumption. Secondly, if the wage-earner spends all his income on, say, duty-free imports or if there are no trade tariffs in the economy, then $\beta = 1$. In other words, we can view β as a factor which corrects for the distortions caused by trade tariffs. Note that β may vary for different consumers depending on the actual composition of their consumption basket. Thirdly, if the government is interested in income distribution, ω will tend to be low for the rich and high for the poor, and for some consumption level one would have $\omega = \beta$, so that the foreign exchange cost incurred by the government, and the social benefit enjoyed by the worker, as a result of a marginal increase in consumption are exactly offsetting. This level of consumption is known as the critical consumption level; the social price equals the efficiency price at the critical consumption level. Fourthly, the government may not wish to include distribution weights in project selection. We examine the possible reasons behind such a wish in para. 14, but here we may note that the wish implies that the social price always equals the efficiency price. This has been the traditional Bank practice. Finally in para. 6 we mentioned two possible ways of introducing income distribution weights into project selection. Thus far, we have only examined the second, which involved the inclusion of distribution weights in shadow prices, but the first method can be directly deduced therefrom, because whether the "distributional impact" is included in the shadow price or handled separately the relevant weight is still $(\beta - \omega)$. In other words, if the project is appraised at efficiency prices, then all increases in private sector consumption resulting from the project must be appropriately weighted and subtracted from net benefits. Of course, β and ω

will vary for different consumption baskets and different consumption levels respectively.

Meaning of ω

11. The purpose of ω is to indicate the value of a marginal increase in private sector consumption measured at domestic prices in terms of the value of foreign exchange in the public sector. Let the welfare value of the former be W_c and that of the latter be W_g [1/], then our choice of public income measured in terms of foreign exchange as numéraire implies that

$$\omega = W_c/W_g \qquad 3)$$

To evaluate this ratio we could attempt direct estimates of W_c and W_g; however, it may be more convenient to adopt a slightly different approach. In particular, we will divide the derivation of ω into two steps. Define v as the value of a marginal increase in public income measured in terms of foreign exchange (W_g) divided by the value of a marginal increase in consumption at domestic prices to someone at the average level of consumption ($W_{\bar{c}}$), i.e.,

$$v = W_g/W_{\bar{c}} \qquad 4)$$

Thus, a marginal increase in consumption at domestic prices to someone at the average level of consumption is worth 1/v units of our numéraire. We now wish to obtain the value of a marginal increase in consumption at domestic prices to someone at some level of consumption other than the average level. Define d as the value

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1/ Thus, W_g measures the increase in aggregate welfare resulting from a marginal increase in public income measured in terms of foreign exchange (i.e., our numéraire). Both W_g and W_c are measured in terms of 'utils' so that ω is a pure number.

of a marginal increase in consumption at domestic prices to someone at a level of consumption represented by $c(W_c)$ divided by the value of a marginal increase in consumption at domestic prices accruing to someone at the average level of consumption ($W_{\bar{c}}$) i.e.,.

$$d = W_c / W_{\bar{c}} \qquad 5)$$

Thus, a marginal increase in consumption at domestic prices accruing to someone enjoying a consumption level represented by c is worth d times as much as a marginal increase in consumption at domestic prices accruing to someone at the average level of consumption.

12. We started this discussion by dividing ω into two constituent elements; we will now combine the elements to obtain our final expression for ω. From equations 3), 4), and 5)

$$\omega = W_c / W_g = W_c / W_{\bar{c}} \times W_{\bar{c}} / W_g$$

$$\omega = d \times \frac{1}{v} \qquad 6)$$

which says that the weight, ω, depends on the following two factors:

(i) d, which is designed to allow for the different values assigned to <u>additional</u> consumption at different <u>existing</u> levels of consumption. This is essentially a pure income distribution parameter. If the government does not wish to use project selection to improve income distribution, d should be set equal to one. However, if it does wish to use project selection for this purpose, then d will be greater or less than one depending on whether project-generated income accrues to those enjoying a level of consumption below or above the average level of consumption; and

(ii) v, which is designed to allow for the different values assigned to public income (measured in terms of foreign exchange) and private sector consumption

(evaluated at the average level of consumption). We can now substitute into equation 2) to obtain

$$\text{Social Price} = \text{Efficiency Price} + C(\beta - d/v) \qquad 7)$$

so that the distributional impact reflects both the cost of the reduction in public income measured in terms of foreign exchange (β) and the social benefit of additional consumption in the private sector (d/v).

13. The consistent inclusion of distributional considerations in project evaluation will bias project selection according to the value judgments implicit in the distribution weights. For example, if public income is particularly scarce, v will tend to be high and, in the limit, when v tends to infinity, the transfer of resources from the public sector to the private sector (resulting from the payment of, say, wages in excess of foregone marginal product) will be treated as a pure cost so that the social price will exceed the efficiency price by $C\beta$ (see equation 7)). Thus, v reflects the public revenue constraint: in general, the higher v (i.e. the scarcer public income) the greater the likelihood that projects will be selected which do not involve a significant transfer of resources from the public sector to private sector consumption; in short, the uses to which public sector income may be put (e.g. investment in education) are considered more valuable than private sector consumption. However, private sector consumption is not homogenous: one might expect that the consumption of the poor is more valuable in the eyes of the government than the consumption of the rich. To allow for this we introduce the d paramter which, unlike v, is specific to the income recipient. Given the overall constraint on public revenue as indicated by the value of v, the purpose of d is to bias project selection in such a way that the private sector consumption which is

generated by project investment will accrue primarily to the poor. Or, to put the point differently, factors of production owned by the poor will appear more attractive and project selection will be biased in favor of projects which use such factors. Thus, given the cost of the resource transfer (β), the offsetting social benefit is determined in the light of the overall constraint on public income (v) and the value of providing additional consumption to a particular income class (d). The next 17 paras. describe each element of the "distributional impact" in more detail: para. 14 provides the general rationale for the use of distributional weights; para. 15 deals with β, the factor correcting for trade distortions; paras. 16 to 21 with d, the pure distribution parameter; and paras. 22 to 26 with v, the value of public income. Paras. 27 to 30 conclude this section with a simple example.

The General Rationale for Distribution Weights

14. The use of distributional weights in project appraisal raises various theoretical and practical questions. On the theoretical side one can question the need for such weights. For example, if the government values all income equally irrespective of its distribution either between the public and private sector or within the private sector then the need for distribution weights disappears. Note, however, that the weights only apparently disappear; in reality they are still there but the implicit value judgments are such that the social cost of each resource transfer is exactly offset by the resulting social benefit. Many people would consider it rather extreme not to assign different values to marginal increments in consumption accruing to different income groups. However, there is an alternative argument for excluding distribution weights. If the government, through its control of fiscal policy, is able to redistribute income as it sees fit then there is no need to

include distribution weights in project selection. Project selection should then aim to maximize income allowing the fiscal system to redistribute it in a desirable fashion. To reverse the argument, the inclusion of distribution weights implies that the government is constrained in its use of fiscal policy and therefore is unable to redistribute income to the extent desired. Viewing the very unequal distribution of income/consumption in most developing countries and considering the difficulty of raising additional revenue one is drawn to the conclusion that the government's use of the fiscal system is severely constrained. These constraints typically reflect a general inability to raise sufficient revenue because of administrative costs and a particular inability to tax the rich sufficiently because of the political power wielded by such. If either (neither) of the arguments advanced in this paragraph is considered valid, then distribution weights are not (are) required for project selection.

Derivation of β

15. The value of β is determined by estimating the increase in the value of consumption at domestic prices if one more unit of foreign exchange is committed to consumption. Consumers may increase their consumption of exportables, importables or non-tradables. To the extent that different income groups will buy different bundles of goods at the margin of their expenditure and given that trade distortions are different for different commodities, one ought to estimate a different β for different income groups. In practice, however, a separate β for rich and poor income groups will probably be sufficient. Calculating β requires information on the (marginal) consumption pattern, the ratio of the value of this consumption at border prices to its value at domestic prices being the required number. Thus, if tradable commodities (i.e. commodities which at the margin are being exported or imported) form part of consumption, the ratio will depend on the import/export tax/

subsidy. But if non-tradables appear in the consumption pattern then one must apply more complicated methods such as valuing the inputs used in the production of non-tradables at border prices (such complications are explained more fully in paras. 56 to 59). To a reasonable approximation, especially if non-tradable consumption is small, we can write

$$\beta = \frac{M + X}{M(1 + t_m) + X(1 - t_x)} \qquad 8)$$

where M(X) is the c.i.f. value of imports (f.o.b. value of exports) in the marginal consumption bundle and $t_m(t_x)$ is the"average" tax on imports (exports), which may be measured by the ratio of the revenue from trade and other taxes on consumption goods to the value of those consumption goods c.i.f. or f.o.b.[1/] Whilst the use of equation 8) to estimate β is a convenient shortcut, it might also lead to misleading results. The analyst should ensure that the basket of commodities (and their respective tax rates) is a reasonable reflection of the consumption basket of the particular income class in question. β and its relationship to the shadow exchange rate are discussed further in para. 59.

Consumption Distribution Weight (d)

16. In order to derive distribution weights it is necessary to specify a utility function. The basic assumption underlying the utility function is that the utility derived from an increment of consumption is less the higher the existing level of one's consumption, i.e. the marginal utility of consumption decreases as

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1/ Note that β translates domestic prices into border prices expressed in units of the domestic currency. Division by the official exchange rate is required to obtain foreign exchange proper.

the level of consumption increases. If marginal utility is expressed as U_c then this type of consideration may be formalised as

$$U_c = c^{-n} \qquad 9)$$

where c is the level of consumption and n a parameter of the utility function.[1/] Whilst this formula is only one of many which could be used to depict the diminishing nature of marginal utility, this particular formulation has the advantage that n can be given an intuitively appealing meaning - namely, the higher n the more egalitarian the government's objectives because the higher n the higher the rate of diminishing marginal utility. For example, if n = 2 (1) marginal utility is four (two) times higher for a man with a given level of consumption than for a man with a consumption level twice as high. And if n = 0, the marginal utility of consumption is independent of the level of consumption. For most governments n would probably center around 1. Values close to zero or two, although possible, may be considered extreme.

17. To compare the value of consumption to different people and at different points of time one needs a point of comparison. For example, one might choose the marginal utility of consumption at today's average level of consumption. That is, one can set

$$\bar{c}^{-n} = 1$$

1/ Total utility {U(c)} is obtained by integrating equation 9), i.e.

$$U(c) = \frac{1}{1-n} c^{1-n} \quad \text{if} \quad n \gtrless 1$$

$$\text{and} \quad U(c) = \log_e c \quad \text{if} \quad n = 1$$

where the bar indicates average. It follows that the marginal utility of consumption to someone with a level of consumption equal to $2\bar{c}$ ($0.5\bar{c}$) is 0.5^n (2^n) so that if n = 2, marginal utility is 0.25(4). Formally, the consumption distribution weight (d) for marginal changes in consumption is

$$d = U_c / U_{\bar{c}} = (\bar{c}/c)^n \qquad 10)$$

18. Table 1 illustrates how the value of d changes both with different value judgments (i.e. different values for n) and with different existing consumption levels.

Table 1

Values of d for Marginal Changes in Consumption

Existing Consumption Level (c)	$\bar{c}/c$	Value Judgment n = 0	n = 0.5	n = 1	n = 2
10	10.00	1.00	3.16	10.00	100.00
25	4.00	1.00	2.00	4.00	16.00
50	2.00	1.00	1.41	2.00	4.00
75	1.33	1.00	1.15	1.33	1.77
100*	1.00	1.00	1.00	1.00	1.00
150	0.66	1.00	0.81	0.66	0.44
300	0.33	1.00	0.57	0.33	0.11
600	0.17	1.00	0.41	0.17	0.03
1,000	0.10	1.00	0.32	0.10	0.01

*Average consumption ($\bar{c}$)

With n set equal to zero, all additional consumption is considered equally valuable regardless of the recipient's existing level of consumption. The Bank has

traditionally set n equal to zero. As n is increased so the egalitarian bias is increased: a value of n equal to one implies quite a pronounced bias in favor of the poor, the weight on additional consumption decreasing proportionately with increases in the existing level of consumption. With n equal to 2 the weight falls with the square of the proportionate increase in the existing consumption level, and, as can be seen from Table 1, this leads to a set of weights which implies a marked egalitarian bias. Note that only one such table is required for all Bank countries because the only information required is the ratio of the existing to the average consumption level which is a pure number (see column 2 in Table 1). However, for any particular income recipient the relevant value of d may change over time if his consumption level and average consumption are growing at different rates.

19. Frequently, we will want to express non-marginal increases in consumption in terms of the marginal utility of consumption at the average level of consumption (i.e. in terms of $\bar{c}^{-n}$). If consumption increases from c_1 to c_2, then the increase in utility is $U(c_2) - U(c_1)$, which, in terms of the marginal utility of consumption at the average level of consumption, is

$$\frac{U(c_2) - U(c_1)}{\bar{c}^{-n}}$$

We now want the weight, d, which can be applied directly to $(c_2 - c_1)$ to give us the normalised utility value, i.e.

$$(c_2 - c_1)d = \frac{U(c_2) - U(c_1)}{\bar{c}^{-n}}$$

hence

$$d = \frac{U(c_2) - U(c_2)}{(c_2 - c_1)\bar{c}^{-n}} \qquad 11)$$

which formula is the non-marginal counterpart of equation 10).

20. Given the form of the utility function, equation 11) can be expressed in terms of n, the basic parameter of the utility function, and two ratios, that of the old to the new level of consumption c_1/c_2 and that of the average to the new level of consumption $\bar{c}/c_2$ (see Appendix I, para. 7). Table 2[1/] indicates the numerical value of d for different values of n, c_1/c_2 and $\bar{c}/c_2$.

Table 2

Values of d for non-marginal Changes in Consumption

$\bar{c}/c_2$	2			1			0.5		
c_1/c_2 / n	0.25	0.5	0.75	0.25	0.5	0.75	0.25	0.5	0.75
0	1	1	1	1	1	1	1	1	1
0.5	1.86	1.64	1.47	1.32	1.16	1.04	0.66	0.58	0.52
1.0	3.70	2.77	2.33	1.85	1.39	1.15	0.92	0.69	0.57
1.5	7.54	4.69	3.45	2.67	1.66	1.22	0.92	0.59	0.43
2.0	16.00	8.00	5.30	4.00	2.00	1.30	1	0.50	0.33

Provided one is talking about an increase in consumption, $c_1/c_2<1$ so that $c_1/c_2 = 0.5$ means that consumption has been doubled. $\bar{c}/c_2$, however, can be>< 1. If $\bar{c}/c_2 = 2(0.5)$ then consumption has been increased to a level half (twice) as high as average consumption. Thus, assuming n>0, the lower c_1/c_2 and the higher $\bar{c}/c_2$, the higher the weight. This is intuitively acceptable because if c_2(the new level of consumption) is very much below $\bar{c}$ (the average level of consumption)

1/ As with Table 1, Table 2 can be used for all countries.

so that $\bar{c}/c_2$ is high, and if c_1 (the old level of consumption) is very much below c_2 (the new level of consumption) so that c_1/c_2 is small, then the increase in consumption is going to someone who is very poor and will in fact still be worse off than the average citizen even after the increase. One would presumably want to attach a high weight to such consumption and this is precisely what the table tells us. For example, if $\bar{c}/c_2$ is 2 and c_1/c_2 is 0.5, then with n = 2, we observe that the value of d is 8. On the other hand, if the consumption accrues to the rich (e.g. $\bar{c}/c_2 = 0.5$ and $c_1/c_2 = 0.75$) then d will be low especially if n is high (i.e. with n = 2, d = 0.33).

Summary Distribution Measure (D)

21. Turning to practical matters there is the question of estimating n and of the additional work involved for the project economist. The former is considered in Appendix II. With regard to the latter the project analyst must obtain information on the beneficiaries of the project. This is already done to some extent, especially in agricultural projects where the levels of consumption both with (c_2) and without (c_1) the project are reported. That is all the information that the project analyst need collect. The values of $\bar{c}$ and n are not project specific but country specific and hence best provided by the responsible country desk. The weights can then be determined directly from Table 2. However, some effects of the project on consumption may be difficult to trace, too small to bother about or so general that all income classes would have to be examined. In such cases, it is recommended that one use a global distribution weight (D) which is defined as the increase in total welfare generated when an increment in consumption is distributed among the population in the same way as is current aggregate consumption. This definition implies that the increase in consumption has a neutral effect on the distribution of consumption. Accordingly, one might wish to assign a slightly

higher (lower) value to D if it is thought that the increase in consumption is improving (worsening) the distribution. A formula for D is derived in Appendix I from which Table 3 is deduced, where n is the parameter of the utility function, as discussed above, and σ is a parameter of the Pareto distribution function.[1/]

Table 3

Values for D

σ \ n	0	0.5	1.0	2.0	3.0
1.5	1.0	0.86	1.0	1.8	3.85
2.0	1.0	0.94	1.0	1.3	2.0

As the table illustrates, for $n \leq 1$, D tends to be close to unity. For $n > 1$, with the government giving considerable weight to income distribution, plausible values range between one and two, but may be higher for a very high n and low σ.

Value of Public Income (v)

22. To obtain the value of public income in terms of the value of additional consumption at the average level of consumption (i.e. v) we must examine the uses to which it is put. Given that at the margin public sector income measured in terms of foreign exchange is used for different purposes such as education, defense, consumption subsidies, administration costs, investment, etc., v may be

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1/ Note that σ is related to the Gini coefficient as follows:

$$\text{Gini coefficient} = 1/(2\sigma - 1)$$

The Bank has information on Gini coefficients for many countries.

interpreted as a weighted average of the values of different types of public expenditure, the weights being the proportion of each in the marginal unit of expenditure. If the value of the jth type of expenditure expressed in terms of the value of consumption at the average level of consumption is v_j, then

$$v = \sum_j a_j v_j \qquad 12)$$

where a_j equals the proportion of a marginal unit of public income devoted to the jth type of expenditure (i.e. $\sum_j a_j = 1$). In principle, all v_j should equal v because a rational government would ensure that at the margin additional expenditure has the same value in all uses. If this is the case, we need only identify one v_j in order to know the value of v. For example, we might be able to assess the value of public investment in terms of private sector consumption and the resulting value would also be the correct value for v. In practice, however, it is unlikely that the government can secure the equality at the margin of the value of additional expenditure for all purposes, especially when it is recalled that the value of additional expenditure on health, defense, administration, etc. is notoriously difficult to assess. Nevertheless, in the absence of information to the contrary, it may be considered a reasonable working rule to assume that all $v_j \doteq v$. In the next paragraph we discuss how one might assess the value of one particular type of public expenditure.

Value of Public Investment

23. In many countries, capital expenditure is often treated as a budget-balancing item: if public revenue is scarce (plentiful), it is capital expenditure which suffers (enjoys) the main cut-back (expansion). In other words, public investment may be the major component of marginal public expenditure. We might

assess its value by assuming, for example, that a unit of foreign exchange allocated to public investment produces a stream of output which, measured in foreign exchange, is denoted by q. We define q net of the cost required to maintain the unit of capital intact forever. We assume further that q accrues to someone at the average level of consumption thereby permitting an increase in consumption measured at domestic prices of q/β, β being the relevant ratio of border to domestic prices (see para. 15). If the average level of consumption is increasing over time and if we accept diminishing marginal utility, then future consumption must be discounted by a rate which reflects the growth rate of consumption (g) and the rate of diminishing marginal utility (n). Furthermore, if the government considers future consumption less valuable than present consumption simply because it occurs in the future, the discount rate must include an element reflecting pure time preference (ρ). The resulting discount rate, known as the consumption rate of interest or social discount rate (i) may be expressed as

$$i = ng + \rho \qquad 13)$$

(See Appendix I for derivation.) We can now denote the present value of the consumption generated by a unit of investment as

$$v = \sum_{t=0}^{\infty} \frac{q}{\beta(1+i)^t} = \frac{q}{\beta i} \qquad 14)$$

Thus, v may be interpreted as the shadow price of public investment (income) in terms of a numéraire defined as the marginal utility of consumption at the average level of consumption. Alternatively, we may say that a unit of consumption measured at domestic prices accruing to someone at the average level of consumption is worth $1/v$ $(=\beta i/q)$ units of public income measured in terms of foreign exchange, this

being our chosen numéraire.

24. Table 4 presents some numerical examples of these relationships.

Table 4

Value of v

n	g	ρ	i=ng+ρ	q	β	v=q/βi
1	.01	0	.01	.12	0.8	15
1	.03	0	.03	.12	0.8	5
1	.03	.03	.06	.12	0.8	2.5
2	.01	0	.02	.12	0.8	7.5
2	.03	0	.06	.12	0.8	2.5
2	.03	.03	.09	.12	0.8	1.7

n = elasticity of marginal utility with respect to consumption;

g = growth rate of per capita consumption;

ρ = rate of pure time preference;

i = consumption rate of interest;

q = marginal product of capital measured in terms of foreign exchange;

β = factor correcting for the distorting influence of trade tariffs and restrictions;

v = value of public investment (= public income) measured in terms of the value of additional consumption to someone at the average level of consumption.

The table illustrates the significance of the CRI in determining v; other things being equal, the higher the CRI the lower v because future consumption is being discounted more heavily. Noting that the CRI is determined by the growth rate in

per capita consumption and by the subjective parameters, n and ρ, we see that whereas the government's preferences concerning income distribution (i.e. the d's) are quantified solely by n, its preference for growth (i.e. v) is determined jointly by n and ρ. Thus, a high (low) value for n is sufficient to impart a strong (weak) egalitarian bias to project selection, whereas a very growth-oriented policy requires a low CRI which may necessitate both a low ρ and a low n.

25. However, it should be clear that values for v derived from equation 14) are based on many simplifying assumptions. In Appendix I we provide a more general formula which allows for the possibility that the return from investment may be used for different purposes (e.g. reinvestment, consumption of the poor, consumption of the rich, etc.) and for the possibility that the values of the parameters may change over time. However, as one introduces more complications, the data requirements become excessive. For estimation purposes, therefore, we are forced either to make simplifications or to seek alternative methods of estimating v (see Appendix II). Whatever the actual method chosen, it is important that the resulting value of v should not seem implausible in the light of our knowledge of government policies in general. One useful test involves computing the critical consumption level at which point public income (measured in terms of foreign exchange) and private consumption (measured in terms of domestic prices at the average level of consumption) are considered equally valuable (see para. 10). In other words, given the value of v derived from some variant of equation 14), one can compute the level of consumption for which the value of d is such that $d/v = \beta$, this being the condition which determines the critical consumption level. For example, if v = 5 (see Table 4), then, with n = 2 and $\beta = 0.8$, d must equal 4.5 (i.e. $d = v\beta$). From Table 1 we see that an existing level of consumption slightly less than half the average level would produce the required value for d.

Thus, our estimate of v implies that the government is indifferent between additions to its own income and additions to the consumption of those who are currently enjoying less than one half of the average consumption level. This implication may not seem plausible in the light of other government policies. For example, if the government is providing consumption subsidies to people at the estimated critical consumption level, one might argue that the government values additional consumption at this level more highly than its own income, which suggests that v has been overestimated. It is only by means of a careful assessment of all the relevant government policies that one can derive an acceptable value for v.

Value of Private Savings

26. Note also that equation 14) (with the variables appropriately redefined), or some variation thereon, should be used to assess the value of private sector investment. Thus far, we have explicitly assumed that additional factor payments lead to additional consumption; more realistically, part will be taxed directly, part will be saved and part will be consumed. The costs and benefits of the resulting transfer in resources from the public to the private sector now depend, not only on the foreign exchange cost of consumption and its social benefit, but also on the social costs and benefits of that portion which is saved. Direct taxation, of course, does not involve a transfer of resources (measured in terms of foreign exchange) from the public to the private sector because the private sector's disposable income is effectively reduced by the tax payment. Direct taxes should, therefore, be netted out in determining the social cost/benefit of additional private sector income. Private savings,however, which result, either directly or indirectly, in private investment will have a foreign exchange cost (i.e. the expenditure on investment goods) and a social benefit (i.e. the stream of consumption reinvestment and taxes generated by the investment). This social benefit

of private investment should be evaluated in a similar fashion to that employed for public investment. However, some private saving may take the form of an interest-bearing loan to the public sector. Although accruing to the public sector, such saving should not, of course, be considered the equivalent of tax payments because the former, but not the latter, commits the government to certain obligations (i.e. debt servicing). Whilst in general one may assume that public investment is at the expense of alternative marginal public investment, in some cases it may displace private investment, in which event one must assess the foregone social benefit of the private investment in order to determine the capital costs of the public investment.

Examples

27. We now bring the various threads of the argument together in the form of two examples. In Economy I per capita consumption levels are very low and for some time the growth rate of per capita consumption has also been low (1% p.a.) and is expected to remain so in the immediate future. In these circumstances, the government of Economy I, rightly or wrongly, has decided to emphasise growth rather than, but not to the exclusion of, the redistribution of income. Recalling the discussion of para. 24, a relatively mild concern with income distribution implies a low value for n (say 0.5) and an emphasis on growth requires a low CRI (say 5%).[1/] The other relevant data for Economy I are presented in Table 5. In Economy II per capita consumption levels are rising quite quickly (4% p.a.) and are expected to continue to do so, but the distribution of income is becoming increasingly skewed. In line with the government's expressed desire to improve the

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1/ Given the formula for the CRI in equation 13), the implied rate of pure time preference is 4.5% for Economy I.

distribution of income (at the expense of some growth if necessary), we select a high value for n (say 2) and a high CRI (say 10%).[1/] The other relevant data for Economy II are presented in Table 5. For both economies v is computed on the assumption that the entire return from investment is consumed (see equation 14)). In the second part of the Table, we derive the weights (the ω's) to be assigned to private sector consumption at different consumption levels. The d's are taken from Table 1 and the ω's are then obtained by dividing v.

Table 5

	Economy I	Economy II
q	0.08	0.10
β	0.8	0.8
n	0.5	2.0
g	0.01	0.04
ρ	0.045	0.02
$i=ng+\rho$	0.05	0.10
$v=q/\beta i$	2	1.5

Existing Relative Consumption Level	Value of $\omega = d/v$			
	Economy I		Economy II	
$c/\bar{c}$	d	ω	d	ω
0.25	2.00	1.00	16.00	10.67
0.50	1.41	0.70	4.00	2.67
0.75	1.15	0.57	1.77	1.18
1.00	1.00	0.50	1.00	0.67
1.50	0.81	0.40	0.44	0.29
3.00	0.57	0.28	0.11	0.07
6.00	0.41	0.20	0.03	0.02
	Critical Relative Consumption Level			
	0.39		0.91	

q = marginal product of capital measured in terms of foreign exchange;
β = factor correcting for the distorting influence of trade tariffs;
n = elasticity of marginal utility with respect to consumption;
g = growth rate of per capita consumption;
ρ = rate of pure time preference; and
i = consumption rate of interest.

1/ Given the formula for the CRI in equation 13), the implied rate of pure time preference is 2% for Economy II. Thus, Economy I displays a higher preference for quick-yielding projects than Economy II.

28. It will be recalled that the ω's are the weights which indicate the value of private sector consumption (measured at domestic prices) in terms of our chosen numéraire, public income (measured in terms of foreign exchange). From Table 5 we see that Economy I's greater concern with growth is reflected in a relatively low weight for average consumption vis-à-vis public income (i.e. a weight of 0.50 in Economy I compared to 0.67 in Economy II); on the other hand, Economy II's greater concern with income distribution is reflected in the wider spread of its consumption weights for different relative consumption levels as compared to those for Economy I.

29. Thus, the choice of n and ρ affects the determination of the weights in two ways:

i) the higher n and ρ (i.e. the higher the CRI) the greater the discount attached to future consumption and hence the smaller the value of investment (public income) in terms of current consumption. Other things being equal, the higher the values for n and ρ, the higher the value of the weight assigned to average consumption; and

ii) the higher n, the greater the emphasis on the current redistribution of income. Other things being equal, the higher the value for n, the greater the spread of the weights.

This twofold influence of the weights has significant implications for the critical consumption level, i.e. the level of private sector consumption at which additional consumption is considered as valuable as additional public income. With a high value for the CRI one expects v to be small and with a high value for n one expects the spread of the d's to be large. It follows that, whilst v may be considerably larger than d for relatively high consumption levels, as one moves down the income scale d will increase rapidly so that the critical consumption level (which is determined by the condition $d = v\beta$) will occur at a higher relative consumption level than if v is large

(requiring a low value for the CRI) and the spread of the d's is small (requiring a low value for n). Thus, the critical consumption level for Economy II (CRI = 10%, n = 2) is 91% of the average consumption level whereas that for Economy I (CRI = 5%, n = 0.5) is only 39% of the average level. The determination of the critical consumption level in this manner is a useful check on the plausibility of the value for v and the spread of the weights. Finally, note that the inclusion of an income distribution objective does not mean that growth is abandoned: in fact, even in Economy II investment (public income) is worth more than consumption at the average level. On the other hand, growth is not considered to the exclusion of income distribution: in fact, even in Economy I, consumption of the poorest group (those enjoying a consumption level less than 25% of the average level) is worth more than public investment. Consideration of growth and income distribution objectives does not mean the exclusion of either but does require a careful specification of the government's preferences in this respect.

Implications for Project Selection

30. We can now examine the significance of using such a system of weights in project selection. The two important points to remember are that

i) if v is high (i.e. public income is considered very scarce), then projects which "save" or "generate" public revenue will be favored; and

ii) if the spread of the d's is large (i.e. income distribution is an important objective) then projects which benefit the poor rather than the rich will be favored.

It is not possible to draw more precise conclusions about the sectoral allocation of investment which would result from the systematic use of such weights but one can make generalizations of the following kind: Projects which make heavy demands on scarce public funds (e.g. most infrastructure projects) will only be justified

if they charge high prices or other user charges (thereby replenishing the government's coffers) or if they benefit the poor either through employment or price reductions; the justification of projects in the private sector (e.g. DFC's) will be eased to the extent that the government reaps part of the benefits through the fiscal system and/or the firms have high reinvestment rates. The examples illustrate that the consistent use of such a system of weights will ensure that the government's revenue position is not eroded and will also bias the selection of projects in favor of those that benefit the poor and against those that benefit the rich. Although one should not expect in practice to estimate these weights with any degree of rigor, it would seem preferable to make rough estimates than to accept the traditional Bank approach and set all weights equal to unity.

Accounting Rate of Interest (ARI)

31. We have defined v (see equation 4)) as the value of public income measured in terms of foreign exchange (i.e. W_g) divided by the value of consumption at domestic prices at the average level of consumption ($W_{\bar{c}}$). From this we can derive a relationship between the rates of change of v, W_g and $W_{\bar{c}}$. As discussed in Appendix I, this provides an interesting relationship between the ARI and the CRI, but unfortunately this is not very helpful as a basis for estimating the ARI. A more promising approach is to remember that the purpose of the ARI is to allocate public investment funds to their socially most desirable uses.

32. If the ARI is set too low, demand for public investment resources will exceed supply, since too many projects will have a positive NPV. If the ARI is set too high, too few projects will pass the test of a positive NPV and there will be an excess supply of public investment funds. In principle, the ARI should be chosen such that the demand for public investment resources just exhausts the

available supply. It follows that the ARI is the internal social rate of return on the marginal project in the public sector. Recalling that q measures the marginal return to public investment measured in terms of foreign exchange, we can express the ARI as

$$ARI = q - h \qquad 15)$$

where h adjusts for the distributional impact of public investment on the private sector. This expression for the social rate of return recalls the basic equation for a social price (equation 1)) with q representing the efficiency price and h representing the distributional impact. Thus, if public sector investment leads to increased private sector consumption as a result of an increase in the wage bill, h would equal the difference between the foreign exchange cost of that consumption and its corresponding social benefit. Only if either the entire return (i.e. q) accrues to the government or the costs and benefits of any income accruing to the private sector are exactly offsetting, will the ARI equal capital's marginal product, the traditional Bank discount rate.

Traditional Bank Practice

33. Traditional Bank practice rests on either of two assumptions (cf. para. 14). The first is that the fiscal system is able to redistribute income to the extent necessary to make, at the margin, all the distributional impact weights approximately zero. Project selection should then aim to maximize aggregate income and project analysis need only be concerned with efficiency prices.[1/] If this is not an acceptable assumption, then one must resort to the assumption that the government is indifferent

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1/ With a large project one would need to change taxes simultaneously in order to ensure that all the weights remain zero.

to the distribution of project benefits both between different consumers and between consumption and investment, so that once more the maximization of aggregate income is the appropriate objective for project selection. The value judgments implicit in this approach are:

i) $n = 0$, thereby removing the need for the pure income distribution weight (i.e. all $d = 1$ as shown in Table 1); and

ii) ρ (the rate of pure time preference)[1/] $= q$, thereby ensuring that the value of a marginal increase in private consumption exactly equals its cost in terms of foregone public income (see para. 23).

In words, the approach implies a zero rate of diminishing marginal utility ($n = 0$) and a rate of pure time preference equal to the opportunity cost of capital ($\rho = q$). If these are the value judgments underlying traditional Bank practice, then Bank practice may be viewed as a special case of the more general methodology outlined in this Annex. Other special cases are also covered,[2/] but none of these, including that traditionally employed by the Bank, should be accepted without careful consideration and justification.

1/ From equation 14) the required condition is $i = q$, but, given $n = 0$, this becomes $\rho = q$.

2/ For example, if the government is not interested in the interpersonal distribution of consumption but is anxious to increase investment, the relevant assumptions are $n = 0$ (so that $d = 1$ for all consumers) and $\rho < q$ (so that the social benefit of increased consumption is less than its cost in terms of foregone public income). In this version, benefits which are consumed will receive a lower weight than benefits which are invested or which accrue to the public sector, but there will be no differentiation of benefits amongst consumers.

III SHADOW WAGE RATES

34. Thus far, we have shown how one may calculate weights which reflect the basic subjective trade-off between growth and income distribution. This, however, is only part of the estimation of shadow prices and in this section we turn to the other elements of the shadow price, i.e. the foregone output or opportunity cost and the increase in income (if any) accruing to the factor of production. As an illustration we consider the shadow wage rate (SWR) but the principle is perfectly general. One general point must be stressed at the outset: shadow prices for labor will vary considerably depending on such factors as skill and location. We will present a general discussion of these factors and then conclude with a specific illustration of one shadow wage rate which, however, may have a fairly wide application.

Foregone Output

35. The use of labor in a project prevents its use elsewhere. The foregone output of this labor in its best alternative use is a major component of the social cost of using that labor, since productive efficiency is presumably a basic objective of policy. We need, therefore, an estimate of output foregone. If the market for the type of labor concerned is reasonably efficient, then the market wage gives a good measure of the marginal product of that labor at market prices (m) as well as the foregone output. In general, this is a good approach for estimating the foregone output of skilled labor, but labor markets for unskilled labor may also be sufficiently active, even in rural areas, to permit the use of this method. Unskilled labor may be drawn from family farms (as is often the case in rural areas), but it is still acceptable to estimate its marginal product by the going (rural) wage rate provided that the labor market is fairly active and that, at the

margin, the family farms generally participate in that market. Note here that the relevant labor market and wage is not where the labor is to be employed but where it comes from. If rural labor is drawn into, say, industrial employment, with industrial wages well above rural ones, the question is whether rural wages form an acceptable measure of output foregone; the higher industrial wage may or may not reflect labor's marginal product in industry, but it is certainly no yardstick of labor's marginal product in agriculture. In all these cases, the estimate of labor output foregone at market prices may need further adjustment by means of an accounting ratio (α) to obtain its value at border prices.[1/]

36. The estimation procedure of para. 35 relies on the equality of the foregone output and labor's marginal product, and of the marginal product and the market wage. This approach is not always suitable or feasible. For example, if more than one rural worker migrates to the urban sector in response to the creation of only one job in that sector, the foregone output will be greater than one worker's marginal product. Whether this is a serious complication is as yet a moot question. For the many Bank projects situated in rural areas the problem probably does not arise, but if there is good reason to believe that an urban project will have an "excess migration" effect then some attempt should be made to assess its cost.

37. If the relevant labor market is imperfect then it is not correct to equate the foregone output with the market wage concerned. Imperfect markets may often be encountered in rural areas especially in the slack agricultural seasons.

1/ For some categories of labor, especially semi-skilled & skilled labor, it may not always be possible to identify the nature of the foregone output even though it is safe to assume that the market wage paid, both in the project and elsewhere, is a good measure of the market value of the foregone output. In other words, it may not always be possible to identify the appropriate accounting ratio, in which case it will be necessary to resort to a "standard conversion factor" (see para. 59)

Frequently, the market wage will be above the supply price of labor (i.e. the wage at which labor is willing to work [1]), which imples that there is a labor surplus in the area. Output foregone when employing workers from the area is less than the market wages prevailing there. However, output foregone is not necessarily zero. For example, the "unemployed" labor may occupy themselves with some form of self-employment, such as house repair or fishing. Even if there is no foregone output at all in the slack season, it may be expected that the labor force will be more or less fully employed during the peak agricultural season. In determining foregone output, and hence the cost of labor it is necessary, therefore, to specify the season(s) for which the labor is required. Moreover, the labor surplus may disappear over time, especially if the area experiences a reasonable rate of economic development. Hence, if the labor is required for a project lasting twenty years, it may be misleading to assume that currently surplus labor will have a zero foregone output over the whole life of the project. This is one aspect of the general problem of predicting future prices for the purpose of project analysis.

38. Lastly, in some rural areas there is no labor market. On family farms which do not hire, or hire out, workers, labor will be employed up to the point where the marginal product equals the disutility of extra work (i.e. the value of foregone leisure). Removing one worker will mean an immediate loss of output equal to that worker's marginal product. But, assuming diminishing returns, the removal of one worker will increase the marginal product of the remaining members of the family who will therefore increase their work input up to the point where marginal product again equals marginal disutility of effort. If this marginal

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1/ This is further discussed in the next subsection, para. 39 ff. Here we are only concerned with foregone output.

disutility is constant over the relevant range of hours worked per man, the net effect on output will be zero. On the other hand, if the marginal disutility rises sharply with extra work, the remaining family members will hardly increase their working hours and the net foregone output will approximately equal the marginal product of the removed worker. In general the foregone output will be somewhere between zero and labor's marginal product.[1/]

Disutility of Effort

39. A new job frequently calls for an increase in effort on the part of the worker either because he has to work more hours or because the work is more arduous. The disutility of this increased effort can be measured by the difference between labor's supply price for the new and the old jobs. This supply price is the wage that must be paid to induce the worker into a particular employment and reflects his private evaluation of all its aspects, pleasant and unpleasant. In a perfect labor market, the supply price of labor equals the market wage. In imperfect markets, however, the market wage will exceed labor's supply price, so that wage differentials are a poor guide to differences in supply prices for different occupations. This may often be the case in LDC's, especially with respect to the transfer of labor from the rural to the urban sector. In such cases one needs to resort to a direct assessment of any disutility of effort that may be involved in a new job. For labor on family farms, in an area without an active labor market, changes in marginal labor product provide a rough estimate of changes in supply

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1/ Note that similar complications arise, even with a perfect labor market, if the project's demand for labor is so large as to affect the wage level. Output foregone in that case depends on the elasticity of labor response to higher wages in the area. Wages are then not a good measure of output foregone (cf. discussion of accounting prices, in Appendix I, para. 18)

price and increased effort (see para. 38 above). Finally, the supply price of an unemployed man is not necessarily zero. There is considerable evidence that unemployed labor cannot be tempted into employment below a (subsistence) wage of three kilograms' grain equivalent per day. In some cases it may be possible to ascertain the specific minimum or "reservation" wage necessary to activate the unemployed in any particular area; otherwise this "universal" subsistence figure may be used.

40. Crude estimates of the disutility of increased effort probably suffice in practice. For example, if the labor for a project is drawn from full-time employment, it is often reasonable to assume that there is no increased effort involved. For previously unemployed labor a rough estimate of the "reservation" wage, as indicated above, will give an acceptable measure of the disutility of effort. Where more information is available, the estimates can be improved. The resulting value will be a measure of the private cost of increased effort in terms of the additional income which is required to just offset that increased effort. The government, however, may not regard the private cost of increased effort as an accurate measure of its social cost.[1/] In some cases, the additional income received may more than offset the increased effort. Let E be the ratio of the wage earner's own evaluation of the disutility of effort to his additional income and ϕ be the ratio of the social to the private evaluation of the disutility of effort. Then the social cost per unit of additional income is ϕE. If the government costs

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1/ Note that given a welfare function which only includes consumption, it is not strictly correct to introduce the disutility of effort or the value of leisure into the SWR. Theoretically, one would have to redefine the welfare function to include leisure and then deduce a new set of shadow prices. However, one might expect that the SWR would be the only price affected to a significant extent.

increased effort in the same way as the private individual, then $\phi = 1$. However, in its desire for development narrowly interpreted as increased consumption, the government may not consider increased effort as a cost, in which case $\phi = 0$. Intermediate values can also be used. If $E = 1$ then the increased income for the wage earner is exactly offset by the increased effort; if $E = 0$, then there is no private cost of increased effort.

Changes in Income

41. Employment on the project frequently involves changes in income especially if the labor is drawn from the rural sector. In general, a shift in employment of industrial/skilled workers does not result in increased labor income, so the following discussion mainly applies to unskilled rural labor. The transfer of one worker from rural un(der) employment to full-time employment on a project has different effects on income depending on whence he comes. If the labor is drawn, directly or indirectly, from an area with an efficient labor market, then the increase in income will equal the difference between the new wage and the wage in the alternative employment. If the laborer is landless, this increase in income will accrue solely to him: if the wage in the new job is w, then the increase in his income is (w - m), where m is the marginal product in his previous employment which, in an efficient labor market, equals the rural wage. Note, however, that for farm family labor part of the increase in income may accrue to the transferred worker's family, and that for labor transferring from the rural to the urban sector part of the increase in income may be offset by higher prices and other increased living costs.

42. The changes in income should be adjusted to obtain their social cost/benefit. This will depend on the proportions consumed and saved and on the disutility

of effort. For simplicity assume that private savings are considered as socially valuable as public income (but see para. 26) so that we can net out both saving and any direct taxation. Assume that the remaining portion (C) of the initial increase in income is spent on a basket of commodities for which the relevant accounting ratio is β (see para. 15). Thus, the foreign exchange cost of the increased consumption is βC. We now wish to measure the social benefit of this consumption. If we treat leisure as a consumption good then the private value of the increase in consumption is $C(1 - E)$ where E is the ratio of the private value of foregone leisure to the market value of consumption. Two adjustments are required to obtain the social value of this increased consumption; firstly, E must be adjusted to reflect the social value of foregone leisure (see para. 40); and secondly, the resulting value of consumption, $C(1 - \phi E)$, must be weighted by the relevant ω or d/v (see paras. 9-12). We thus obtain a social value for the increased consumption of $C(1-\phi E)\omega$ and a net social cost of $C\{\beta-(1-\phi E)\}\omega$. The numerical implications of this result will be examined for a particular case in the following four paragraphs.

The SWR: an illustrative example

43. We can now insert the various elements of the SWR into the basic formula for the social price, which was written in equation 2) as

$$\text{Social Price} = \text{Efficiency Price} + C(\beta - \omega)$$

The efficiency price, or opportunity cost of labor, has been discussed in paras. 35 to 38, the change in income in paras. 41 and 42 and ω and β have been discussed in paras 9 to 30. In the particular case of the SWR we have an additional element in the form of the disutility of increased effort (see paras. 39 to 40). From the discussion, it should be apparent that the various elements of the formula depend

on the type of labor, i.e. we must estimate a SWR for each particular type of labor. Consider the case of an unskilled worker being drawn from a perfect labor market into employment which pays a fixed wage (w) which exceeds the foregone marginal product (m). If the worker consumes the entire increase in income then, using the notation already established,

$$SWR = m\alpha + (w - m)\{\beta - (1-\emptyset E)d/v\} \qquad 16)$$

where $m\alpha$ is the foregone output measured at border prices (i.e. the efficiency price), $(w - m)$ is the increase in consumption measured at market prices which is multiplied by an accounting ratio, β, to obtain the cost to the government in terms of foregone foreign exchange and a weight, $(1 - \phi E)d/v$, reflecting both the social evaluation of foregone leisure and the social value of increased consumption.

44. It is useful to consider further the implications of certain critical values of the parameters, or of certain simplifying assumptions that may be appropriate:

(i) Set $d/v = \beta$ (i.e. the government is indifferent about the distribution of income between the private and public sectors) and

set $\phi = 0$ (i.e. the social cost of increased effort is zero). Then

$$SWR = m\alpha \qquad 17)$$

This SWR only measures foregone output (in terms of accounting prices) and is a good starting place for the examination of alternative assumptions.

(ii) Let $v \to \infty$ (i.e. the government does not value private sector consumption), then

$$SWR = m\alpha + (w - m)\beta \qquad 18)$$

This SWR would be appropriate if the government's sole aim is to maximize growth. Equation 18) can be rewritten as

$$SWR = w\beta + (\alpha - \beta)m$$

The factor $(\alpha - \beta)$ adjusts the marginal product so that it reflects accounting rather than market prices (see Section IV below). α is applied to m when it is viewed as output: β is applied to m when it is viewed as consumption goods bought with the income represented by m. If $\alpha = \beta$, then the SWR = $w\beta$, i.e. the consumption cost of the market wage paid on the project (in terms of accounting prices).

(iii) Set d and v equal to specific values based on the country's income distribution and growth objectives and set $\phi = 0$. Then,

$$SWR = m\alpha + (w - m)(\beta - d/v) \qquad 19)$$

(iv) Set d and v equal to specific values and set $\phi = 1$. Then,

$$SWR = m\alpha + (w - m)\{\beta - (1 - E)d/v\} \qquad 20)$$

This SWR considers the social cost of private effort on a par with other costs and benefits. The SWR will be lower if ϕ is set at a level less than unity, reflecting a judgment that the government does not consider increased private effort as much of a cost as output foregone or consumption.

45. In the past, Bank appraisals have usually assumed that the SWR equals the foregone marginal output at market prices i.e. SWR = m. In other words, the implicit assumptions have been:

(i) the government does not regard increased effort as a social cost so that $\phi = 0$;

(ii) the distribution of consumption is considered optimal or the government does not wish to use project selection to influence the existing distribution so that $d = 1$;

(iii) public income is considered as valuable as private consumption both measured in terms of foreign exchange so that $v = 1/\beta$;

(iv) the market price of the foregone output reflects the social value of that output so that $\alpha = 1$, and

(v) the foregone output equals labor's marginal product.

Example

46. Assume the following best estimates of the parameters required for the SWR given by equation 16):

$$m/w = 0.5 \qquad \bar{c}/w = 1.0 \qquad E = 0.5$$

$$\alpha = 0.9 \qquad \beta = 0.8$$

$$n = 1 \qquad \phi = 0.5$$

$$v = 3$$

where $\bar{c}$ is the average per capita consumption level. Note that if the wage is supporting more than one person, it should be transformed into per capita terms, this being the relevant concept for comparison with $\bar{c}$. Given the value of n and the ratio $\bar{c}/w$, the distribution parameter, d, can be determined from Table 2.[1/] The value of v implies that public income is considered four times as valuable as average consumption. Using the formulas given in paras. 43 and 44, the alternative SWR estimates are:

1/ The value of d is taken from Table 2 using a value of $c_1 = m$ and and $c_2 = w - \phi E(w - m)$.

(i) Using equation 17)

SWR = 0.5 x 0.9 w = 0.45 w

(ii) Using equation 18)

SWR = (0.45 + 0.5 x 0.8)w = 0.85 w

(iii) Using equation 19)

SWR = (0.85 - 0.5 x 1.4/3)w = 0.62 w

(iv) Using equation 20)

SWR = (0.85 - 0.5 x 0.5 x 1.6/3)w = 0.72 w

(v) Using equation 16)

SWR = (0.85 - 0.5 x 0.75 x 1.1/3)w = 0.71 w

In this particular example the smallest SWR occurs when one only considers foregone output (equation 17)) which is the traditional Bank approach. If one then treats the increased consumption as a pure cost (equation 18)) we obtain the maximum SWR. Recognizing that consumption does have some value (equation 19)) reduces the SWR, but the inclusion of the disutility of effort (equation 20)) again raises the SWR. Finally, if the government only costs part of the disutility of effort (equation 16)) we arrive at a slightly lower SWR.[1/]

Other Factor Incomes

47. The discussion of the SWR showed how the increased consumption out of wage income generated by employment should be weighted to reflect both its foreign exchange cost to the government and its social value either as consumption or savings. All increases in income attributable to the project, from profits, rents, consumer surplus, should be treated in a similar manner, but four points should be borne in

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1/ Note that it is quite possible to obtain a SWR which is lower than labor's foregone output, especially if the labor involved remains poor even after the increase in income (i.e. if $c_2 < \bar{c}$.)

mind. Firstly, the value of d will vary with the existing level of the individual's consumption. For example, one might want to attach a high weight if the increased consumption accrues to peasant farmers and a very low weight if it takes the form of profits paid out to the rich. Secondly, one should only consider increases in income. For example, if it is reasonable to assume that a rentier will receive the same interest payment wherever he invests his capital, then investing in a government project will not imply any increase in income and hence consumption and/or savings. Thirdly, some increases in income may appear on the cost side and some may appear on the benefit side. In the SWR case, the increased income was included on the cost side. If, however, one wanted to transfer it to the benefit side, a change in sign is all that is required. In other words, the numerical value of the weight is not affected by the transfer but the sign must be changed. And, finally, note that distributional weights are not applied to the output or sales generated by the project, but only to the increases in income to which it gives rise. In other words, the benefits of a project are not greater because its output is sold to the poor rather than the rich (unless sales to the poor involve subsidies, i.e. income transfers). What matters is whether their consumption (income) increases because of the project.

Consumer Surplus

48. Consumer surplus is usually defined as the area below the demand curve and above the price line. A reduction in the price of a commodity causes an immediate gain to consumers represented by the quantity they consume times the price reduction. In addition, the price reduction may also induce consumers to buy more of the commodity and this will again lead to an increase in consumer surplus (i.e., the small consumer surplus "triangle"). The total increase in

consumer surplus should be treated as a benefit and as such needs to be weighted by the appropriate d/v in order to express it in terms of our chosen numeraire. The reallocation of expenditure may also involve a foreign exchange cost or benefit, depending on whether the elasticity of demand is greater or less than one. If the elasticity is greater (less) than one, then the reduction in price will reduce (increase) expenditure on that commodity, thereby increasing (reducing) the foreign exchange cost of higher (lower) consumption of other commodities. Note that we do not include the foreign exchange cost of the commodity whose price has been reduced because generally this commodity will be the output of our project and hence its costs of production will appear as project costs.

IV COMMODITY PRICES

Accounting Prices for Traded Commodities

49. It is convenient to distinguish three categories of tradables:

(i) Commodities which, at the margin, are being imported (exported) and for which the elasticity of world supply (demand) is infinite.

(ii) Commodities which, at the margin, are being imported (exported) and for which the elasticity or world supply (demand) is less than infinite.

(iii) Commodities which are not currently being traded but which ought to be traded if the country adopted "optimal" trade policies.

Each category will be discussed in turn.

Infinite Elasticities

50. Imported commodities falling in category (i) should be valued/costed at the c.i.f. border price, plus the relevant marketing margin revalued at accounting

prices.[1] Similarly, exported commodities falling in this category should be valued/costed at the f.o.b. price, minus the relevant marketing margin revalued at accounting prices.[1]

51. The rationale of this treatment is straightforward. The impact of an increased demand for, or increased supply of, such commodities is solely on trade. The infinite elasticity assumption ensures that domestic prices and hence domestic consumption and production remain unchanged. Thus, the production of imports (i.e. import substitution) or exports (i.e. export promotion) increases the availability of foreign exchange by an amount equal to the quantity produced times the relevant border price. Projects which demand imports or exports have the reverse effect. It is important to note three points concerning the use of border prices. Firstly, project demand may be supplied by domestic sources rather than imports. However, provided the local and imported product are equivalent[2] and provided the elasticity of foreign supply is infinite, then, at the margin, the impact will still be on trade because other domestic users will now have to switch from domestic supplies to imported supplies. Secondly, the use of border prices implies that commodities are valued/costed directly in terms of our chosen numeraire, uncommitted public income measured in terms of foreign exchange.[3] This is an additional

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1/ This revaluation is an aspect of the general revaluation of non-traded commodities and will be discussed in paras. 56-59. It is recommended that the marketing margins be kept separate and then be converted en bloc into accounting prices at the end of the exercise.

2/ Formally, the condition for perfect substitutes is infinite cross-elasticities of demand.

3/ As explained earlier, the border prices should be expressed in units of the domestic currency. See para. 8.

reason for the selection of this particular numeraire. And lastly, the use of border prices does not require the assumption of free trade; for example, a commodity subject to a high import tariff should still be valued/costed at its c.i.f price provided it is imported (i.e. the tariff is not prohibitive) and provided the elasticity of foreign supply is infinite (i.e. domestic prices are not affected).

Finite Elasticities

52. If a project causes an increase in the demand for or supply of commodities falling in category (ii), there will be a change in the border price which will have repercussions on domestic consumers and producers. Most LDCs are too small to influence the border prices of importables so the following discussion is couched in terms of an increase in supply of an exportable for which the world demand is less than perfectly elastic. In this case it is still necessary to establish the relationship between the border and domestic price, but in principle a further adjustment is now required to allow for the transfers of income caused by the price change and the effects on foreign exchange. This includes the social value and (foreign exchange) cost of changes in producer and consumer income plus the foreign exchange effects of a lower price for existing exports and of switches in domestic production and consumption. In practice, it may be sufficiently accurate to only consider the direct foreign exchange effect and ignore the income transfers. The appropriate accounting price is then the marginal export revenue which may be expressed as the border price times $(1 - 1/\eta)$ where η is the elasticity of foreign demand defined so as to be positive.[1/] By analogy, the appropriate accounting price

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1/ Note that if foreign demand is perfectly elastic (i.e. $\eta \to \infty$), then the correct accounting price is the border price, as prescribed for commodities falling in category (i).

for an importable is the marginal import cost which may be expressed as the border price times $(1 + 1/\varepsilon)$ where ε is the elasticity of foregin supply.[1/]

Potentially Traded

53. Category (iii) includes commodities which are not currently being traded but which "ought" to be traded if the country adopted "optimal" trade policies. This applies to industries which produce behind prohibitive tariffs or quotas and for which the marginal cost (at accounting prices) of increasing domestic production exceeds the cost of importing. In the evaluation of projects which use inputs supplied by such industries the evaluator faces a dilemma. On the one hand, he does not want to jeopardize the project by pricing the input at the marginal cost of inefficient domestic production when, in the absence of the protective barrier, the input could be imported at a much lower cost; on the other hand, he does not want to use the (relatively) low border price if in fact the input will be supplied by a high cost domestic producer. The solution is to predict the actual source of supply, and to price the input according to the cost of that supply. However, the presumption should be that the predicted supplier will be the lowest cost supplier, and that the government can be persuaded to lower the prohibitive tariff (or remove the quota) so that at the margin the input is actually imported.[2/] If this proves impossible, the government may permit at least the project access to imports, thereby making the input an importable for the purposes of the evaluation.

1/ Note that if foreign supply is perfectly elastic (i.e. $\varepsilon \to \infty$) then the correct accounting price is the border price, as prescribed for commodities falling in category (i).

2/ What matters is not whether the project imports its inputs, but whether the demand from the project leads to additional imports to meet the increase in domestic demand.

If, despite all efforts, it is clear that the project will be supplied by the high-cost domestic producer, the input should be regarded as a non-tradable (see paras. 56-59). Note, however, that production may take place behind a high tariff, while at the margin additional demand, e.g. for the project, is met by imports; the inputs should then be treated as traded.

54. There is one important exception to this general prescription. Some industries are afforded temporary protection during their early development, whilst their efficiency is being increased to a level which will permit them to compete successfully against imports. Such industries should be encouraged. It is recommended, therefore, that if an infant industry is clearly identifiable, project demand should be supplied by that industry but the input should be costed at its border price in order not to jeopardize the project being evaluated. However, caution should be exercised in deciding whether a protected industry can be considered in its infancy. Frequently, import substitution industries never become competitive with imports; each case must be examined on its merits.

55. Similar comments apply to the valuation of a project's output which, although potentially importable, is not currently being imported at the margin because of high import tariffs or quotas. Every effort should be made to persuade the government to remove the protective barrier (unless the infant industry argument applies) so that the output can be treated as a tradable. If this fails, the output should be regarded as a non-tradable and valued accordingly (see paras. 56-59). In such cases it is a useful additional exercise to evaluate the project as though its output were tradable. If the project is still profitable when the output is valued on the basis of the c.i.f. price, then the project will survive even if at some future date the protective barrier is removed. If the project is not profitable at border prices, then the excess cost of domestic production (properly assessed)

over the cost of imports measures the cost of retaining the protective barrier. The government should be made fully aware of the cost that will be incurred if they proceed with the project rather than lower the protective barrier to permit imports.

Accounting Prices for Non-Traded Commodities

56. Non-tradable commodities are defined as having a domestic supply price, at the given level of local demand, below the c.i.f. price of imports but above the f.o.b. price of exports.[1/] Depending on the elasticities of supply and demand, an increase in demand for non-tradables on account of the project will be satisfied by decreased consumption elsewhere in the economy and/or increased production. If the main source of supply is increased domestic production, without a significant price increase, it is recommended that the accounting price be interpreted as the marginal social cost (MSC) of increased production. Alternatively, if the main source of supply is reduced consumption elsewhere, with a significant price increase, it is recommended that the accounting price be interpreted as the foregone marginal social benefit (MSB) in consumption. In the long-run, it may be reasonable to assume that demand is primarily met by increased production but in the short-run, especially for capital intensive non-tradables, the supply may be relatively fixed.

Estimating MSC

57. The MSC of a non-tradable is determined as follows: decompose the non-tradable into its constituent inputs and value each input at its accounting price. Some of these inputs will be tradables with accounting prices determined in the manner described in paras. 50-55. Others will be primary factors, with

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1/ This definition should also include commodities which are potentially tradable but actually non-tradable because of trade barriers. See paras. 53-55.

shadow prices determined in the manner described for labor (see paras. 34-46). The remaining inputs will themselves be non-tradables, which in turn must be evaluated through a further round of decomposition, until, eventually, everything is expressed in terms of tradables and primary factors. The degree of sophistication required will depend on the case in hand and the availability of time and data.

Estimating MSB

58. If demand is met by decreasing consumption elsewhere, the accounting price is the MSB which may be calculated by observing the benefits foregone as a result of project demand. For intermediates, one wants an estimate of the social profit foregone and, for commodities entering final consumption, one wants an estimate of the loss in consumer surplus appropriately revalued in terms of our numeraire (see para. 48). In addition, for both types of commodity one should allow for any reallocation of expenditure induced by the price rise. Only if the elasticity of demand is unity (i.e. total expenditure on the commodity both before and after the price rise is the same) will this effect be zero. If the elasticity is greater (less) than unity, then the price increase will increase (reduce) expenditure on the commodity, thereby reducing (increasing) the foreign exchange cost of expenditure on other commodities. Finally, the price increase will cause a transfer of income from consumers to producers equal to the original quantity demanded times the change in price. The social cost/benefit of this transfer will depend on the weights appropriate to the income groups involved. These weights must be derived in the manner described in paras. 11-13. If it is thought that in general producers are richer than consumers the net effect of the transfer would constitute a social cost, but if producers and consumers are indistinguishable it will be reasonable to assume that the transfer has a zero net social cost.

Standard Conversion Factor (SCF)

59. Whilst in general it is recommended that one estimate a different accounting price for different non-tradables, it is useful to have available a standard conversion factor (SCF) which can be used for minor non-tradables or for the non-tradables remaining after one or two rounds of decomposition. For this purpose, one might use the ratio of the value at border prices of all exports and imports to their value at domestic prices.[1/] As such, the SCF bears a close relationship to the more familiar concept of the shadow exchange rate (SER). The precise relationship is

$$SCF/OER = 1/SER \qquad 21)$$

where OER is the official exchange rate. Thus, the SCF translates domestic prices into border prices expressed in units of the domestic currency, and division by the OER expresses the result in units of foreign exchange. The SER combines these two steps.[2/]

Dependence on Policy Assumptions

60. The shadow prices are sensitive to the assumptions made about the future development of the economy and, in particular, of trade policy. Changes in tariffs, quota-restrictions and the exchange rate will affect the accounting ratios and the remuneration of primary factors as relative (domestic) prices change and resources

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1/ Imports subject to fixed quotas should be treated as non-tradables in perfectly inelastic supply provided that the quotas are already fully used and are not expected to be relaxed in the near future.

2/ Note that β, the ratio of the value of a basket of consumption goods at border prices to its value at domestic prices, may also be interpreted as the accounting ratio for a non-tradable (i.e. consumption). One could, therefore, with some loss of accuracy, use the SCF for all consumption baskets rather than estimate individual β's. See para. 15.

are reallocated. The range of possible policy scenarios is obviously large. Only two (extreme) alternatives are considered here to illustrate the considerations that should be borne in mind in adjusting shadow prices to expected policy developments.

61. In the first case the country is faced with a balance of payments deficit caused by "living beyond one's means", and domestic factor prices are inflexible. If one envisages a devaluation to cope with this situation, then it may be appropriate to recalculate some of the shadow prices. The border prices of tradables expressed in units of the domestic currency will be increased by a factor equal to the ratio of the anticipated to the current official exchange rate [1/] given that most border prices will remain fixed when expressed in units of foreign currency. Real wages will be reduced in the sense that a fixed money wage can now purchase fewer tradable commodities, thereby securing an immediate improvement in the balance of payments.[2/] In addition, there may be a change in the prices of domestic resources (especially labor) relative to those for tradables which will further improve the balance of payments by making non-tradables more attractive (in both production and consumption) relative to tradables. Note that in terms of our numeraire the SWR will increase because some elements of the formula (see equation 16)) are fixed in terms of physical quantities (e.g. m) and hence foreign exchange but it will not increase as much as the prices for tradables in general because other parts of the formula (e.g. w) are fixed in terms of domestic currency by assumption.[2/] Similarly, the MSC of non-tradables will increase because some of the inputs will be tradables,

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1/ The exchange rate is defined as so many units of domestic currency per dollar.

2/ These comments do not apply to the type of economy which is experiencing successive rounds of exchange rate devaluation and domestic price inflation. As a first approximation one might assume that in such an economy the real exchange rate is constant.

but it will not increase as much as the prices for tradables in general because some of the inputs will be domestic resources such as labour. The information required to trace through these effects is formidable and in practice it may be necessary to ignore the substitution possibilities in both production and consumption and concentrate solely on the immediate (relative) reduction in the cost of consumption when making new estimates of SWR's and MSC's for non-tradables.

62. In the second case the economy is thought to be moving rapidly towards a (relatively) free-trade policy. Assuming there are no sales taxes, market prices will correspond to border prices so that there is no need to estimate a SCF but now one must estimate the free-trade exchange rate, which will depend on the elasticities of domestic supply of exports and demand for improts, which in turn will depend on substitution possibilities in production and consumption. As a first approximation, a convenient simple formula is

$$\frac{OER}{FTER} = \frac{X\varepsilon + M\eta}{X\varepsilon\ (1 - t_x) + M\eta\ (1 + t_m)} \qquad 22)$$

where X is the fob value of exports and M the cif value of imports under protection; ε the elasticity of export supply and η the elasticity of import demand; t_x the average export tax (negative if it is a subsidy) and t_m the average import tax, or the tax equivalent if quantitative restrictions are used; OER the existing official exchange rate and FTER the free trade exchange rate (per unit of foreign currency). The movement to free trade will have a major impact on the economy and hence on shadow prices. Clearly, border prices (expressed in units of the domestic currency) will increase by a factor equal to FTER/OER and all the β ratios will now equal one but the effect on the shadow prices of primary factors is less clear. The removal of distortion-inducing trade restrictions will cause previously protected sectors (whether tradables or non-tradables) to contract relative to previously non-

protected sectors (whether tradables or non-tradables). The ultimate change in the shadow prices of primary factors (including the ARI) will then depend on the distribution of the efficiency gain between the various factors of production.

63. If one confidently expects that a free trade policy will be implemented in the immediate future then considerable care should be taken in estimating both the FTER [1/] and the likely effects on the prices of primary factors. Cruder methods will be appropriate if the intention is simply to test the effects of a free trade policy if such a policy were implemented. t_m and t_x can be set equal to the ratio of total import duties to total imports and of total export taxes to total exports, respectively. If quantitative restrictions are employed to restrain imports or exports, some attempt should be made to calculate tax equivalents. If the country is initially in balance of payments equilibrium, the only estimates required are for the elasticities and M and X. Table 6 shows the sensitivity of the ratio of the OER to the FTER for different assumptions about the elasticities assuming that $t_m = 0.3$, $t_x = -0.05$ and $X = M$.

Table 6

Sensitivity of OER/FTER

ε \ η	1	2	4	6
1	0.85	0.82	0.80	0.79
2	0.88	0.85	0.82	0.81
4	0.91	0.88	0.85	0.83
6	0.92	0.90	0.87	0.85

1/ In particular, it may be necessary to allow for a less than perfectly elastic foreign demand for the country's exports.

The table shows that the higher the elasticity of supply (ε) the higher the ratio OER/FTER and that the higher the elasticity of demand (η) the lower the ratio.[1/] In the event that no information is available on the elasticities, a reasonable approximation is to assume that the elasticities are the same so that they cancel from the formula.[2/] As is apparent from the table, the ratio OER/FTER is not very sensitive to different assumptions about the elasticities.

1/ The result holds as long as $t_m > t_x$ which is probably the typical case.

2/ Note that the resulting formula is then very similar to that for the SCF discussed in para. 59. However, the formula developed in this paragraph includes, in principle, the effects of quantitative restrictions and tariffs whereas that of para. 59 assumes that the quantitative restrictions will be retained and therefore excludes them. Moreover, the SCF allows for sales taxes whereas the FTER only allows for trade tariffs and other restrictions.

APPENDIX I

Table of Contents

APPENDIX I

TECHNICAL DERIVATION OF SHADOW PRICES

I INTRODUCTION

1. The Annex has discussed in fairly general terms the ideas underlying the derivation of shadow prices. The derivation itself, however, was not rigorous, the intention being to present an intuitively acceptable rationale of shadow pricing. Ideally, the complete set of shadow prices should be deduced from a fully specified model of the economy, in which the various constraints are explicitly identified. The general equilibrium approach to shadow pricing has obvious conceptual advantages over partial equilibrium analysis, but the general equilibrium models presently amenable to analytical or numerical solution are necessarily fairly simple.[1/] In the following, the basic ideas are established in very general terms, but for the derivation of individual shadow prices we resort to partial equilibrium analysis.

II DERIVATION OF WEIGHTS

2. The welfare function assumes the following:

i) No consumption externalities, i.e. the individual's utility is assumed to derive solely from his own consumption;

ii) The same utility function is assumed for all individuals and displays diminishing marginal utility with respect to consumption;

iii) Total welfare in any period is the sum of the individual utility levels.

1/ For examples of analytically and numerically soluble models see Stern (1972) and Blitzer and Manne (1974) respectively.

Given these assumptions welfare in period t may be expressed as:

$$W_t = \int_0 U(c)\, f(c)\, dc \qquad 1)$$

$$U_c > o, \; U_{cc} < o$$

where U(c) is the utility from consumption level c and f(c) is the density function of the distribution of consumption. The government is assumed to maximize the following objective function:

$$\text{Max } W = \int_0^{\infty} W_t \; e^{-\rho t} \; dt \qquad 2)$$

where $\rho > 0$ and is the rate of pure time preference.

Shadow Prices

3. The shadow price of the j^{th} commodity or resource in period t=1 ($W_{j,1}$) is defined as

$$W_{j,1} = \Delta W / \Delta Q_{j,1} \qquad 3)$$

i.e., the increase in welfare (ΔW) resulting from a marginal increase in the j^{th} commodity or resource ($\Delta Q_{j,1}$). Typically, one commodity or resource is chosen as numeraire and the shadow prices are then redefined in terms of that numeraire. For example, if we choose the J^{th} commodity as numeraire, then $W_{J,1} = 1$ and the shadow prices may then be redefined in terms of this numeraire as

$$\lambda_{j,1} = W_{j,1} / W_{J,1} \qquad 4)$$

General equilibrium analysis involves the simultaneous solution for all λ_j; in principle, this approach takes into account all changes in prices and incomes

that are engendered by a marginal increase in the availability of any particular resource or commodity given full specification of all the constraints and technological and behavioral relationships. In practice, however, its value for actual project selection is severely circumscribed by the lack of detail and realism in the general models presently susceptible to economic analysis. The alternative approach, and the one adopted here, concentrates on the major price and income effects resulting from a marginal increase in any resource or commodity but stops short of a comprehensive coverage of all the general equilibrium effects on the grounds that the significance of the omitted effects is negligible.

Numeraire

4. We choose as numeraire (i.e., the J^{th} commodity/resource) public income measured in terms of foreign exchange.[1/] The choice of this numeraire permits us to rewrite the formula for a shadow price in the following fashion. For simplicity of exposition, assume that a marginal increase in the availability of the j^{th} resource in period t=1 only affects welfare in period one[2/] so that we can drop the explicit reference to the time period and write

$$\lambda_j = \frac{\Delta W}{\Delta Q_j} \frac{1}{W_g} \qquad 5)$$

where ΔW occurs in period $t = 1$ and $W_g = W_{J,1}$, W_g being the notation adopted in the annex.

If we assume that the change in Q_j is sufficiently small that it does not alter W_g and if we define

$$H = \Delta W - \Delta Q_g W_g$$

1/ This is the numeraire used in Little and Mirrlees (1974). For an alternative formulation using aggregate consumption as numeraire see UNIDO (1972).

2/ This assumption is relaxed in para. 13.

then, setting $\Delta Q_j = 1$ by choice of units,

$$\lambda_j = \Delta Q_g + H/W_g \qquad 6)$$

which says that the shadow price equals the change in the numeraire commodity (public income measured in terms of foreign exchange) plus any change in utility levels in the private sector measured in terms of the chosen numeraire. Note that if an increase in the avilability of any resource or commodity affects private sector consumption then our measure of ΔQ_g must allow for the increased demand for foreign exchange (our numeraire) required to satisfy this increase in private sector consumption. Thus, if $H \neq 0$ (i.e., if utility levels in the private sector are altered), ΔQ_g will include, not only the resource/commodity's direct impact on foreign exchange, but also the indirect effects resulting from changes in consumption patterns and levels. 1/

Outline

5. The remainder of this Appendix derives certain components of the shadow price formula presented as equation 6. In particular, the next six paras. will describe a method of systematically incorporating changes in utility levels (i.e., H/W_g) into the shadow price formula by means of a set of distribution weights. In paras. 12 to 15 we derive the link between this set of weights and the discount rate required for project selection. Finally in paras. 16 to 22 we bring the various threads of the argument together to derive shadow price formulas for tradables and non-tradables.

Distribution Weights

6. If we assume that the increased availability of the j^{th} commodity only has a marginal effect on one consumer's utility (W_c) then $H = W_c$

1/ In the terminology of the Annex, ΔQ_g corresponds to the sum of the efficiency price and βC and H/W_g corresponds to Cd/v (See Annex, equation 7).

Defining $$d = W_c/W_{\bar{c}} = U_c/U_{\bar{c}} \text{ and } v = W_g/W_{\bar{c}} \quad 7)$$

where $W_{\bar{c}}$ indicates the welfare value of consumption to someone at the average level of consumption ($\bar{c}$), we obtain

$$H/W_g = d/v \quad 8)$$

In other words, we will compare different increments in consumption in terms of a consumption numeraire (i.e., the marginal utility of consumption to someone at the average level of consumption) and then translate the consumption numeraire into public income measured in terms of foreign exchange. The public income numeraire is v times as valuable as the consumption numeraire.

Derivation of "d"

7. In order to determine the d weights we must specify a utility function. The function usually selected has the property that the marginal utility of consumption has a constant elasticity (n) with respect to consumption at all levels of consumption. Thus, we may write

$$U_c = c^{-n} \quad 9)$$

where $n \geq 0$ in order that marginal utility be non-increasing. Total utility is obtained by integrating equation 9) i.e.,

$$U(c) = \frac{1}{1-n} C^{1-n} \quad \text{for } n \neq 1$$

$$\text{and} \quad U(c) = \log_e c \quad \text{for } n = 1$$

For infinitesimal changes in consumption

$$d = U_c/U_{\bar{c}} = (\bar{c}/c)^n \quad 10)$$

For non-marginal changes in consumption, we redefine d as

$$d = \frac{U(c_2) - U(c_1)}{U_{\bar{c}} \quad (c_2 - c_1)}$$

where $c_2 > c_1$ which gives

$$d = \frac{x^n (1 - y^{1-n})}{(1-n)(1-y)} \quad \text{for } n \neq 1 \qquad 11)$$

$$d = \frac{x \log_e y^{-1}}{(1-y)} \quad \text{for } n = 1$$

where $x = \bar{c}/c_2$ and $y = c_1/c_2$. 1/

8. The choice of an iso-elastic utility function imparts certain properties to the weights, which properties may be conveniently examined in terms of equation 10. These properties are:

i) The weight on consumption increments at all consumption levels is unity if n = o;

ii) For n > o,

d > 1 if $c < \bar{c}$, and also d increases as n increases,

and d < 1 if $c > \bar{c}$, and also d decreases as n increases;

iii) For any given n > o, d depends only on the proportionality factor $(\bar{c}/c)$ and is independent of the level of $\bar{c}$. This is called constant (relative) inequality aversion. 2/

1/ Equations 10 and 11 were used to derive the numerical values for Tables I and II in the Annex.

2/ Increasing (relative) inequality aversion implies that d increases with $\bar{c}$ for given n. See Atkinson (1970) and Ahluwalia (1973)

Derivation of "D"

9. Some effects of a project on the distribution of consumption may be difficult to trace, too small to bother about or so general that all income classes may be affected. In principle, one whould evaluate the impact on each consumption class and integrate over the affected income classes, i.e.,

$$H/U_{\bar{c}} = 1/U_{\bar{c}} \int_{c_o}^{\infty} U_c \, g(c) \, dc \qquad 12)$$

where c_o is the minimum consumption level and g(c) describes the distribution of the increase in consumption across consumption classes. In practice, one might be able to obtain specific information about g(c) but, in the absence of such, one might assume that the increase in consumption is distributed in the same way as current aggregate consumption, which implies that

$$g(c) = f(c) \, c/\bar{c} \qquad 13)$$

f(c) being the density function of the distribution of aggregate consumption. Assuming that consumption is distributed according to the Pareto function, for which the cumulative distribution function F(c) is

$$1 - F(c) = (c_o/c)^{\sigma}$$

the corresponding density function is given by

$$f(c) = F_c = \sigma \, c_o^{\sigma} \, c^{-\sigma-1} \qquad 14)$$

Inserting equation 14 into 13 and thence 12 gives

$$H/U_{\bar{c}} = D = \sigma \, c_o^{\sigma} \, c^{n-1} \int_{c_o}^{\infty} c^{-n-\sigma} \, dc$$

Noting that for a Pareto distribution, provided $\sigma > 1$,

$$(\sigma-1)\,\bar{c} = \sigma\, c_o$$

we may write $$D = \sigma^n (\sigma-1)^{1-n}\, c_o^{n+\sigma-1} \int_{c_o}^{\infty} c^{-n-\sigma}\, dc$$

$$\text{or} \quad D = \frac{\sigma^n\,(\sigma-1)^{1-n}}{(n+\sigma-1)} \qquad 15)$$

which formula depends only on n, the elasticity of marginal utility with respect to consumption, and σ, the parameter of the Pareto function.[1/]

10. In principle, one can derive a more general formulation of D which allows for changes in distribution. Substituting the iso-elastic utility function and the Pareto density function into the expression for total welfare in any period (equation 1) gives

$$W = \frac{\sigma\, c_o^{\sigma}}{1-n} \int_{c_o}^{\infty} c^{-\sigma-n}\, dc$$

$$\text{or} \quad W = \frac{(\sigma-1)^{1-n}\ \bar{c}^{1-n}}{(n-1)\ (n+\sigma-1)\sigma^{-n}} \qquad 16)$$

If both $\bar{c}$ and σ are allowed to vary, then

$$dW = \frac{\partial W}{\partial \bar{c}}\, d\bar{c} + \frac{\partial W}{\partial \sigma}\, \sigma$$

The required welfare measure (D') is defined as $dW/d\bar{c}$. Noting that $\partial W/\partial \bar{c} = D$, we obtain

$$D'/D = 1 + \eta\, n/(\sigma - 1)\ (n + \sigma - 1) \qquad 17)$$

1/ Equation 15 was used to derive the numerical values for Table III in the Annex.

where $\eta = \bar{c}d\sigma/\sigma d\bar{c}$. We may interpret η as the "elasticity" of σ with respect to $\bar{c}$; if $\eta = 0$, $D' = D$.

Changes in d Over time

11. It should be apparent that the distribution weight, d, for any given increment in consumption may vary over time. For example, suppose we want to trace the growth path of d for a given individual. Assuming that the difference in the growth rates of the average and the individual's consumption level is δ, for an infinitesimal change in consumption, we have in period τ

$$d_\tau = \left(\frac{\bar{c}_\tau}{c_\tau}\right)^n = \left(\frac{\bar{c}_o \rho^{\delta\tau}}{c_o}\right)^n = d_o \, e^{\delta\tau n} \qquad 18)$$

where the subscripts indicate time period. Clearly, if $\delta = 0$, then $d_\tau = d_o$ for all τ. Alternatively, if $d_o > 1$, then d_τ increases over time if $\delta > 0$ and decreases if $\delta < 0$; and if $d_o < 1$, then d_τ increases over time if $\delta > 0$ and decreases if $\delta < 0$. Similarly, the weight for non-marginal increments in consumption may also vary over time.

Consumption Rate of Interest (CRI)

12. Thus far, we have shown how increments in consumption occuring at various consumption levels can be measured in terms of the welfare value of an infinitesimal increment in consumption accruing at the average level of consumption. This can be done in each time period. However, we may also want to compare the value of consumption across time periods. Clearly, given a set of d's for each time period we need only compare the marginal value of consumption at the average level across time periods in order to be able to measure the present worth of any increment in consumption occuring at any consumption level and in any time period.

Accordingly, we define the consumption rate of interest (i) as the rate of fall over time in the value of the marginal utility of consumption at the average level of consumption.[1/] Given our particular utility function the welfare value ($W_{\bar{c}}$) of a marginal increment in consumption accruing at the average level of consumption in period τ is

$$W_{\bar{c}} = \bar{c}_{\tau}^{-n} \; e^{-\rho\tau}$$

where ρ is the rate of pure time preference. The CRI is defined as

$$CRI = i = -\dot{W}_{\bar{c}}/W_{\bar{c}}$$

where the $\dot{}$ indicates differentiation with respect to time, so that

$$i = ng + \rho$$

where g is the growth rate of average consumption.

Derivation of v

13. We may interpret v as the shadow price of public income expressed in terms of a numeraire defined as the welfare value of a marginal increase in consumption accruing to someone at the average level of consumption, i.e.,

$$v = \Delta W/W_{\bar{c}} = 1/W_{\bar{c}} \int_0^{\infty} \Delta W_t \; e^{-\rho t} \; dt$$

The precise derivation of v depends on the assumed economic environment. For

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1/ In principle, one can define a CRI for any consumption level. See Ahluwalia (1973). In UNIDO (1972) the CRI is defined as the rate of fall over time in the value of aggregate consumption and in Little and Mirrlees (1974) as the rate of fall over time in the value of employment-generated consumption.

example, one might assume that at the margin all public expenditure is either assigned to investment or to uses which are as socially valuable as investment. In this case, v may be interpreted as the shadow price (in terms of the consumption numeraire) of both public income and public investment. One can then proceed as follows. Assume that a unit of public income (measured in terms of foreign exchange) assigned to investment produces an annual return net of depreciation of q. Assume that out of this return s is reinvested[1/] and (1-s) is assigned to private sector consumption either directly, through factor payments, or indirectly, through public current expenditure. We can now derive v by summing the present value of the return in each period, i.e.,,

$$v_o = \sum_{t=o}^{\infty} (1-s_t)q_t G_t \prod_{t=1}^{t}(1 + s_t q_t) / \prod_{t=o}^{t} (1 + i_t) \qquad 19)$$

where the subscripts indicate time periods, G_t is the value of a unit of non-reinvested benefits in terms of the consumption numeraire, and Π indicates multiplication. Thus in period t the capital stock, growing at a rate of $s_t q_t$, will equal

$$\prod_{t=1}^{t} (1 + s_t q_t);$$

that portion of the return which is not invested has a value in period t in terms of the consumption numeraire of $(1-s_t)q_t G_t$ times the then existing capital stock; the present value of non-reinvested benefits in period t is obtained by application

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1/ For simplicity, we assume that all reinvestment occurs in the public sector or that private saving is as valuable as public investment. More complicated formulations which distinguish between private and public reinvestment are described in UNIDO (1972).

of the relevant discount factor, $\prod_{t=0}^{t} (1 + i_t)$, where i_t is the CRI in period t; and finally, summation over all periods gives the required value for v_o.

14. Equation 19 is still too general for estimation purposes (see Appendix II) but does provide some useful insights. Firstly, if $s_t q_t > i_t$ for all t (i.e., if the growth rate of capital exceeds the discount rate), then $v_o \to \infty$; alternatively, if $s_t q_t < i_t$, then the present value of future benefits will become very small as t increases which ensures a finite value for v_o. Secondly, estimates of v tend to be very sensitive to the estimates of sq and i over time especially if $s_t q_t \doteq i_t$ for all t. And thirdly, if all the parameter values stay constant over time and i > sq, then, dropping the time subscript,

$$v = \frac{(q - sq)G}{(i - sq)} \quad \underline{1}/ \qquad 20)$$

The implied constancy of v, however, has certain implications for the discount rate which are discussed in the next paragraph.

Accounting Rate of Interest (ARI)

15. The discount rate is defined as the rate of fall over time in the value of the numeraire (public income measured in terms of foreign exchange). From equation 7

$$\dot{v}/v = \dot{W}_g/W_g - \dot{W}_c/W_c$$

But the ARI = $-\dot{W}_g/W_g$ and the CRI = $-\dot{W}_c/W_c$ so that

$$-\dot{v}/v = r - i \qquad 21)$$

1/ Equation 14 in the Annex was derived from equation 20 by setting s = o and assuming that the entire return accrued at the average level of consumption so that $G = 1/\beta$, the β being required to obtain the increase in consumption at domestic prices made possible by an additional unit of foreign exchange. β is discussed further in para. 22.

where r = the ARI. It follows that if $r \neq i$, then v is changing over time and the use of equation 20 to estimate v must necessarily involve some degree of error. In particular, if $r > i$ (perhaps the typical case), then v is declining over time and equation 20 will overestimate v_o. Whilst equation 21 does not prove useful in estimating the ARI, we can give the ARI a simple interpretation, provided we accept the assumption that at the margin all public expenditure is either assigned to investment or to uses which are as socially valuable as investment.[1/] In this case, the ARI is simply the internal social rate of return on the marginal public sector project, this being the discount rate which ensures a balance between the supply of and demand for public investible resources.

III COMMODITY PRICES

16. We will illustrate the use of distribution weights by deriving some expressions for the shadow prices of commodities. We can examine the appropriate shadow prices for tradables and non-tradables in terms of a general formula which can be adjusted to fit specific cases. The only limitation on the formula is that it must be specified either for an exportable or on importable; whichever is chosen, the implications for a non-tradable follow immediately. Here, we will consider the formula for an exportable because we are more likely to encounter on exportable for which world demand is less than perfectly elastic, than an importable for which world supply is less than perfectly elastic. The derivation for an importable, however, is analogous.

17. Assume that a public sector project demands an exportable which is both produced and consumed in the private sector, and for which world demand is less

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1/ Of course, this condition would be met if the government possessed perfect knowledge and acted rationally, i.e., in a way consistent with the maximisation of the specified welfare function.

than perfectly elastic. The increase in demand will then lead to an increase in the border price (dp)[1/] and an increase in private welfare given by

$$(-C - X + Q)\ dp \quad [2/] \qquad 22)$$

where C = domestic consumption, X = exports and Q = domestic production (=X+C). Reading from left to right, we have the loss in domestic consumer surplus (Cdp), the loss in foreign consumer surplus (X dp) and the gain in domestic producer surplus (Q dp). To determine the change in social welfare we must revalue these in terms of our numeraire (public income measured in terms of foreign exchange). Following the discussion in para. 6, let d_1/v and d_2/v be the values assigned to domestic consumer and producer surplus respectively and assume that foreign consumer surplus is assigned a value of zero. Thus, the value of the gain in private welfare in terms of our numeraire is

$$(d_2 - ad_1)Q\ dp/v \quad [3/]$$

where a = C/Q.

18. However, we must also consider any other repercussions of the price change. There are at least four other effects:-

i) The change in price may affect export earnings. If the elasticity of world demand is η_w, then the increase in foreign exchange earnings is $(1-\eta_w)X\ dp$. As this is already expressed in terms of our numeraire, it requires no further adjustment;

1/ The border and domestic prices are assumed to be the same.

2/ This expression is only approximate for non-marginal changes in price.

3/ This expression corresponds to H/W_g in equation 6.

ii) The increase in price will increase or reduce domestic consumer expenditure on the exportable depending on whether the elasticity of domestic demand is less than or greater than one. Thus, depending on the value of the elasticity, consumer expenditure on other commodities will either be increased or reduced and any change in consumer expenditure will have a foreign exchange impact. If the elasticity of domestic demand is η_d, then the increase in consumer expenditure on other commodities is $-(1-\eta_d)C\ dp$. To express this in terms of our numeraire, we multiply by a weighted average of shadow to market price ratios, the weights being the proportion of the increased expenditure on other commodities devoted to each commodity. Let this weighted average be β_1, so that the change in consumer expenditure causes a reduction of $-(1 - \eta_d)\beta_1\ C\ dp$ in terms of our numeraire.

iii) The increase in producer expenditure will have a similar effect. Defining β_2 for producer expenditure analogously to β_1, the increased producer expenditure causes a reduction of $B_2\ Q\ dp$ in terms of our numeraire.

iv) Finally, we must consider the cost of the increased domestic production. At domestic prices the increased production cost is $\varepsilon\ Q\ dp$ where ε is the elasticity of domestic supply. To express this in terms of our numeraire, we multiply by a weighted average of shadow to market price ratios, the weights being the proportion of increased costs attributable to each input. Let this weighted average be α, so that the increased production causes a reduction

of $\alpha \varepsilon Q\, dp$ in terms of our numeraire commodity.[1/]

19. Thus far, we have expressed all the effects of the price change in terms of our numeraire so that they are directly additive. Noting that the increase in the value of demand at market prices is $(\eta_w X + \eta_d C + \varepsilon Q)dp$, the ratio of the commodity's value at shadow and market prices is given by

$$\frac{\varepsilon\alpha - (1-a)\,(1-\eta_w) + a\eta_d\beta_1 + (\beta_2 - d_2/v) - a(\beta_1 - d_1/v)}{\varepsilon + (1-a)\,\eta_w + a\eta_d} \qquad 23)$$

We can use this general formula to derive the shadow price for both exportables and non-tradables.

Shadow Prices for Exportables

20. Expression 23 is the appropriate shadow price formula for an exportable, for which world demand is less than perfectly elastic. Note that the last two terms of the numerator may be interpreted as income transfers between the public and private sectors. An increase in private sector consumption reduces public income measured in terms of foreign exchange (hence the β's) but does increase welfare (hence the d/v's). If the β's $\doteq$ the d/v's, then the net social cost of the income transfers is zero. If we also assume that domestic production is relatively inelastic (i.e., $\varepsilon \to 0$) and that domestic demand is relatively inelastic (i.e., $\eta_d \to 0$) or is small compared to exports (i.e., $a \to 0$), then the ratio becomes $(1 - 1/\eta_w)$ which is the ratio of the marginal export revenue to the domestic price. And finally, if foreign demand is perfectly elastic (i.e., $\eta_w \to \infty$),

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1/ The summation of these four effects corresponds approximately to ΔQ_g in equation 6. The correspondence is only approximate because the β's and the α's may contain elements reflecting changes in utility levels in the private sector and which should, in principle, be included in H/W_g.

then the ratio is unity, the border and domestic prices being equal by assumption.[1/]

Non-tradables

21. If we assume that there are no exports (i.e., a = 1), then we obtain the appropriate shadow price formula for a non-tradable i.e.,

$$\frac{\varepsilon\alpha + \eta_d \beta_1 + (\beta_2 - d_2/v) - (\beta_1 - d_1/v)}{\varepsilon + \eta_d} \qquad 24)$$

If supply is perfectly elastic (i.e., $\varepsilon \to \infty$), then there is no change in price and the ratio is simply α, the ratio of the marginal social cost (MSC) of production to the domestic price. Thus, given $\varepsilon \to \infty$, the domestic price is the appropriate price for project analysis only if $\alpha = 1$. Alternatively, if supply is perfectly inelastic (i.e., $\varepsilon = o$), then the ratio may be interpreted as the marginal social benefit (MSB) of the output in the private sector divided by the market value of output. If, in addition, the β's = the d/v's then this ratio becomes β_1. Thus, given $\varepsilon = o$, the domestic price is the appropriate price for project analysis only if the income transfers cancel out and $\beta_1 = 1$.[2/]

Derivation of β/MSC

22. Inasmuch as the derivations of β and MSC (α) are essentially the same we will only comment briefly on the former. β is required to transform the value of

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1/ This analysis underlies the recommendations made in paras. 50 and 52 of the Annex concerning the shadow price of tradables.

2/ This analysis underlies the recommendations in paras. 56 to 58 of the Annex concerning the shadow price for non-tradables and importables subject to fully-used quotas.

a marginal increase in consumption measured at domestic prices into its equivalent value in terms of our chosen numeraire. If the increase in consumption comprises only one commodity, then β will equal the ratio of the shadow to the market price; for more than one commodity β will be a weighted average of price ratios, the weights being the proportion of marginal expenditure devoted to each commodity. For example, if the market price of the j^{th} commodity is p_j and the proportion of marginal expenditure devoted to the j^{th} commodity is a_j, then

$$\beta = \sum_j a_j \lambda_j / p_j$$

where $\Sigma a_j = 1$ and λ_j is the shadow price of the j^{th} commodity.[1/] It should be clear that the a_j will be different for different consumers and will depend on both income elasticities and price elasticities if prices are changing. For α, the a_j should be defined as the proportion of increased costs attributable to each input.

IV. SHADOW WAGE-RATES

23. We do not derive a shadow wage-rate formula here because the actual derivation will depend crucially on the way in which the relevant labour market works. In essence, one is still working with equation 24 but the distortions typically assumed to be present in LDC labour markets may warrant the introduction of additional considerations.[2/]

1/ Note the similarity between β and the standard shadow exchange rate formulas. See para. 59 in the Annex and Scott (1973)

2/ See Paras 34 to 46 in the Annex and Lal (1973).

APPENDIX II: ESTIMATION OF SHADOW PRICES

TABLE OF CONTENTS

APPENDIX II: ESTIMATION OF SHADOW PRICES

I. INTRODUCTION

1. In this Appendix we consider various ways of estimating the shadow prices discussed in the Annex. As usual in applied economics any method of estimation must be based on certain simplifying assumptions which may be more or less appropriate in a particular country. Since it is impossible to consider every conceivable eventuality, we have striven to make the assumptions underlying the proposed estimating techniques very explicit. This should enable the analyst to judge, in the light of his special country knowledge, whether or not an estimation technique is justified and, if not, what alternatives may be more appropriate. The essential point is that the proposed methods of estimation should not be applied mechanically without first examining their relevance in the context of the specific country concerned. However, it should be apparent that any refinement in the techniques can only be achieved at a cost, possibly in terms of data collection, and certainly in terms of time. It is important, therefore, to weigh carefully the possible improvement in project selection wrought by a more refined estimate against the cost of that refinement.

Procedure

2. We follow the Annex in presenting the material, i.e., Section II discusses estimation techniques for the distribution weights (the d's, and v) as well as for the accounting rate of interest (ARI); Section III examines the shadow wage rate (SWR); and Section IV suggests methods of estimation for commodity prices including the standard conversion factor (SCF). At

various points we suggest likely ranges for some of the parameters, based on available estimates and the experience of practitioners in this field. However, this should not be interpreted as an attempt to impose rigid limits on particular parameter values but as a guide to the analyst. Whilst it may be desirable to subject estimates lying outside the proposed range to close scrutiny, it does not mean that such estimates should be rejected out of hand. Whenever possible analysts should present a range of likely parameter values as well as a best estimate. The range should not cover all possible values but only those which could occur with some reasonable degree of probability. The specification of such a range cannot be rigorous, but subsequent analyses will be better informed, given the analyst's best judgement about the likely range of parameter values.

II. DISTRIBUTION WEIGHTS

3. In this section we describe methods of estimating a complete set of distribution weights for private consumption and private savings. It will be recalled that the weights for private consumption comprise two elements:

- d - the marginal value of non-average consumption (measured in terms of domestic prices) in terms of the marginal value of average consumption (also measured in terms of domestic prices); and
- v - the value of public income (measured in terms of foreign exchange) in terms of the marginal value of consumption (measured in terms of domestic prices and at the average level of consumption).

If the spread of the d's is large then projects which benefit the poor rather than the rich will be favored; if v is high then projects which "save" or "generate" public income will be favored. In the light of stated government objectives and observed actions and policies, the analyst should formulate some preliminary views whether or not (i) the government is seriously concerned with income distribution and (ii) the government's revenue position is seriously constraining its actions. The former tells us something about the spread of the d's; a government anxious to secure some redistribution of income through project selection will require the spread of the d's to be large, thereby favouring projects which benefit the poor. Vice versa for a government which is not so worried about redistribution. The latter tells us something about v; a government facing a severe shortage of public revenue will require v to be large, thereby favoring projects which save or generate public revenue. Vice versa for a government which can improve its revenue position fairly easily.

4. Statements of this kind are very helpful in indicating the likely magnitude of the distribution weights and v , however, they do not provide precise numerical values, but before turning to that question, several caveats are in order. Firstly, government actions and policies may be misleading guides and may frequently appear to contradict government statements. Thus, government actions with regard to, say, fiscal policy may often conflict with the government's stated objectives concerning income distribution. However, it is precisely because there are constraints on fiscal policy that one wants to include income distribution weights in project selection. Secondly, a severe shortage of public revenue does not

necessarily imply a high value of v ; administrative bottlenecks may so reduce the effectiveness of public expenditure that the funds would be worth more in the hands of the private sector. It is clear from these two examples that, in interpreting government actions or statements, the analyst should proceed with caution.

Determining the d's

5. It should be apparent that any set of distribution weights involves value judgements and as such is not susceptible to objective estimation. In the Annex (paras. 16-20) we derived a set of distribution weights, the egalitarian bias of which could be summarized in terms of one parameter, n . For convenience we reproduce Table 1 of the Annex to illustrate the relationship between n and the set of distribution weights relevant for marginal changes in consumption.

Table 1

Values of d for Marginal Changes in Consumption

Existing Consumption		Value Judgement			
Level (c)	$\bar{c}/c$	n=0	n=0.5	n=1	n=2
10	10.00	1.00	3.16	10.00	100.00
25	4.00	1.00	2.00	4.00	16.00
50	2.00	1.00	1.41	2.00	4.00
75	1.33	1.00	1.15	1.33	1.77
100 *	1.00	1.00	1.00	1.00	1.00
150	0.66	1.00	0.81	0.66	0.44
300	0.33	1.00	0.57	0.33	0.11
600	0.17	1.00	0.41	0.17	0.03
1,000	0.10	1.00	0.32	0.10	0.01

* Average Consumption ($\bar{c}$)

Given that most governments employ some kind of progressive income tax, one can deduce that the government puts a lower value on increments in consumption the higher the existing consumption level. Accordingly, we can rule out $n = 0$ which would imply equal weights regardless of the existing consumption level. Note, however, that it is recommended that all projects be appraised also at efficiency prices which, of course, corresponds to the case $n = 0$. See Annex para. 7.

6. As Table 1 shows, as n increases so the weight applied to any particular consumption level below (above) the average consumption level increases (decreases). For example, for an existing consumption level of 25(300) $n = 0.5$ implies a weight of 2(0.57), $n = 1$ a weight of 4, i.e., 2^2 (0.33, i.e., 0.57^2), and $n = 2$ a weight of 16, i.e., 4^2 (0.11, i.e., 0.33^2). Thus, doubling n implies squaring the weight, so that small changes in n can have fairly significant effects on the weight applicable to any particular consumption level. Now examine the change as the existing consumption level varies for a given n. For example, with $n = 1$ the weight on additional consumption decreases proportionately with increases in the existing consumption level, i.e., for a consumption level x times as high (low) as some base level, the weight is $1/x$ times as low (high) as that applicable to the base consumption level. This may be considered quite a pronounced bias in favour of the poor in that the marginal consumption of a man four times as rich as another is only worth one quarter of the value of consumption to the poor man. For $n = 2$, the bias is even more pronounced, the weight decreasing with the square of the proportionate increase in the existing consumption level, i.e., for a consumption level x times as

(low) as some base level, the weight is (1/x) times as low (high) as that applicable to the base consumption level. Thus, the marginal consumption of a man four times as rich as another is only worth one sixteenth of the value of consumption to the poor man. Alternatively, if n = 0.5, the bias in favour of the poor is relatively mild, the weight on additional consumption decreasing proportionately with the square root of the proportionate increase in the existing consumption level, i.e., for a consumption level x times as high (low) as some base level, the weight is $(1/x)^{\frac{1}{2}}$ times as (low) high as that applicable to the base consumption level. The marginal consumption of a man four times as rich as another is then worth one half of the value of consumption to the poor man.

7. In principle, any value for n is conceivable; in practice, it probably makes sense to rule out extreme values, and to consider a range for the likely value of n rather than select a single value. Given the discussion in the previous two paragraphs the following procedure is recommended:-

i) As a preliminary step set n = 1 for all countries.

ii) As part of the sensitivity analysis, consider values of n ranging up to 1.5 (or possibly 2) for countries expressing a keen interest in redistribution and values ranging down to 0.5 for countries expressing only a mild interest in redistribution. This approach has two advantages. Firstly, all projects in all countries will be appraised for a value of n equal to one, thereby facilitating international comparisons. Secondly, the analyst is not required to select a specific value for n but only to indicate the range in which the true value is likely to fall. The main

disadvantage, of course, is that a project may have, for example, a positive NPV when n equals 1.5 and a negative NPV when n equals 1 or vice versa. In this instance, the analyst would be required to make up his mind whether n is closer to 1.5 than to 1, or vice versa, and the project would be accepted or rejected accordingly. However, it is important that such a judgement, for example that n is closer to 1.5 than to 1 in one particular project, be consistently applied to other projects in the same country. As one learns more about the influence of n on project selection (i.e., as projects are rejected or accepted), it may be possible to narrow down the range of likely values for this parameter.

Estimate of D

8. D, the summary distribution parameter, (see Annex p. 21) depends on n, the elasticity of marginal utility with respect to consumption, and σ, the parameter of the Pareto cumulative distribution function, Given the range of values for n estimated in the manner described above, all one needs to estimate D is an estimate of σ. Fortunately, σ is related to the Gini coefficient (a summary measure of inequality in income distribution) and the Bank's Development Development Research Center 1/ has information on Gini coefficients for many countries. The relationship is

$$\text{Gini coefficient} = 1/(2\sigma - 1) \qquad (1)$$

The value of D can then be derived from table 3 in the Annex or equation 15 in Appendix I.

1/ See Jain and Tiemann (1973).

Value of Public Income (v)

9. The value of public income (v) is one of the most difficult variables to estimate. Public income is used for many different purposes and it is hardly possible to measure directly the value of some types of expenditure such as administration or defence. Of course, an omniscient and perfectly rational government would ensure that at the margin all types of expenditure were equally valuable, but in reality, such an ideal is rarely attained. It may, nevertheless, be a good working rule for deriving an estimate of v to proceed on the initial assumption of a perfect allocation of public resources.

10. Inasmuch as public investment is probably a major component of marginal public expenditure, it would seem important to attempt some estimate of its value whether or not one accepts the assumption of a perfect allocation of public expenditure. The Annex (para. 23) and Appendix I (para. 14) derived formulas which may be used to obtain a preliminary estimate of the value of public investment. The variables required for these formulas are:-

q = the marginal product of capital in the public sector, i.e., the net return earned by a marginal unit of public investment (measured in terms of foreign exchange) when all inputs and outputs are measured at efficiency prices (in terms of foreign exchange);

i = the consumption rate of interest (CRI);

β = the ratio of the value of a marginal increase in consumption at shadow prices to its value at market prices for the average consumer.

s = the public sector's propensity to reinvest out of q.

All variables relate to the immediate future, i.e., the period five to ten years from the date of appraisal. Provided $i > sq$, one can estimate v from the formula

$$v = \frac{q - sq}{i - sq} \quad \frac{1}{\beta} \qquad (2)$$

The assumptions underlying this formula are:-

i) all the variables (i.e., q, i, s and β) remain constant over time so that v also remains constant over time. This assumption generally implies that equation 2 overestimates v because it may be reasonably expected that the divergence between q and i will decrease over time, thereby reducing the value of current investment. It may be sensible, therefore, to treat the value of v resulting from equation 2 as a <u>maximum</u> estimate of its true value. In some cases, the maximum may not be very helpful. For example, if i is only slightly larger than sq then one can obtain very high values for v which prove very sensitive to minor changes in i or sq. And if $i < sq$, then the value of v tends to infinity which is not a plausible result because it implies a zero value for consumption; and

ii) all project benefits either augment average private sector consumption or public investment. More realistically the benefits will have a wider distribution, resulting in increases in consumption at many different consumption levels, increases in private savings and public current expenditure as well as increases in public investment. With regard to consumption benefits, one might assume that they are distributed in the same way as is aggregate consumption so that public investment neither improves

nor worsens income distribution. This assumption requires that equation 2 be multiplied by D, the summary distribution measure, but, given that D will often be close to one, this may not be an important adjustment. A more important omission is the failure to allow for the possibility that some of the benefits may augment public current expenditure and private savings. Given our assumption that all public income is equally valuable and assuming that private savings are as valuable as public investment,[1/] then the simplest solution to the problem is to redefine 1 - s as the proportion of q which is consumed in the private sector. This, however, raises two problems: firstly, it is extremely difficult to estimate this version of s (see paras. 20-21); and secondly, it increases the possibility that sq exceeds i because the public sector's marginal propensity to reinvest out of q is only a fraction of the revised concept of s.

11. To offset the tendency to overestimate implicit in equation 2, one might attempt a minimum estimate by assuming that there is no reinvestment, i.e., $s = 0$. The formula then becomes

$$v = \frac{q}{i} \frac{1}{\beta} \qquad (3)$$

Provided investment is considered more valuable than average consumption (i.e., $v > 1$), the elimination of reinvestment will reduce the value of v estimated from equation 3. However, even this approach could involve an

1/ For the purpose of this general formula it is probably reasonable to assume that private savings are as valuable as public investment, but, when the benefits of a specific project are being assessed, we recommend that a different value be used for private savings. See paras. 24-25.

overestimate of v if the assumed constancy over time of q and i (which imparts an upward bias to v) has a greater influence than the elimination of reinvestment (which imparts a downward bias to v). Given this caveat, it is nevertheless probably reasonable to treat equation (3) as a lower limit for the true value of v.

Critical Consumption Level

12. Having thus computed a preliminary value, or range of values, for v, one should check its plausibility by relating it to estimates of the critical consumption level. This is defined as the level of consumption at which a unit of public income (measured in terms of foreign exchange) is considered as valuable as a unit of private sector consumption (measured at domestic prices). Symbolically, this requires that one compute the consumption level at which $d = v\beta$. In other words, an estimate of v implies an estimate of the critical consumption level, and vice versa. This has two important consequences. Firstly, one can say that public income is as valuable as private consumption at a level of consumption equal to, say, one-half of the average consumption level. Thus one can comment on the plausibility of estimates for v. For example, it would be reasonable to rule out estimates of v which imply a critical consumption level below some minimum (starvation) consumption level. Secondly, one can examine other government policies to shed further light on the critical consumption level and hence on v. The most obvious policy from this point of view is the payment of consumption subsidies. One might reasonably presume that the payment of consumption subsidies (monetary or otherwise) indicates that the

government places a higher value on the consumption of the subsidized consumers than on its own income. It follows that the point on the income scale at which consumption subsidies cease may be identified as the critical consumption level. However. subsidies have administration costs and efficiency costs in terms of a disincentive effect. In principle allowance should be made for these costs, which suggests that the true critical consumption level is below the point at which subsidies cease. The general upshot of this discussion is that in determining v one should not rely too heavily on any single method of estimation. Ideally, one should attempt to assess the value of public expenditure in as many different directions as is possible and draw conclusions only after due consideration of all available estimates.

13. In addition, it is important that the analyst keep in mind the overall objective of this part of the estimation exercise. This objective is to derive a set of d's and a value for v which provide the correct signals for the selection of projects. Various formulas have been suggested which provide the theoretical rationale for the approach and also provide some assistance in estimation; however, they should not be interpreted as binding constraints on the analyst. The simplicity of the recommended formulas can lead to misleading results, especially in the case of v. It was for this reason that we recommend a careful assessment of the critical consumption level. Equations 2 and 3 can help in setting the probable range for v but, when considered independently, they can produce very implausible results. Similarly, it was possible to offer some advice on the appropriate value of n and hence the spread of the d's but, again,

if considered independently of other estimates, the advice could prove misleading. The critical consumption level, however, provides a useful, independent check on the plausibility of the value judgements underlying both the d's and v. To make use of this check, we recommend the following procedure:-

i) make initial estimates of n and the CRI along the lines suggested in paras. 7 and 16 respectively;

ii) estimate q, s and β as explained in paras. 17-19, 20-21, and 45-47, respectively;

iii) employ equations 2 and 3 to derive the probable range for v;

iv) calculate the range of critical consumption levels implied by the above estimates of v, β and the d's;

v) estimate the critical consumption level independently employing the method outlined in para. 12;

vi) if the independent estimate of the critical consumption level falls within the range derived from estimates of v (especially if it is near the lower limit) accept the initial value judgements; and

vii) if the independent estimate falls outside the range derived from estimates of v adjust n and/or CRI to either change the d's or the estimates of v.

By means of this iterative cross-checking it should be possible to derive a consistent, plausible and fairly reliable set of weights.

Estimating the parameters of v

11. As noted above, the preliminary estimate of v from the return to investment requires estimates of the four variables defined in para. 10. Inasmuch as any project lasts for a number of years, these estimates should refer to the future values of the variables. Naturally, all projections are based on past behaviour to some extent but, where possible, important future developments, which may affect the variables to be estimated, should be allowed for. In particular, the estimates used in project appraisal should be consistent with those given in the Country Program Paper
In paras. 15 and 16 we examine the consumption rate of interest; in paras. 17 and 19 we suggest methods of estimating the marginal product of capital and in paras. 20 and 21 we examine the reinvestment rate. The discussion of β is deferred to para. 45.

Consumption Rate of Interest (CRI)

15. The CRI (i) was defined in the Annex para. 23 as

$$CRI = ng + \rho$$

where n = the elasticity of marginal utility with respect to consumption

g = the growth rate of per capita consumption; and

ρ = the rate of pure time preference

The CRI (which underlies the intertemporal weighting system) clearly involves value judgements and as such cannot be estimated objectively (except for g). The purpose of the CRI in project selection is to ensure that the government's preferences concerning future consumption (growth) and current consumption are adequately reflected in shadow prices. Countries which are heavily committed

to growth should employ a low CRI which ensures that the future consumption benefits from today's investment are not heavily discounted. The ultimate effect is to make investment appear more attractive than current consumption, and, as can be seen from equations 2 and 3, the result is translated into shadow price terms by increasing the value of v.

16. To determine the CRI we can examine its three component variables, n, g. and ρ. We have already discussed n in paras. 5 to 7. An estimate of g may be derived from the growth rate estimates of GNP, savings and population contained in the relevant CPP. Of course, consumption measured in money terms would have to be deflated by an appropriate consumer price index. With regard to ρ, we recommend fairly low values (say, 0 to 5%) on the grounds that most governments recognize their obligation to future generations as well as to the present. (Of course, the possibility that future generations may be richer than the present generation is allowed for by the presence of ng in the CRI formula. Pure time preference, ρ, is an additional element.) However, inasmuch as the CRI depends on both n and ρ, ρ should not be determined independently of n. For example, for a growth - conscious economy which is also employing a high value of n on (current) income distribution grounds, one might set $\rho = o$ thereby ensuring that the CRI is fairly low, and hence correctly reflecting the government's growth objective despite the high value for n. On the other hand, for a country which is more interested in current consumption than in growth but is not interested in income distribution (implying a low n), one might set $\rho = 5\%$ to ensure that the CRI is fairly high, and hence correctly reflecting the government's preference for current compared to future consumption despite the low value of n. Intermediate values of ρ would be appropriate for

countries which are not interested in (current) income distribution (low n) but are interested in growth (low CRI), or for countries which are interested in income distribution (high n), but not in growth (high CRI). In general, values for the CRI ranging from 5%, for a country which is very growth-conscious, to 10%, for a country which is more concerned with current consumption, would not be unreasonable but values outside this range are possible.

Marginal Product of Capital (q)

17. The marginal product of capital in the public sector is the net return earned by a marginal unit of public investment at border prices, i.e., when all inputs and outputs are measured at efficiency prices. Thus, whereas the CRI indicates the social marginal rate of substitution between present and future consumption and is consequently a subjective parameter, q indicates the marginal rate of transformation between present and future foreign exchange and is an objective parameter which, in principle, can be observed. We describe two methods of estimation: - para. 18 describes an approach based on macro data; and para. 19 examines the use of micro data.

18. As an upper limit for q, we can take the incremental net output - capital ratio in the economy, which is the inverse of the more conventional incremental capital - output ratio (ICOR). Given national data on net investment and increases in net national product at constant prices, one can immediately obtain the required ratio at least in terms of constant market prices. Ideally, the ratio should be measured in terms of border prices. This can be achieved by multiplying net output by a standard conversion factor (see para.49) and multiplying net investment by a conversion factor for capital (see para. 48). Denoting the resulting ratio by k, we may conclude that k overestimates q for

at least two reasons:-

i) k is an average (or incremental) concept whereas q is a marginal concept; and

ii) k neglects the contribution of other factors of production as well as that of technical progress.

We can make a crude allowance for labour's contribution by subtracting from k the ratio of the incremental national wage-bill to investment on the grounds that the numerator of this ratio reflects labour's incremental (rather than marginal) product. As with k, this second ratio should also be estimated in terms of constant market prices and then be adjusted to reflect border prices. The subtraction of this ratio from k provides an improved estimate of q. Incremental employment - capital ratios can usually be derived from the relevant Economic reports or CPP's but wage data are usually more difficult to obtain especially for the informal and agricultural sectors. With this in mind, it may be more productive to confine this approach to the modern sector of the economy, i.e., derive an estimate of k and hence q for the modern sector of the economy. Insufficient data on sectoral investment flows may limit the applicability of this approach but the analyst may find the relevant information in sector reports, especially industry reports.

19. Despite the adjustment for labour's contribution, the macro approach will probably still involve an overestimation of q, so that it may be more fruitful to rely on micro estimates. Where available pre-tax profits net of depreciation in the industrial sector will provide a useful base on which to estimate q. If this approach is adopted the following points should be kept in mind. Firstly, we are interested in the return to <u>all</u> invested capital. Thus, if industry is financed by equity, medium-term borrowing and

and long-term borrowing, one requires a weighted average of the return to each type of investment, the weights being the proportion of total investment financed in each of the three ways. The relevant interest rate may be interpreted as the return on loan finance. Secondly, we are interested in the real return. Both the pre-tax profits rate and the interest rates should be deflated by the rate of inflation. And lastly, we want the return at border prices rather than domestic prices. Application of the appropriate conversion factors is the required adjustment. If the observed variations about the average return are interpreted as random deviations from the true value,then the average value may be taken as the best estimate of the yield on capital in the economy. Of course, in reality deviations from the average may reflect monopoly power, risk differentials and market fragmentation. As a final exercise, therefore, it may be useful to examine the economic return on recent Bank (and other) projects. However, it may be necessary to make some adjustment to the estimated internal rate of return to ensure that it reflects efficiency rather than market prices.

Marginal Propensity to Reinvest (s)

20. In para. 10 we revised the concept of s to allow for public current expenditure and private savings out of q. Given this revision, it is probably easier for estimation purposes to concentrate on (1-s), the proportion of q which is consumed in the private sector. As with q, we suggest the use of both macro and micro data. The macro approach is based on the assumption that both public and private investment have, on average, the same

impact on private consumption. Given this assumption, it is possible to deduce the increment in private sector consumption at constant (border) prices as a proportion of the increment in GNP at constant (border) prices in any year. An average over, say, five years based on CPP projections would be the most appropriate data source.[1/] The weaknesses of this approach are immediately apparent. Firstly, no allowance is made for changes in the fiscal system which could bias the estimate either upwards or downwards. However, averaging over five years may reduce the significance of this point and, anyway, crude adjustments could be made for any major tax changes. Secondly, and more importantly, one might anticipate that the increment in private sector consumption resulting from private investment is larger than that resulting from public investment, given that the financial profits of public investment accrue directly to the public sector. On the other hand, some public investment (which, for example, provides free social services) increases private sector consumption and in most countries the profits of private investment are subject to taxation. Nevertheless, on balance, we might conclude that reliance on this method will result in an overestimate of (1-s) and hence on underestimate of s.

21. The alternative micro approach involves estimating the value of (1-s) from a sample of public sector projects. The main difficulty of this approach is that (1-s) will probably vary considerably depending on the type of project. Thus, (1-s) might be very high for a road project because most of the benefits will accrue to the private sector, whereas an industrial project

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1/ This exercise should proceed in conjunction with the estimate of q from macro data.

within the public sector might produce a low value for (1-s). In principle, we are interested in the value of (1-s) for the "average" marginal project which suggests the following procedure. From a selection of public sector projects covering the main investment sectors compute the "return" to private sector consumption. This involves calculating the internal rate of return of each project if net benefits are redefined as the increase in private sector consumption at border prices for each year of the project's life. Note that increases in private sector income, and hence consumption, could appear on the benefit side of the original project (e.g. reduction in transport costs) or on the cost side (e.g., increased wage payments). The specific values of (1-s) obtained by expressing the estimated "return" as a proportion of the respective q for each project are then averaged, the weights being the proportion of total public investment devoted to the different types of project. This exercise essentially involves a series of crude cost-benefit analyses (as does the estimate of q if one works with project data) and is obviously time consuming. However, it offers a valuable cross-check on the value of s.

Accounting Rate of Interest (ARI)

22. The ARI is defined as the rate of fall in the value of the numeraire, public income measured in terms of foreign exchange. It follows that the real rate of return on foreign lending must represent a lower limit for the ARI because foreign lending is denominated in terms of our numeraire. Historical estimates of the marginal return from foreign lending on international markets suggest that this lower bound for the ARI is of the order of

4% in real terms.[1/] A best estimate of the ARI may be derived by recalling that the ARI is that rate of discount which balances the supply of and demand for public investible resources. As such, the ARI should equal the internal social rate of return on the marginally-acceptable project. In principle, this can only be obtained by an overall analysis of the investment budget, but, in practice, one might employ the following formula, as a rough guide to the true value of the ARI:-

$$ARI = q - h$$

where h adjusts for the distributional impact of public investment on private sector consumption.

23. We have already discussed q (see paras. 17 to 19) and we may derive h as follows. Given that s is the proportion of q that accrues to the public sector(and private sector savings), it follows that $(1-s)q$ units of foreign exchange accrue to private sector consumption. If this increment augments the consumption of those at the average level of consumption, then

$$\begin{aligned} h &= (1-s)q(1-1/v\beta) \\ \text{and } ARI &= sq + (1-s)q/v\beta \end{aligned} \qquad (6)$$

Given the particular formulation of the ARI in equation 6, it is obvious that the ARI $\gtrless$ q depending on whether $1/v\beta \gtrless 1$. However, it should be noted that if the increment in consumption accrues primarily to the poor then the term $1/v\beta$ should be replaced by $d/v\beta$ where $d > 1$, which increases the probability that $1/v\beta > 1$ and hence that the ARI > q. The exact

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1/ See Lal (1973)

condition for this result is that on average all the increased consumption arising from public investment must accrue to people whose consumption is considered more valuable than public income. As this requires that on average the increment in consumption must accrue to those below the critical consumption level, it is probably safe to conclude that the ARI < q. Accepting that the consumption generated by public investment is less valuable than public income, it follows that the ARI decreases when s decreases. In para. 20 we derived a minimum estimate for s; this now enables us to deduce a lower bound for the ARI which may be above the return from foreign lending. Setting limits on the ARI in this fashion may be a more fruitful approach than trying to derive a best estimate, since the limits suggested above may be sufficiently narrow for most appraisal purposes, especially if v is reasonably small and/or s is reasonably large.

Private Savings

24. For estimating v and the ARI we have assumed that private savings are as valuable as public income. This is probably a reasonable assumption for this purpose, given the level of accuracy at which one is operating, but it may be important to have a more precise valuation of private savings when computing benefits for a particular project. We recommend the following procedure. As with direct taxes, we suggest that private saving be netted out of private sector income. However, unlike taxes, private savings lead to future private income which should be costed/valued in the same way as any other increase in private sector income. In other words, private saving is initially assumed to be socially costless (i.e., as valuable as public investment/income) but then one adjusts to allow for the increase in future private sector income in excess of that

generated by public investment.

25. We provide two examples to illustrate the above procedure. Consider first private saving which takes the form of lending to the public sector. This is very similar to tax payments except that public borrowing involves debt servicing which will lead to future increases in private sector income. For example, if the entire annual debt repayment (x) per unit of private saving is consumed, then the net cost of the consumption generated in any year is $x(\beta - d/v)/(1+\mu)^{\tau}$ where $(\beta - d/v)$ adjusts for the social costs and benefits of consumption and μ is the rate of inflation. Discounting by the ARI and summing over the life of the loan gives $x(\beta - d/v)/(r + \mu)$[1/], where r is the ARI. Alternatively, private sector saving may lead directly to private sector investment. In this case, assuming that private and public investment are equally efficient (i.e., have the same q), the increase in future consumption (in excess of that generated by public investment) must be used in place of x. We know that the return to private consumption from public investment is $(1 - s)q$, so that, if we think that the entire return from private investment accrues to private consumption, we must replace $x/(r+\mu)$ by $sq/\beta r$, q being expressed in constant border prices. Further refinements may be required in either formulation, especially if private savings are a large portion of project benefits. For example, one may wish to allow for future savings out of the return from current savings or for profits tax.[2/] For estimation purposes, the distribution weight d applicable to the consumption out of the return

1/ This is the sum of an infinite series. Given that most debt repayment schedules are finite the expression employed in the text will overstate the true cost of consumption.

2/ Compare the section on public savings (para. 10).

to savings might be set equal to the d applicable to the portion of the saver's income which is consumed in the initial period. The implicit assumption here is that the saver's consumption grows at the same rate as average consumption so that d remains constant. Whatever approach is deemed appropriate in the specific project context, the ultimate objective is to obtain the net present social cost of the future private sector income per unit of current savings, this being the weight applicable to private savings.

III. SHADOW WAGE RATES

26. In estimating shadow wage rates, it is necessary to consider three different types of "cost" which may occur when one extra man is employed on a project. These costs are:-

i) foregone marginal product;

ii) changes in consumption and savings; and

iii) changes in leisure.

These three components of the shadow wage rate (SWR) were discussed at some length in the Annex (paras. 34-46) so that the emphasis here will be on particular estimation problems not considered in the Annex. However, two general points should be stressed at the outset. Firstly, the three components of the SWR, and hence the SWR itself, will differ between different types of labour depending on skill, location, season, etc. Secondly, the three components of the SWR may not relate solely to the worker who is employed but, because of a migration effect or a change in wage rates, may affect other workers.

Foregone Marginal Product

27. Paras. 35 to 38 of the Annex described the standard procedure of estimating foregone output from market wage rates and also indicated the limitations of the approach in situations where the labour market does not operate efficiently. Rather than repeat this discussion, attention in this section will be focussed on two specific problems - that of estimating α, the accounting ratio to be applied to the market wage rate, and that of incorporating migration effects into the SWR.

28. According to marginal productivity theory, labour will be hired up to the point where its marginal value product equals the wage, the marginal value product being given by the marginal physical product times the output's market (producer) price. The social value of labour's marginal product is, of course, the marginal physical product times the output's shadow price or, more conveniently, the marginal value product (i.e., the market wage) multiplied by the ratio of the shadow to the market price. For example, if the output is an exportable subject to an infinitely elastic world demand the appropriate shadow price for the output is its border price (see Annex, paras. 50-51), so that in this case α equals the ratio of the border price to the domestic producer price. However, more complicated cases can arise in which the marginal physical product comprises more than one type of output. The simple ratio must now be replaced by a weighted average of the accounting ratios for the different outputs, the weights being the proportion of the marginal value product accounted for by each type of output. In the absence of any specific information to the contrary, one might employ the standard conversion factor

(SCF) as the appropriate accounting ratio. This, however, is only an approximation in that the commodities on which the SCF is based may bear little correspondence to the commodities comprising the marginal value product, and should, therefore, be used sparingly.

29. There is growing evidence to suggest that the creation of one urban sector job may induce more than one rural sector worker to migrate to the city. The economics of this migration effect presupposes that the urban wage is fixed, and that the labour market is adjusted by changes in the level of urban unemployment such that at the margin the potential migrant is indifferent between the expectation of high-paying urban employment and the actuality of low-paying rural (under) employment. The essential feature of this equilibriating mechanism is that the rate of unemployment in the urban sector is unaffected by the creation of one new job, the number of responding migrants being exactly equal to the ratio of the total labour force (i.e., employed and unemployed) to total employment.[1/] Multiplication of one worker's marginal product by this ratio will provide the required value of foregone output.

Changes in Private Sector Income

30. Frequently, workers on a project will gain an increase in income, especially if the labour involved is drawn from the ranks of the rural un(der) employed (see paras. 41-42 in the Annex). In this section we underscore several points which should be borne in mind when estimating such increases in income. Firstly, the transfer of labour from the rural sector to the urban sector may involve both an increase in nominal income and an increase in the cost of living. Unfortunately, the estimate of changes in

1/ For more information on the assumptions underlying such results, see Mazumdar (1974).

real income runs into the usual index-number problem in that the estimate will differ depending on whether one weights the individual price differentials by the rural or urban consumption pattern.[1/] The geometric mean is often used as an acceptable compromise price index but, where breakdowns of consumption patterns are unavailable, it will probably be sufficiently accurate to inflate rural income by a rough estimate of the average difference between urban and rural price levels. In addition, one may wish to make some adjustments for other considerations such as free government services, on the one hand, and increased transport and adjustment costs for the worker, on the other hand. Note, however, that whereas government services have both a resource cost and a benefit in terms of private welfare, transport and adjustment costs are not offset by some increase in private welfare. It may be appropriate, therefore, to add an extra component to the SWR fromula to allow for such costs if they are thought to be significant.

31. It should also be noted that the increase in consumption may accrue to more than one worker. This is obvious if more than one worker migrates in response to the creation of one urban sector job. It is now necessary to consider not only the change in consumption of the worker who obtains the job but also the changes in consumption of the migrants who join the ranks of the urban unemployed or obtain casual employment in the informal sector of the urban labour market. Tracing through these effects is difficult but, provided the number of workers migrating is small (see para. 29), fairly rough estimates of the consumption change for the "excess" migrants will probably suffice. The consumption of more than one worker may also be affected through induced changes in wage rates. For example,

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1/ See MacArthur, Newbery and Scott (1974)

assume that project demand for a particular type of labour is satisfied by an increase in the wage rate which releases labour from employment elsewhere. In this case, we may note two consumption effects:- firstly, there is a transfer of income from producers (or consumers) to labour equal to the increase in the wage rate times the number already employed; and secondly, producers (or consumers) will now have more or less income available for expenditure on other commodities depending on whether the elasticity of demand for labour is less than or greater than one. 1/

32. The final point on consumption increases concerns their distribution and hence the identification of the relevant distribution weight. These weights (the d's) were defined for per capita consumption levels. It follows that increases in consumption must also be expressed in per capita terms which requires that allowance be made for the number of dependents supported by the worker. For example, if family income increases from w_1 to w_2, then, assuming equal sharing within the family, the distribution weight to be applied to the increase should be deduced from Table 2 in the Annex for values of $c_1 = w_1/N$ and $c_2 = w_2/N$ where N is family size. For any given pair of w's, the larger N, the higher the distribution weight because the increased consumption is going to a greater number of individuals with lower per capita incomes than if N is smaller.

Changes in leisure

33. Methods of evaluating changes in leisure were discussed in paras. 39-40 of the Annex. Here we merely recommend that for pruposes of sensitivity analysis Ø, the ratio of the social to the private evaluation of the disutility

1/ This analysis duplicates that for the shadow price of a non-tradable. See Appendix I, para. 21.

of effort, be set equal to its limits of zero and one.

IV. COMMODITY PRICES

34. Feasibility studies usually contain estimates of commodity inputs and outputs either in volume terms or value terms. The social cost/value of these commodities may be obtained by multiplying the volume by the relevant shadow price or the value by the ratio of the shadow price to the relevant market price. Following the Annex we discuss in order methods of estimating shadow prices for (i) tradables with a fixed border price; (ii) tradables with a variable border price; and (iii) non-tradables. In addition, we examine various short-cuts which essentially involve using average border-to-market price ratios rather than commodity-specific ratios. In particular, we discuss conversion factors for consumption goods and capital goods and a standard conversion factor (SCF).

Tradables with Fixed Border Prices

35. The appropriate shadow price for an importable in perfectly elastic supply or an exportable in perfectly elastic demand is the relevant c.i.f. or f.o.b. border price adjusted for transport and marketing margins (see Annex paras. 50-51). For the major imported inputs the feasibility study will often express costs in terms of c.i.f. prices, and for the more important internationally-traded commodities the Bank's Commodity and Export Projections Division regularly estimates f.o.b./c.i.f. prices at the major exporting/importing ports. Thus, one may often have a fairly firm data base for the major project inputs and outputs.

36. For other commodity inputs and outputs one may have to adopt less reliable methods. Obtaining unit values for imports and exports from the Trade Statistics is one possibility, but usually the level of aggregation

is sufficiently detailed and/or the reliability of value and volume figures is questionable. An alternative method involves computing the border price from the domestic price. For example, for importables the c.i.f. price can be derived by subtracting (i) the relevant marketing margin (wholesale or retail) (ii) the transport cost and (iii) the import tariff and/or sales tax from the domestic price. Conversely, for an exportable the f.o.b. price can be derived by adding to the domestic price (i) the relevant marketing margin (wholesale or retail), (ii) the transport cost and (iii) any export tariff and/or sales tax. Marketing margins are available for some countries from Surveys of Distribution and tariff rates can be obtained from the country's Custom Tariff Code.

37. The above account has not covered all eventualities: in any particular case one might be able to use additional information sources[1/] or encounter additional complications.[2/] Procedurally, it will probably prove most convenient to keep the marketing margins separate and at the end of the exercise convert them en bloc into shadow prices by means of an appropriate conversion factor (see para 40). It may also prove easier to attempt projections overtime of border prices rather than to project domestic prices and convert them into border prices by means of the projected ratio between domestic and border prices.

Tradables with Variable border prices

38. For importables in less than perfectly elastic world supply or exportables in less than perfectly elastic world demand the appropriate shadow price, under certain circumstances (for which see Appendix I, para. 20)

1/ See Guisinger (1973)

2/ For example, a domestically-produced version of an importable may be considered qualitatively inferior (superior) to the imported article.

is the marginal import cost or marginal export revenue (see Annex, para. 52). Some of the major primary commodity exports from the LDCs are likely to be subject to a less than infinitely elastic world demand and such commodities, of course, are often the main output of a project. Estimates of the relevant elasticity of world demand for some of these primary commodities are prepared regularly by the Bank's Commodity and Export Projections Division. However, it is important to distinguish between the elasticity of demand for a particular commodity from a particular country and the elasticity of world demand for that commodity. Writing the former as η and the latter as η_w (both defined so as to be positive), the relationship between the two is given by

$$\eta = \frac{\eta_w + (1 - a)\,\varepsilon}{a} \qquad (7)$$

where a is the country's share in the world export market and ε the export supply elasticity of competing exporters. Thus, the formula adjusts for the supply response of competing exporters: only if $a = 1$ (i.e., all exports are produced by one country) will $\eta = \eta_w$. In the absence of specific information on the supply response of competitors, one can obtain a minimum estimate of η by setting $\varepsilon = 0$, so that η equals the world demand elasticity divided by the country's share in the world export market. η is then the relevant elasticity for computing marginal export revenue. International trade yearbooks provide data on export shares by commodities but in calculating these shares trade subject to bilateral agreements should be excluded.

39. However, as was pointed out in Appendix I, para. 20, the use of marginal export revenue is itself only an approximation to the true shadow price. More sophisticated estimates involve calculating domestic demand and supply elasticities (see equation 23, Appendix I). If the exportable is an important part of domestic consumption (e.g., rice) some attempt should be made to estimate the domestic demand elasticity, information on which is often available from budget studies. If the export is not consumed domestically (e.g., rubber), one only needs to estimate the domestic supply elasticity. Unless one has specific information from a supply response study, it is recommended that fairly low values be used for the domestic supply elasticities,[1/] in view of the fact that most LDC exports are agriculturally-based and may be subject to land constraints. Finally, equation 23 in Appendix I also allows for the income transfers occasioned by the change in price. Unless one has specific information to the contrary, it is recommended that the β's for producers and consumers be assumed equal and that the d's for producers and consumers be assumed equal and equated with D, the summary distribution measure. The income transfer effect may then be written as $(1-a)(\beta - D/v)$ where a is the quantity consumed domestically expressed as a proportion of total domestic output. In some cases it may be important to allow for different distribution weights for consumers and producers,[2/] but, clearly, the degree of refinement must depend on both data availabilities and the sensitivity of NPV to different assumptions about the commodity's shadow price.

1/ See Balassa (1965)

2/ The most important example of this is when production occurs in the public sector.

Non-tradables

40. Equation 24 in Appendix 1 is the basic formula for the shadow price of a non-tradable. It comprises the marginal social cost (MSC) of an increase in supply, foregone marginal social benefit (MSB) of a reduction in consumption elsewhere including an income transfer effect. Provided we make the same assumptions as in para. 39 (i.e., the β's for producers and consumers be assumed equal and the d's for producers and consumers be assumed equal), then the income transfer effect is zero. This may often be an acceptable approach, but, where one has specific information concerning the respective income classes to which producers and consumers belong, different values should be used for the distribution weights.[1/]

41. Whatever the assumptions made about the income transfers, one also needs information on MSC, MSB and the elasticities of domestic supply and demand. With regard to the elasticities, it is recommended that, unless one has specific information to the contrary, one assume an infinite elasticity of domestic supply. This assumption produces the simple result that shadow price equals MSC, there being no price change and hence no income transfers. Moreover, an infinitely elastic supply may be a reasonable assumption for most services which are usually labour intensive and also for some of the more capital intensive non-tradables (e.g., electricity), especially if one adopts a relatively long time horizon (say, five years). However, for some non-tradables this assumption would be very misleading. In particular, some commodities may be in perfectly inelastic supply as a result of trade policies. For example, importables subject to fully-used quotas may be regarded as non-tradables in perfectly inelastic supply, provided there is no reason to

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1/ The most important example of this is when production occurs in the public sector.

believe that the quota will be released; the shadow price in this case equals MSB. We describe methods of estimating MSC in para. 41-42 and MSB in para. 43.

Marginal Social Cost (MSC)

42. In principle, one should estimate the MSC of each non-tradable input by the decomposition method (see Annex para. 57). In practice, however, is is probably more convenient to compute the MSC and hence the conversion factor, for "representative examples" of each of the major types on non-tradable. The resulting conversion factors can then be applied directly to project-specific non-tradable inputs. Conversion factors might usefully be estimated for such non-tradables as electricity, retailing, wholesaling, construction and transport. It should be borne in mind, however, that the conversion factors estimated in this fashion will only be approximate, in that the inputs of the "representative examples" need not correspond exactly to the inputs of the project-specific non-tradable. If this correspondence is thought to be especially weak in a particular case, and precision is important, the analyst should attempt a direct breakdown of the project-specific non-tradable.

43. Decomposition of a non-tradable into its constituent inputs to determine MSC would ideally be accomplished through an input-output table, but use of existing or ad hoc industry studies and manufacturing and distribution censuses is also appropriate. In some cases only a crude analysis of inputs will be necessary. 1/ As a first approximation one could simply "deflate" the

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1/ In principle, one is looking for the marginal input output relationships, but in practice the average relationships will be sufficiently accurate. If constant returns prevail, then marginal and average coincide.

market value of the output net of corporate and business taxes (and any excise tax included in the gross value of final output) by the Standard Conversion Factor (see para. 49); to increase accuracy one could decompose for one round and then use the Standard Conversion Factor for the remaining non-tradable inputs; and for greatest accuracy one could decompose completely thereby avoiding the use of the Standard Conversion Factor. A first round decomposition into tradables, non-tradables, and labor will give a useful insight into the likely magnitude of MSC. The general approach essentially involves a cost-benefit analysis of the non-traded industry. If this is kept in mind, it should help in deciding which approximations are or are not acceptable. In estimating MSC one should include both current and capital costs. The latter may be converted into annuities which, when discounted by the ARI over the capital's lifetime, have the same net present value as the capital inputs they represent. One may then treat the annuity as a current input.

Marginal Social Benefit (MSB)

44. From equation 24 in Appendix I we can write the ratio of MSB to the domestic price (p) as

$$\frac{MSB}{p} = \beta_1 + \frac{(\beta_2 - d_2/v) - (\beta_1 - d_1/v)}{\eta_d} \qquad (8)$$

where β_1 (β_2) is the conversion factor for consumers' (producers') consumption (see para. 45);

d_1 (d_2) is the pure distribution weight assigned to consumers' (producers') consumption;

v is the value of public income; and

η_d is the elasticity of domestic demand

It is apparent from equation 8 that if $\beta_2 - d_2 v = \beta_1 - d_1 v$ (i.e., the redistribution has a zero net social cost/value) or if $\eta_d \rightarrow \infty$ (i.e., there is no redistribution), then $MSB/p = \beta_1$.

In general, it is recommended that one set $MSB/p = \beta$ unless there is evidence to the contrary. The most important exception arises when demand is relatively inelastic and the non-tradable in question is produced in the public sector. In this case, we have

$$\frac{MSB}{p} = \frac{d_1/v - (1 - \eta_d)\beta_1}{\eta_d} \qquad (9)$$

and if further $\eta_d \doteq 1$, then $MSB/p = d_1/v$ which is the social value of private sector consumption. Whilst this is a convenient simplification, where possible one should employ direct estimates of η_d. Budget studies may provide information on this elasticity. If this approach is adopted it may be appropriate to set $d_1 = D$, the summary distribution measure.

Conversion Factor for Consumption (β)

45. The consumption conversion factors (β's) are required to transform a marginal increase in consumer expenditure into its equivalent value at shadow prices, i.e., the basket of commodities comprising the consumer's marginal consumption pattern must be valued at shadow prices and the resulting sum be expressed as a proportion of the value of the same basket at market prices. In symbols we have

$$\beta = \sum_j \alpha_j \lambda_j / p_j$$

where $\Sigma a_j = 1$, a_j being the proportion of marginal expenditure devoted to the

j^{th} commodity, and p_j (λ_j) is the j^{th} commodity's market (shadow) price. Of course, the a_j may differ for different consumers at the same income level and may also differ for the same consumer at different income levels. In practice, however, it will probably prove sufficiently accurate to calculate different β's for urban and rural consumers and possibly for two or three different income groups.

46. Expenditure surveys provide the most detailed information on the a_j. To obtain the marginal consumption pattern one can either subtract the consumption patterns of consumers in different income groups or make use of the identity between a_j and the product of the average propensity to consume the j^{th} commodity and its expenditure elasticity. In the absence of information on the consumption patterns of different income groups and on expenditure elasticities, one will probably have to forego the refinement of calculating different β's for different income groups and resort to a single consumption conversion factor. Failing this, one must rely on "guesstimates", based on data from other countries, for the proportions of exportables, importables and non-tradables in marginal expenditure, or employ equation 8 in the Annex which only requries trade data on the value of the country's imports and exports of consumer goods. Clearly, this latter approach is only approximate since the composition of trade in consumer goods need not correspond to the composition of domestic consumption. For example, coffee may bulk large in exports but may be a very small proportion of domestic consumption. Similar problems can arise on the import side if domestic production is the main source of supply for an importable

which accounts for a large proportion of domestic consumption (e.g., rice). With this in mind, ad hoc adjustments should be made in equation 8 on the basis of the guesstimates approach.

47. If one has a detailed breakdown of consumer expenditure, the shadow to market price ratios (i.e., λ_j/p_j) should be estimated in the manner described in paras. 35 to 44. However, if one has to resort to the more approximate methods suggested above, one requires average conversion factors for exportable, importable and non-tradable consumer goods. For exportables and importables one can use the average rate of tariffs or subsidies. The average tariff rate on imports may be equated with the ratio of total revenues from import tariffs on consumer goods divided by the c.i.f. value of total imports of consumer goods. If this ratio is expressed as τ_m, then the λ_j/p_j appropriate for the proportion of marginal expenditure devoted to importables is $1/(1 + \tau_m)$. An identical procedure can be employed for exportables. If τ_x is the ratio of total revenue from export duties on consumer goods, divided by the f.o.b. value of total exports of consumer goods, then the λ_j/p_j appropriate for the proportion of marginal expenditure devoted to exportables is $1/(1 - \tau_x)$. For export subsidies τ_x is negative. The most convenient conversion factor for non-tradable consumer goods is the SCF which is discussed in para. 49. It should be apparent that the use of such average conversion factors is itself an approximation which may not always be appropriate. In particular, it may be important to make some allowance for a less than perfectly elastic world demand for exports (see para. 38) and to allow for excise taxes levied on consumption goods.

Conversion Factor for Capital Goods

48. The conversion factor for capital goods performs the same service for capital goods as the consumption conversion factor does for consumption goods. Inasmuch as this conversion factor is only required for estimating q, capital's marginal product, fairly crude methods will suffice. The following procedure is recommended: (i) estimate the proportion of capital formation accounted for by construction and multiply the result by the conversion factor for construction (see para. 43); (ii) the remaining portion of capital formation will represent importable (and probably imported) items of equipment, machinery and vehicles; (iii) estimate the average import tariff on such goods and hence their average conversion factor,[1/] (iv) multiply the results of steps (ii) and (iii); and (v) the required conversion factor is then obtained by adding the results of steps (i) and (iv).

Standard Conversion Factor (SCF)

49. Whilst in general it is recommended that one estimate a different conversion factor for each non-tradable, it is useful to have available a SCF which can be used for minor non-tradable inputs or for the non-tradables remaining after one or two rounds of decomposition (see para. 43). For this purpose, one might use the ratio of the value at international prices of all imports and exports to their value at domestic prices.[2/] This is a generalization of the formula for β discussed in para. 45 and as such is subject to

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1/ Many countries admit capital goods duty-free so that the average import tariff is zero and the average conversion factor is one.

2/ Imports subject to fixed quotas should be treated as non-tradables in perfectly inelastic supply provided that they are already fully used and that they are not expected to be relaxed in the near future.

the same limitations. An alternative approach involves estimating a set of conversion factors for as many commodities and services as possible, including the most important items in the economy (many of which will already have been estimated), and selecting the median of the resulting frequency distribution of conversion factors as the SCF. Whatever the method chosen one should not resort to the SCF unless one has reason to believe that any resulting error will be small in relation to the project's NPV.