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BENEFIT-COST ANALYSIS METHODOLOGIES: UNTANGLING THEIR EQUIVALENCES AND DISCREPANCIES

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CONTENTS

I. Introduction

It is well accepted among economists that the contribution of an investment project to social welfare is quite different depending on whether the output (input) of the project comprises traded or non-traded goods and on whether it increases (decreases) consumption or investment. This is due to the existence of distortions in the foreign exchange and capital markets respectively, which create divergencies between the social marginal value and the social marginal cost of increasing (or decreasing) the amount of both foreign exchange and savings. Most economists also accept that the social contribution of a project may be different depending on whether all or part of its net output goes to the government or to the private sector. This is so because a lack of optimality in the size of the public sector budget creates divergencies between the value of government consumption and investment on the one hand and its counterparts in the private sector on the other.

Since projects will in general have different impacts on foreign exchange, investment and government income and since their benefits and costs have to be compared in order to make rational investment decisions, a common numeraire is needed. If this numeraire were arbitrarily selected to be private consumption in domestic units, a way to transform foreign exchange, investment and government income into private domestic consumption is needed. This is the method followed by Schydlowsky et al., (Schy. et al.) who make use of the Shadow Exchange Rate (P$) to transform the value of foreign exchange into private domestic consumption, of the shadow price of capital (P_K) to transform the value of private investment into private domestic consumption and of the shadow price of fiscal resources to translate government income into private domestic consumption. If, on the other side, the numeraire was arbitrarily selected to be investment in the hands of the government in foreign exchange units, a way of transforming consumption into investment values, domestic into foreign exchange values and private into public income values is needed. This is the method followed by the World Bank's Squire-Van der Tak (SVT) approach which is based upon I.M.D. Little and J.A. Mirrlees's method.[1] They make use of conversion factors to transform domestic values into foreign exchange values and of the reciprocal of the value of public income ($\frac{1}{v}$) to transform domestic private consumption into both public income and public investment. This "double" transformation is possible for SVT because the intended numeraire is "uncommitted or freely available government income" and it is assumed that all uncommitted government income is equally valuable because it is spent optimally, i.e., the distribution between government consumption and investment is such that the social marginal value of one unit of public investment is equal to the social marginal value of one unit of public consumption.[2]

In principle, methodologies using different numeraires should be exactly equivalent, i.e., the selection of a numeraire should make no difference to the investment decision process. For this to be true, however, it is

1 All references in this paper correspond to Lyn Squire & H.G. Van der Tak, "Economic Analysis of Projects," a World Bank Research Publication, J. Hopkins University Press, 1975 and to I.M.D. Little & J.A. Mirrlees, "Project Appraisal & Planning for Developing Countries," Basic Bk., Inc. New York, 1974.

2 This assumption may be easily modified by making only part of government income to be the numeraire (i.e., government investment) without changing the nature of SVT's method. Shadow prices would then be needed to transform all other expenditures into the selected numeraire (this is not done by SVT however). It should also be noted that no specific shadow price is calculated to transform private savings into public income. "Private saving is initially assumed to be socially costless (...as valuable as public investment, or income), but then an adjustment is made to allow for the increase in future private sector income in excess of that generated by public investment." SVT, p. 116. It should also be noted that no shadow price is defined to transform committed into uncommitted government income.

absolutely necessary that all methodologies compute the same "shadow prices" to transform one numeraire into another; the same numbers would be required to transform foreign exchange into domestic values or investment into consumption values or government income into private income, etc., or vice versa.

This paper examines the above issues in order to establish the equivalences and discrepancies between SVT and Schy. et al. Section II is devoted to explore the equivalence of using multiple conversion factors to transform the domestic value of non-traded goods into its foreign exchange equivalent as opposed to the use of a Shadow Exchange Rate (SER) to transform foreign exchange into its private consumption equivalent. Section III explores the valuation given by Schy. et al. as opposed to SVT to a very special non-traded good, labor. Section IV examines the effects of a project on the rate of investment and the valuation given to transform it into its consumption equivalent, including the valuation of public as opposed to private income. Finally, Section V compares the process of discounting and the choice criterion which summarizes all the above into a single algorithm for investment decisions.

II. Conversion Factors versus Shadow Exchange Rate

II. 1. The two approaches in general In order to compare projects with different impact on the availability of traded and non-traded goods, a foreign exchange equivalent to the domestic value of non-traded goods or a domestic equivalent to the foreign exchange value of traded goods is required. Schy. et al. belong to the set of methodologies that "inflate" the foreign exchange value of traded goods in order to arrive at their domestic equivalent. This is done by using the Shadow Exchange Rate which is meant to reflect the domestic value of the increase (decrease) in consumption (their numeraire) generated by a small change in the availability of foreign exchange. SVT on the other hand, prefer to "deflate" the domestic value of non-traded goods to arrive at their foreign exchange equivalent. Therefore, if the same classification of traded and non-traded goods were made by the users of both methodologies and the same number were to be used to inflate or deflate respectively, both methods would be exactly equivalent. SVT argue, however, that their method to deflate the value of non-traded goods is fundamentally different from the one used by "more traditional approaches."[1] This would be so because the deflation process should be done, in principle, by using a different conversion factor for each non-traded good:

> A more traditional approach ignores the need for differential conversion factors altogether and simply applies one conversion factor for all non-traded items. [2]

It is argued in this paper, however, that SVT's method of computing the foreign exchange equivalent of a non-traded good is, in theory at least, exactly the same as Schy. et al's [3] method of computing shadow prices for non-traded goods:

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[1] SVT, pp.35

[2] Ibid, pp.35

[3] The same as UNIDO Guidelines also, see UNIDO chapters 4 and 5.

> Consider, for example, that a project increases demand for a non-traded commodity that is met in part by expanding its output and in part by a shift in consumption away from other uses. With respect to expanding output, the marginal social cost of increased production should be assessed. This is accomplished by valuing the inputs required to expand production at shadow prices. Traded inputs can be valued directly at border prices. Non-traded inputs can be further decomposed into their constituent inputs -- unless they are drawn away from use elsewhere, in which case they must be treated in the manner described below -- until all inputs consist of directly and indirectly traded goods and of basic domestic inputs (that is, mainly labor and possibly some other primary resources,such as land, which are evaluated at their shadow prices). With respect to the second part, a shift away from other uses, the forgone marginal social benefit of reduced consumption elsewhere should be assessed..."[4]

The above quote corresponds exactly to Schy. et al.'s advocacy of "second best shadow supply prices and second best shadow demand prices".[5] In other words, non-traded goods would be shadow priced by computing Marginal Social Cost (MSC), Marginal Social Benefit (MSB) or a combination of the last two <u>as required by market conditions</u>.[6] In practice, however, most SVT's conversion factors are computed on the supply side only: "with regard to elasticities, it is recommended that, unless there is specific information to the contrary, an infinite elasticity of domestic supply be assumed".[7]

In summary, methodologies using multiple conversion factors to value non-traded goods generate the same yearly flow of net benefits as the ones using a unique shadow exchange rate provided that: a) the same classification of traded and non-traded goods is made by the users

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[4]SVT, pp. 33 and 34.

[5]D. M. Schydlowsky, "Project Evaluation in Economies in General Disequilibrium: An Application of Second Best Analysis." p.17.

[6]On this, see Section II.3. below.

[7]SVT, p. 125.

of both methodologies, b) the same decision is made with respect to shadow pricing non-traded goods at Marginal Social Cost, Marginal Social Value or a combination of the last two as required by market conditions, and c) The same number is computed to "deflate" the value on non-traded goods or to "inflate" the value of foreign exchange. For this to happen, the same assumptions would need to be made with respect to the nature of the Balance of Payment adjustments necessary for the country to obtain additional consumption or to absorb additional foreign exchange.[8]

II.2. The equivalence of the two approacnes

It does not suffice to compare SVT's multiple conversions factors to Schy. et al.'s unique shadow exchange rate to arrive at the conclusion that they are different methodologies. It is necessary to go beyond the first appearance and look into how the conversion factors are computed and used to obtain a yearly flow of benefits and costs and compare them to the yearly flow obtained by Schyd. et al when applying the SER to the value of traded goods.[9] The following subsections examine further the conclusion that both yearly flows are exactly the same provided some care is taken with the definition and valuation of non-traded goods and with the Balance of Payment assumption required to arrive at the Shadow Exchange Rate.

II.2.1. The yearly flow of benefits and costs

In order to clarify the equivalence of using multiple conversions as opposed to a unique SER in obtaining yearly flows of benefits and costs, let us take a simple case where all conversion factors are valued on the supply side, at Marginal Social Cost. At this stage, let us also

8 See section II.2.3 below.

9 The same conclusions arrived at the end of this Chapter apply to UNIDO's and Harberger's use of a unique SER.

assume that consumption is equally valuable as investment.

Imagine a project that produces one traded good T_1 and requires inputs of a traded good T_2, non-traded inputs N_1, N_2, and Labor L.

Let us define,

a_{xy} = amount of input x required to produce one unit of output Y; where $x = N_1, N_2, T_2, L$; $Y = T_1, N_1, N_2$; $X \neq Y$

P_{Ti} = Border price of Ti; i = 1, 2.

F_{Ni} = Conversion factor of non-traded good Ni; i = 1, 2 (Border price "equivalent" of Ni)

F_L = Conversion factor of labor (Shadow wage rate at border price "equivalent").

Therefore, the net benefits at border prices ($B^{Bp}_{T_1}$) of a project increasing the availability of T_1 by one unit are:

$$B^{BP}_{T_1} = P_{T_1} - a_{T_2T_1} P_{T_2} - a_{N_1T_1} F_{N_1} - a_{N_2T_1} F_{N_2} - a_{LT_1} F_L \quad (1)$$

Since F_{N_1} and F_{N_2} are conversion factors and it is assumed that they will be computed on the supply side, i.e., at Marginal Social Cost (MSC), we would need to "decompose" the cost of producing N_1 and N_2 into its traded and non-traded inputs, therefore,

$$F_{N_1} = a_{T_2N_1}P_{T_2} + a_{N_2N_1}F_{N_2} + a_{LN_1}F_L$$ Marginal Cost of producing N_1 (at border prices equivalent)

$$F_{N_2} = a_{T_2N_2}P_{T_2} + a_{LN_2} F_L$$ Marginal Cost of producing N_2 (at border prices equivalent)

By replacing F_{N_1} and F_{N_2} into (1), we have

$$B_{T_1}^{BP} = P_{T_1} - a_{T_2T_1} P_{T_2}$$

$$- a_{N_1T_1} [a_{T_2N_1} P_{T_2} + a_{N_2N_1} F_{N_2} + a_{LN_1}F_L] \qquad (2)$$

$$- a_{N_2T_1} [a_{T_2N_2} P_{T_2} + a_{LN_2} F_L]$$

$$- a_{LT_1} F_L$$

By replacing F_{N_2} into (2) and factoring, we get

$$B_{T_1}^{BP} = P_{T_1} - A_{T_2T_1} P_{T_2} - A_{LT_1} F_L \qquad (3)$$

where,

$$A_{T_2T_1} = a_{T_2T_1} + a_{T_2N_1} a_{N_1T_1} + a_{T_2N_2} a_{N_2T_1} + + a_{T_2N_2} a_{N_2N_1} a_{N_1T_1}$$

= per unit direct and indirect cost of the total amount of T_2 required to produce one unit of T_1

$$A_{LT_1} = a_{LT_1} + a_{LN_1} a_{N_1T_1} + a_{LN_2} a_{N_2T_1} + a_{LN_2} a_{N_2N_1} a_{N_1T_1}$$

= per unit direct and indirect cost of the total amount of labor required to produce one unit of T_1

As we can see from (3), in the process of calculating MSC for each non-traded good, everything was left in terms of the international prices of the (only two in this example) existing traded goods T_1 and T_2 and in terms of only one conversion factor, F_L.

Therefore, in spite of there being initially 3 conversion factors (F_{N_1}, F_{N_2} and F_L), one for each non-traded good and one for labor, which gives the impression of "multiple exchange rates," at the bottom there is only one conversion factor, the one that transforms the cost of labor into its border price equivalent.[10] But labor is a typical non-traded intermediate good which should be valued at its supply price, demand value, or a combination of both depending upon the conditions of the labor market.[11] Furthermore, the supply price of labor is no more than the marginal utility of consumption of leisure. Also, the social value of its demand price is no more than the marginal utility of the final consumption goods (net of social costs) created directly or indirectly by the productivity of labor. Therefore, at the end, everything is reduced to transforming the marginal utility of consumption into its border price equivalent. This is obviously done by the so-called "Consumption Conversion Factor."

This conclusion is particularly ironical if you take into account the emphasis placed by SVT on the need for multiple conversion factors,[12] one for each non traded good, and that the origin of the OECD manual,[13] on which SVT

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10 It should be noticed that only one type of homogeneous labor is assumed and that this is the only primary factor of production here.

11 See Sections II.2.2 and II.2.3 below.

12 See specifically pp. 35 of SVT.

13 I.M.D. Little & J.A. Mirrlees (LM henceforth), op. cit.

is based, rested on the desire of its authors to get rid of a concept so "casual" as the SER: "In principle the SER appropriate for UNIDO is the inverse of our 'consumption conversion factor', i.e., the change in the border value of imports and exports caused by a marginal change in aggregate consumption measured in domestic market prices. This is of course a difficult thing to measure: and there is a danger that much less appropriate procedures will be used (and, indeed, in the Guidelines' case studies the SER is apparently estimated in a casual manner)."[14] We have shown, however, that LM or SVT's use of multiple exchange rates (conversion factors), one for each non traded good, is only apparent. The only conversion factor they really have is the one they want to reject: the consumption conversion factor.

In general, however, you would have to transform the domestic value of each different "primary factor of production", i.e., labor, land, and entrepreneurship, into its border price equivalents. This is done by using the same kind of conversion factor: the consumption conversion factor. Of course, if the consumption pattern created (or foregone) by each one of these primary factors of production were far apart from the consumption basket of the average consumer, different consumption conversion factors would be needed. This is quite a different issue, however. It is not that you need one different conversion factor (exchange rate) for each non-traded good, but that the pattern of demand for present and future consumption created by each project may be different, originating different effects on consumption and savings (see Chapter IV below).

In the case of land, although no explicit formulation is given for its shadow price either in L-M or in SVT, a reference to it is made on p. 223

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14 Ibid, p. 361.

of the 1974 version of L-M. Also, what is said by SVT in relation to labor's marginal product foregone is applicable to land's marginal productivity (see page 118). The issue would be one of estimating the social value of its marginal productivity as opposed to its market price. To do that you would need to see the multiple uses for which this factor of production is required. Since part of the land will be used to produce traded goods and part to produce non-traded, its valuation will follow a process similar to that of "decomposing" the cost of producing non-traded goods to get their conversion factors. In this case, however, the decomposition would be on the demand side, looking for the multiple uses of land.

Therefore, if at the end of the decomposition process one converts the domestic values of primary factors of production by using a unique consumption conversion factor, the yearly flow of benefits and costs are the same for both approaches. This will be exactly true, however, only if the same process of classifying and valuing non-traded goods is carried and if the same formula were to be used to compute the consumption conversion factor.

II.2.2. Classification and valuation of traded and non-traded goods

The decision of what goods are to be considered non-traded goods (and therefore to compute conversion factors for them) does not really belong to any methodology in particular, but to the best judgement of the experts (economists?) on the country under study. Since there always exist non-traded goods which could potentially, under different trade policies, be traded (the so-called tradeables[15]), a decision should normally be based upon a judgement

15 See Lyn Squire-Van der Tak, p. 90.

on the stability of the existing trade restrictions like import quotas, or prohibitive tariffs. If these are taken as given, second best shadow prices are not only required, but they imply to value those potentially traded goods as if they were non-traded. Traditionally, however, decisions have been based upon the physical characteristics of those goods that could not be transported to or from outside the country at reasonable costs, or could not be transported at all. This explains why electricity, construction and domestic transportation are the typical examples for which conversion factors are normally computed in spite of the existence of many products which will probably never be exported or imported due to restrictions to international trade.

The very nature of a second best world implies, therefore, that the inclusion (or exclusion) of tradeable goods in the non-traded category is a matter of judgement. It has been argued however, that L-M's methodology, on which SVT's methodology is based, requires dealing with tradeables as if they were traded, implicitly assuming that trade distortions should (and would) be removed.[16] They would therefore value benefits and costs at first best rather than the more accepted second best shadow prices. L-M and SVT's methodologies are not, however, dependent upon the classification of goods among traded and non-traded. Conversion factors could be applied to any good selected to be non-traded. There may be, on the other hand, a personal bias of the authors of the OECD manual who seem to feel more

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16 See Partha Dasgupta, "A Comparative Analysis of the UNIDO Guidelines and the O.E.C.D. Manual," Bulletin of the Oxford University Institute of Economics and Statistics, Feb. 1977. Also, S. Marglin, "The Essentials of the UNIDO Approach to Benefit Cost Analysis," Symposia on the use of socio-economic investment criteria in project evaluation, IDB-UNIDO, Washington, D.C., 1973.

comfortable the more goods are valued at world rather than domestic prices, even if those goods never get involved in trade due to (right or wrong) restrictions to international trade. UNIDO and Schydlowsky, on the other hand, place their emphasis on valuing a good as traded only if it is in fact exported or if it in fact substitutes for imports.[17]

In order to decide whether a particular good is to be considered traded or non-traded, an analysis of the market conditions affecting its production and sale is needed. For example, if domestic relative prices of commodities change as a response to changes in their availability, both domestic consumption and domestic production will be affected, requiring a measurement of their shadow price in terms of Marginal Social Benefit (MSB) and Marginal Social Cost (MSC). Only if there are no changes in price and it is rather the availability of exports or imports that is affected, should the good be considered traded and be valued at the corresponding FOB or CIF price.

It is worth noting here that this dependence upon the specific characteristics of the market conditions (i.e., price elasticities and adjustment mechanisms of the market) in order to decide whether to value a non-traded good at MSB or MSC or both is one of the reasons why Schy. et al. do not compute shadow prices for non-traded goods (conversion factors) that could be used mechanically without an analysis of the specific market

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[17] See Schydlowsky, op. cit. March, 1973, p. 17.

at hand. The idea is that this is better done by the project economists who are supposed to know the characteristics of the markets for the outputs and inputs involved in their projects. On the other hand, it may be very convenient in practice to have numbers (conversion factors) previously prepared by the Central Office of Project Evaluation (Little-Mirrlees COPE) ready at hand for the use by project economists. But since it will not be clear what type of valuation is most adequate until market conditions for each non-traded good are analysed, it would be better for COPE not to prepare conversion factors, but to give measurements of MSB, MSC and price elasticities, asking the project economist to decide how to use them.

Furthermore, it may well be the case that changes in the availability of a particular good affect not only domestic demand and domestic supply, but also exports and imports at the same time, which would mean that this good is traded and non-traded at the same time! For example, there may be cases where the increase in production is large enough to transform previously imported goods into exports. Since the CIF price is higher than the FOB price,[18] the increase in supply would imply not only import substitution and export creation, but also displaced domestic production and increased domestic consumption. Part of this production should be valued at border prices of course, but displaced domestic production has to be valued at MSC and increases in consumption at MSB. The analysis to decide what is going on has to be left to the good judgement of the project economist who is supposed to know the market for the product of his project. In this particular case he would need to have not only the CIF and FOB prices, but also the values of MSC and MSB.

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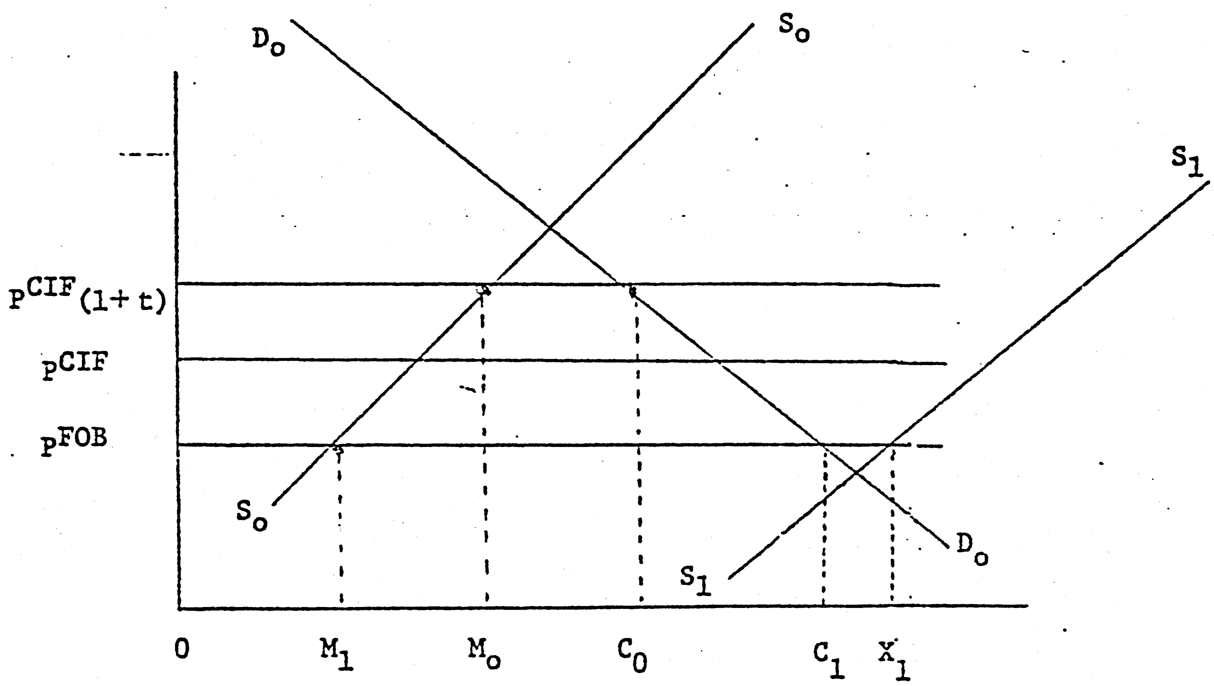
[18] The existence of an import tariff would reinforce this argument.

The following graph illustrates the above example. S_oS_o is domestic supply before a project is implemented. D_oD_o is domestic demand. Assuming a small country situation (international prices given), domestic price would be $P^{cif}(1+t)$ where t is an import tariff. At this price, consumption before the project is implemented would be OC_o, domestic production would be OM_o and imports would be M_oC_o. If supply increases to S_1S_1 due to the project, the domestic price will go down to the level of the FOB price, displacing domestic production of M_oM_1 of those who cannot compete at this lower price, substituting all imports of M_oC_o which are now produced by the project, inducing additional consumption of C_oC_1 due to the lower domestic price and creating exports of C_1X_1 at the FOB price.



Is this production traded or non-traded? Both, of course. Part is traded and part is non-traded. Should the non-traded part of this production be valued at MSC or MSB? Both, of course. The reduction of domestic production from M_o to M_1 represents a saving of resources, a saving of the marginal cost of producing M_1M_o (which is now produced by the project) and should therefore be measured at MSC. The increase in consumption from C_o to C_1 should clearly be valued at Marginal willingness to pay or MSB. Should the traded part of the project production be valued at CIF price or FOB price? Both, of course. Import substitution of M_oC_o should be valued at CIF price and additional exports of C_1X_1 should be valued at the FOB price. The total new amount of M_1X_1 produced by the project (horizontal difference between S_oS_o and S_1S_1) is divided between $M_1M_o + M_oC_o + C_oC_1 + C_1X_1$, of which M_1M_o and C_oC_1 are non-traded, M_1M_o valued at MSC and C_oC_1 valued at MSB. M_oC_o and C_1X_1 represent traded production, of which M_oC_o is import substitution and C_1X_1 are exports.

Both Little - Mirrlees[19] and Squire-Van der Tak[20] accept the possibility of valuing non-traded goods at Marginal Social Benefit (MSB), Marginal Social Cost (MSC) or a combination of both, depending upon whether extra demand for (supply of) a unit of the commodity reduces (adds to) consumption of it elsewhere or increases (decreases) production of it, or both. In the extreme case where supply of the non-traded is totally fixed, an increase in its demand will necessarily forego consumption of it elsewhere and the shadow price would have to be MSB. Also, in the extreme case where supply of the non-traded could be expanded at constant marginal costs in response to an increase in its demand, the shadow price will have to be MSC. In general,

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[19] See Section 9.4 of the 1974 version.

[20] See Lyn Squire-Van der Tak, pp. 33-35.

production of a non-traded could be expanded in response to an increase in its demand, but only at increasing marginal costs. Therefore, higher price is required which in turn means some consumption by former users is foregone. The shadow value of the non-traded would then be, in general, a weighted average of MSB and MSC depending on how the market for the non-traded good reacts in response to marginal increases in its demand or supply.

This is well reflected by SVT when they indicate that non-traded goods should be valued according to the expression,[21]

$$P_{Nt}^{sh} = \frac{\varepsilon \alpha + \eta \beta}{\varepsilon + \eta}$$

where P_{Nt}^{sh} = shadow price of a non-traded good

ε = supply elasticity

η = demand elasticity

α = ratio of MSC to domestic price = production conversion factor

β = ratio of MSB to domestic price = consumption conversion factor

In case $\varepsilon \rightarrow \infty$, $P_{Nt}^{sh} \rightarrow \alpha$, therefore MSC should be computed. In case $\varepsilon \rightarrow 0$, $P_{Nt}^{sh} \rightarrow \beta$, therefore MSB should be computed. Therefore both MSC and MSB should be computed when $0<\varepsilon<\infty$.

In spite of the clarity with which this is expressed both in Little-Mirrlees and SVT, they almost never in practice recommend one to calculate conversion factors for non-traded goods at MSB: "With regard to elasticities, it is recommended that, unless there is specific information to the contrary, an infinite elasticity of domestic supply be assumed" (SVT, p.125). The

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[21] See Squire-Van der Tak, p. 145.

practical consequence of this recommendation is that conversion factors are always computed on the supply side only. They constitute, in fact, a cost decomposition aimed at estimation of MSC.

The existence of multiple conversion factors (multiple exchange rates), one for each non-traded good, is then no more than multiple MSC, for each one of them. Furthermore, in order to obtain each MSC, it is necessary to decompose the cost of production into the traded and non-traded inputs required to produce it. If non-traded inputs are involved, they should be valued by repeating the same procedure until one has, hopefully, gone through the whole input-output matrix and arrived at primary factors of production.[22]

Once one arrives at some primary factor of production, let us say labor, one would have to transform it into its equivalent in border prices. As we have already mentioned, this is at the end of the process reduced to applying the consumption conversion factor, the meaning of which could be interpreted as the reciprocal of the shadow exchange rate. At the end, therefore, both methodologies would be using only one kind of conversion factor (exchange rate), the consumption conversion factor. As a consequence, the yearly flow of net benefits computed by L-M and SVT would be the same as those by UNIDO, Schydlowsky and Harberger, provided that everybody uses the same algorithm to compute this shadow exchange rate. In turn, the particular formula to be used would depend upon the special characteristics of the foreign exchange market, which will react to the increases in demand for present consumption and future consumption (savings) created by the projects in quite different ways depending on the different nature of the foreign exchange markets of each country. Consequently, it could not be that the same formula for the consumption conversion factor be applied for so many different countries having such different adjustment conditions.

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[22] By the way, the similar procedure would have to be used if one were computing MSB for an intermediate good, looking into all the uses of it until arriving at final consumption.

II.2.3. Link to the labor market and balance of payments adjustment mechanisms

Let us now examine the cost of labor, which is the only value we are left in equation (3) of page 8 that has to be "converted" from domestic to border prices. To do that, we will examine each one of the components of SVT's Shadow Wage rate.[23]

$$SWR = m\alpha + (w-m)(\beta - \frac{d}{v}) + (w-m)\phi e \frac{d}{v}$$

(Shadow wage rate)	=	[labor's foregone Mg. product at accounting prices]	+	[net social cost of increased consumption]	+	[social cost of reduced leisure]

where,

α = conversion factor for output = ratio of marginal social cost of production (at border prices equivalent) to domestic price of production

m = foregone marginal product at domestic prices

w = wage rate at the new job (market rate)

d = distribution parameter (value of private sector consumption level c relative to that of the average level of consumption $\bar{c}$)

$$v = [\frac{q(1-s)}{i - sq}] \div \beta$$

i = consumption rate of interest (social time preference)

q = marginal product of capital

β = consumption conversion factor

s = marginal propensity to save

ϕ = ratio of the social to the private evaluation of foregone leisure (disutility of effort)

e = ratio of the wage earner's own evaluation of the disutility of effort to his additional income.

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[23] See page 83 of Squire-Van der Tak, 1975.

Let's call $P_K = \frac{q(1-s)}{i - Sq} = V\beta$ = partial equilibrium shadow price of investment.

In order to compare this SWR to Schydlowsky's, let us make $\phi = 1$ and $d = 1$. This is equivalent to saying that the worker's own evaluation of leisure adds to social welfare, and that either there is no concern for income distribution or that the value of leisure is measured at some "average consumer level."

Then,

$$SWR = m\alpha + (w - m)\beta\left(\frac{P_K - 1}{P_K}\right) + P_L \frac{\beta}{P_K} \qquad (5)$$

where, P_L = wage earner's own evaluation of the disutility of effort. [Note that $e = \frac{P_L}{(w - m)}$]

The 2nd term of equation (5), $(w - m)\left(\frac{P_K - 1}{P_K}\right)\beta$ is (additional income of a worker who was getting m before) x (excess value of P_K above one) x (consumption conversion factor), everything measured in the numeraire, investment, so it is divided by P_K. This is so because, a) it is assumed that former wage was his marginal productivity, and b) all workers' additional income is <u>totally</u> consumed therefore it is transformed into border prices equivalent using the consumption conversion factor (β) [see page 83 of SVT.]

Taking World Bank efficiency analysis only (before adjustments for income distribution and before investment reinvestment effects), therefore measuring consumption only in terms of the SVT numeraire, we may forget about the 2nd term $(w - m)\beta\left(\frac{P_K - 1}{P_K}\right)$. This is equivalent to our initial assumption (page 7) that consumption is equally valuable as investment, i.e., $P_K = 1$.[24]

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[24] On the inclusion of this "investment effect" within the shadow price of labor, see Chapter III of this paper.

So,

$$SWR = m\alpha + P_L \frac{\beta}{P_K} = m\alpha + P_L\beta$$

where,

$m\alpha$ = labor marginal productivity x production conversion factor

$P_L\beta$ = supply price of labor x consumption conversion factor.

To add labor's marginal productivity to its leisure value is an unintended mistake. SVT do not mean to add both (m and P_L), but a weighted average, Harberger style (see Appendix, page 146) where they say, "A shadow wage rate is not derived here because the actual derivation will depend crucially on the way in which the relevant labor market works"[25] ... "In essence, the analyst is still working with equation (A24)*, but..."[26]

Therefore, depending upon the working of the adjustment mechanism of the labor market, a weighted average of m and P_L would be needed, or m alone in the case of full employment with inelastic supply of labor or, as Schydlowsky assumes it, only P_L in case you assume unemployment and no product foregone as a new investment pulls labor from some kind of unlimited supply. So, if only leisure is foregone,

$$SWR = P_L\beta$$

which would be the "consumption" value of leisure in foreign exchange equivalent. So, replacing F_L on equation (3) of page 8, we have,

$$B^{BP}_{T_1} = P_{T_1} - A_{T_2T_1}P_{T_2} - A_{LT_1}\, P_L\beta \qquad (3')$$

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[25] There is a very strange asymmetry between this and the treatment given to other non-traded goods. Actually, the actual derivation of ALL NON-TRADED will depend crucially on the way the relevant market works, as it is argued in this paper.

[26] Equation A24 is, in essence, Harberger's. See page 16 of this report.

Equation (3') shows the yearly flow of net benefits in foreign exchange units. To measure them in consumption units we need to divide by β, the consumption conversion factor,

$$B^{BP}_{T_1} \frac{1}{\beta} = P_{T_1} \frac{1}{\beta} - A_{T_2T_1} P_{T_2} \frac{1}{\beta} - A_{LT_1} P_L \qquad (3'')$$

However, the conceptual meaning of β is that of the reciprocal of Schydlowsky's (and UNIDO's) shadow price of foreign exchange (P$). The latter is defined as "the increase in consumption generated by a marginal increase in the availability of foreign exchange."

Therefore, by making $\beta = \frac{1}{P\$}$ and $B^C_{T_1} = B^{BP}_{T_1}$ P$ = consumption value of foreign exchange benefits, we have,

$$B^C_{T_1} = P_{T_1} P\$ - A_{T_2T_1} P_{T_2} P\$ - A_{LT_1} P_L \qquad (6)$$

which is the yearly value of benefits in consumption units (Schydlowsky-UNIDO). Therefore, the yearly flow of benefits measured in foreign exchange units (Little-Mirrlees, Squire-Van der Tak) could easily be transformed into benefits measured in consumption units (Schydlowsky-UNIDO) by simply dividing them by the consumption conversion factor (or what is the same, multiplying them by the shadow price of foreign exchange.) In order for this to be exactly correct, however, we need to remember that, at this stage: a) no reinvestment of benefits nor income distribution effects have yet been computed, i.e., there was a need to eliminate the expression $(w - m)\,\beta\,(\frac{P_K - 1}{P_K})$ from the SWR's formulae on page 19 of this report, assuming P_K, ϕ and d had values of one (same page), b) the same valuation of non-traded goods has to be made, i.e., at MSB, MSC or both, according to the working of their respective markets, and c) the consumption conversion factor has to be interpreted as the reciprocal of the shadow exchange rate. The next section, II.3 is devoted to discussing point c). Chapter III, in turn, is devoted to the shadow wage rate and the inclusion of a savings effect in it.

II.3. Balance of payment adjustment mechanism

We have argued that in spite of seeming to have different exchange rates for different non-traded goods, L-M and SVT only have one exchange rate, the consumption conversion factor (CCF). All the others do not properly fall within the category of "exchange rates," but are computations of the Marginal Social Cost or Marginal Social Benefit of producing non-traded goods. The only exchange rate they have at the end of the process of shadow pricing these non-traded goods is the one that transforms the marginal utility of final consumption goods into its foreign exchange equivalent, i.e., the consumption conversion factor.

The conceptual definition of the shadow exchange rate is "the increase (change) in consumption that is created by an increase (change) in one unit of foreign exchange," By the same token, a consumption conversion factor could be defined as "the increase (change) in foreign exchange that is necessary in order to generate an increase (change) in one unit of consumption."[27] But the amount of foreign exchange needed for that purpose will certainly depend upon how the economy adjusts when facing an increase in its demand for (supply of) foreign exchange. That is why different authors (Harberger, Schydlowsky, UNIDO, etc.) have different algorithms when computing the shadow

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[27] See Little & Mirrlees, op. cit. 1974, page 361.

exchange rate, (consumption conversion factor); i.e., they are making different assumptions about the way the economy adjusts.

II.3.1. The UNIDO Guidelines form as compared to SVT

If an increase in the availability of foreign exchange were immediately spent on consumer goods (assuming all imports are consumer goods in the margin),[28] then the shadow price of foreign exchange (S.E.R.) would be as specified in UNIDO's and very similar to the reciprocal of SVT's consumption conversion factor:

$$P\$ = \sum_i \alpha i \frac{p_i^{DOM}}{p_i^{CIF}} \quad , \text{ where } \Sigma \alpha_i = 1 \qquad (7)$$

The above is the UNIDO guidelines' shadow price of foreign exchange. Since $\alpha_i = \frac{\partial M_i}{\partial M}$ is the marginal share of i imports in total imports, and all foreign exchange is immediately spent on additional imports, $\sum_i \alpha_i \frac{1}{p_i^{CIF}}$ represent physical amounts of the different additional goods that would be imported with one additional unit of foreign exchange. Their "social value" is, therefore, the above amount times the domestic willingness to pay for each good, represented here by its domestic demand price (p_i^{DOM}).

It should be noted that the fundamental assumption underlying UNIDO's P$ is the absence of capital goods in the marginal composition of imports.[29] This is consistent with the fact that the domestic price (p_i^{DOM}) is being used as a proxy for "welfare value." In fact, in the absence of rationing or of creation of consumer surplus, the domestic price reflects marginal willingness to pay which is, by definition, the "social" value of a final comsumption good. If capital goods were to be included in the formula, however, they could not be shadow priced at their domestic price. The net

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[28] This would be the equivalent to L-M's saying that all additional consumption of the wage-earners is composed of only traded goods, see p. 271, op.cit., 1974.

[29] See UNIDO, p.220

present value of the flow of consumption added by one additional unit of a capital good would be needed. This "social" value would be quite different from the domestic price of a capital good.[30]

Under the simplifying assumption that marginal and average propensities to import are the same $\left(\frac{\partial M_i}{\partial M} = \frac{M_i}{M}\right)$ and that tariffs are the only cause for divergence between domestic and world prices, (7) becomes

$$\frac{P\$}{R} = (1 + t_m) \qquad (8)$$

where R is the nominal exchange rate and t_m are tariff collections on imports as percentage of total imports.

Both formulations (7) and (8) have their image reflected in SVT's consumption conversion factor[31]

$$\beta = \sum_i a_j \frac{\lambda i}{P_i} \qquad (7')$$

and

$$\beta = \frac{1}{1 + t_m} \qquad (8')$$

The only difference -- an important one -- lies in the definition of the α_i's and a_j's which are not necessarily the same: while the α_i's represent marginal propensities to import for UNIDO, the a_j's represent proportions of marginal expenditures for SVT.[32] For both to be exactly equal, therefore, it would be necessary that all the additional income created by a project be not only immediately consumed, but totally consumed in traded goods.

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[30] It should be noted that even when according to UNIDO Guidelines, intermediate goods imports needed to produce consumption goods are allowed, they do not adjust the corresponding domestic price to obtain a shadow valuation that reflects distortions in the related markets for complementary inputs and for final output. See UNIDO, p.220.

[31] See SVT, op.cit., pp.128-129.

[32] See SVT, op.cit., p.128.

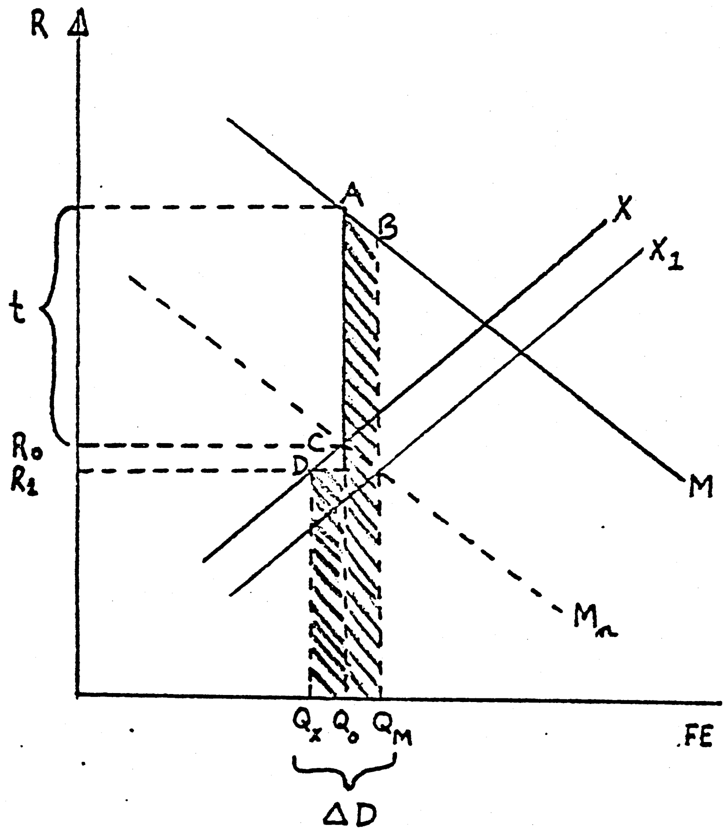
The normal case, however, will be one where part of the new income generated is consumed and part is invested, and both consumption and investment may be on traded or non-traded items.[33] Furthermore, the final outcome on the composition of imports will depend upon the adjustment mechanism of the Balance of Payments in the economy.

II.3.2. The Harberger form as compared to SVT

Neither UNIDO nor SVT explain what market adjustment mechanisms determine the values of α_i's and a_j's respectively. Harberger shows an improvement in this respect by explicitly specifying an adjustment mechanism of the foreign exchange market as determining the effects of a change in the availability of foreign exchange on imports and exports: increases in the availability of foreign exchange would lower the relative price of traded as compared to non-traded goods, which is equivalent to a revaluation of the domestic money, increasing therefore the demand for imports and decreasing the supply of exports.

The following is a typical "Harberger" graph illustrating the above. Here R is the exchange rate, X and M are the supply and demand for foreign exchange respectively (equivalent to exports and imports under the small country assumption of given world prices). R_o is the initial exchange rate and t is the average difference between supply and demand prices for foreign exchange due to distortions in international trade. After a shift in the supply of foreign exchange by ΔD, R_o goes down to R_1 increasing the demand for imports from Q_o to Q_M and decreasing the supply of pre-existing exports from Q_o to Q_x. The magnitude of the respective changes depends upon the

33 See Chapters III and IV below.



respective demand and supply elasticities. The above explain the following formula for Harberger's shadow exchange rate:

$$P\$ = \frac{\varepsilon_x X(1 - t_x) + \eta_M \cdot M(1 + t_m)}{\varepsilon_x \cdot X + \eta_M \cdot M}$$

where ε_x is the supply elasticity of exports, t_x is the average differential between domestic and FOB prices of exports due to distortions on the export side, η_M is the demand elasticity for imports and t_m is the average differential between domestic and CIF prices of imports due to distortions on the import side.

This Harberger formula is exactly the reciprocal of the so-called "Standard Conversion Factor" of SVT. Even when theoretically they would never use it (since each non-traded good would have its own conversion factor), this value has been recommended as a proxy to estimate the difference between domestic and border prices for non-important non-traded items, for which it would not be worthwhile to do detailed calculations.[34]

II.3.3. The Schydlowsky et al. form

As may have been noticed already from the previous discussion, one of the main characteristics of Schydlowsky et al.'s shadow prices is that they are strongly dependent upon the structure and functioning of each of the relevant markets, i.e. depending on its specific characteristics, each market will adjust differently in response to changes in demand or supply. That is why conversion factors for non-traded goods are not computed.[35] The need to determine the adjustment mechanism of each non-traded good market in order to decide whether a MSC, a MSB, or a combination of MSC and MSB, is relevant as a shadow price, makes the task more project specific (strictly speaking, "product" specific) rather than "country specific". The computation of shadow prices left to COPE has rather to do with the so-called "national parameters," i.e. those which computation requires systematic information on facts that are relevant to all (or many) different projects, like P$, P_K, P_L and P_G. On the other side, this dependence upon the specific characteristics of each market makes the task of computing "national parameters" more difficult. Here lies the main source of discrepancy between Schy. et al. and the rest of the methodologies.

The existence of import quotas, earnings repatriation schemes and other regulations, will imply a shadow price of foreign exchange for one

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34 See SVT, p.95.

35 See Section I.1. of this report

country quite different from the one relevant to another not having those characteristics. The Balance of Payments of each country will adjust differently in the face of an increase in the demand for foreign exchange. This will imply a different algorithm to compute P$ for Schy. et al. This is not so for L-M, or SVT: the same formula for the consumption conversion factor will be used irrespective of what country is under analysis.

In general, since the value of foreign exchange will depend upon the different uses to which it is allocated, it may very well be, depending upon the the Balance of Payments adjustment mechanism, that additional foreign exchange be used to increase imports of consumption, intermediate or capital goods. Of course, neither intermediate nor capital goods have a value by themselves, except in their capacity to create or collaborate in the production of final consumption goods. So, conceptually, the shadow price of foreign exchange measures how much consumption is created directly and indirectly when extra foreign exchange is available. This is certainly different from the way the consumption conversion factor is computed in spite of the conceptual similarity between it and P$. The consumption conversion factor asks for the foreign exchange necessary to buy a consumption basket of goods. It does not take into account, however, that part of the consumption basket may be obtained, not simply by directly importing consumer goods, but also by importing intermediate goods in an economy, let us say, with unused capacity.

The above reasoning explains the following differences between the algorithm used to compute the consumption conversion factor (CCF) and

Schy. et al.'s shadow exchange rate (SER), which recognizes that both intermediate and capital goods are also affected when there is a change in the availability of foreign exchange:

SVT's Consumption Conversion Factor:

$$CCF = \sum_c m_c \frac{\lambda_c}{P_c}$$

where,

$\sum_c m_c = 1$

λ_c = world price of each consumption good c

P_c = Marginal willingness to pay for each consumption good c

Schydlowsky et al.'s Shadow Exchange Rate:

$$P\$ = \sum_c m_c \frac{P_c}{\lambda_c} + \sum_I m_I \frac{P_I}{\lambda_I} + \sum_K m_K \frac{P_K}{\lambda_K}$$

where,

$\Sigma m_c + \Sigma m_I + \Sigma m_K = 1$

λ_i = world price of good i, for i = c, I, K

P_c = marginal willingness to pay for consumption good c

P_I = value of final consumption goods produced by the use of intermediate good I net of social costs

P_K = net present value of consumption generated out of one unit of investment in capital good K

One should notice that in order to estimate P$, both an estimation of P_K and P_I are needed. To estimate P_I in turn, the marginal social cost of all other inputs complementary to the imported intermediate goods will be required. Also, many uses to which the intermediate imports will be allocated will probably generate taxes in addition to tariff collections. As a consequence, the shadow exchange rate will depend upon the shadow wage rate, the shadow price of capital and the shadow price of fiscal resources (public income). Therefore, $P\$ = F(P_L , P_K , P_G)$. This interdependence between shadow prices created by the indirect way of producing final consumption, by importing not only consumer goods but also intermediate and capital goods is certainly not present in the computation for the consumption conversion factor.

III. The Shadow Price of Labor

III. 1. Alternative concepts and their implications

The method to obtain a shadow price for labor should not be, in principle at least, different from the method of obtaining the shadow price of any other non-traded good, i.e., a demand price, a supply price or a combination of both of them would be needed as required by the adjustment mechanism of the labor market. Therefore, the social marginal productivity of labor would be the correct shadow price under full employment with inelastic supply of labor. The value of leisure foregone would be the correct shadow price under unemployment where workers could be picked up from an unlimited supply of them. A weighted average of the above values would be needed in case the wage rate changes in response to increases in the demand for labor. Different methodologies differ in their valuation of labor mostly because of different implicit assumptions about the adjustment mechanism of the labor market. Once the assumptions are made explicit, the differences normally disappear. The main difference between SVT and Schydlowsky et al.'s valuation of labor, however, lies in the treatment given to the savings effect.

III. 2. The Savings Effect

Another source of discrepancy between different methodologies for Cost-Benefit analysis is the treatment given to the effects of the project on the rate of saving. Different projects differ in their savings effects mainly because they generate income for people having different marginal propensities to save. Little and Mirrlees, Squire-Van der Tak and UNIDO seem to oversimplify by incorporating this effect within the shadow price of labor-- shadow wage rate— (SWR). It will be argued in this chapter that it is very inconvenient to do so, mainly because the assumptions needed for this treatment to be correct are not very realistic. This is why Schydlowsky et al. consider that the effects of the project on the rate of savings should be part of the benefit-cost analysis of the project and should not be incorporated as part of the shadow price of labor (SWR).

III.2.1 Schydlowsky et al., treatment of the savings effect

To show the above, let us start with our equation (6), page 21. In order to concentrate our attention on the shadow wage rate, let us simplify by assuming that labor is the only cost of production to produce T_1 and that there are no distortions other than those in the labor market. Recall that we are measuring net benefits in consumption units and have not incorporated any effect on savings. In other words, it is assumed that all this "potential" consumption is actually totally consumed, nothing is saved. We will now separate what part of this potential consumption goes to each one of the only two economic agents we have in this simplified case: labor and profit owners. Equation (6) is transformed into:

$$B^C_{T_1} = P_{T_1} - a_{LT_1} P_L \qquad (7)$$

Equation (7) could be rewritten as:

$$\begin{aligned} B^C_{T_1} &= P^B_{T_1} - a_{LT_1} w && \text{(profits)} \\ &\quad + a_{LT_1} w && \text{(wages)} \\ &\quad - a_{LT_1} P_L && \text{(consumption of leisure foregone by workers[1])} \end{aligned} \qquad (8)$$

If s_π and s_L are the marginal propensities to save out of profits and wages, we may separate the total potential consumption ($B^C_{T_1}$) into

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[1]Or, as Squire-Van der Tak call it, "disutility of effort," See pages 83 and 150.

actual consumption and future consumption (savings). Since P_K reflects the consumption value of savings, the total value of present plus future consumption generated out of producing T_1 will be $B^{C*}_{T_1}$, where:

$$B^{C*}_{T_1} = (P^B_{T_1} - a_{LT_1} w)[(1-s_\pi) + s_\pi P_K] + a_{LT_1} w[(1-s_L) + s_L P_K] - a_{LT_1} P_L \qquad (9)$$

Each term in (9) has the following meaning:

$(P^B_{T_1} - a_{LT_1} w)(1-s_\pi)$ is additional consumption of profit owners

$a_{LT_1} w\ (1-s_L)$ is additional consumption of workers

$-a_{LT_1} P_L$ is consumption of leisure foregone by workers

$[a_{LT_1} w s_L + (P^B_{T_1} - a_{LT_1} w) s_\pi] P_K$ is net present value of consumption generated by savings out of wages and profits

Equation (9) reflects what Schydlowsky et al. mean when they say that the savings effects should be incorporated into the benefit-cost analysis of the project.

III.2.2. UNIDO's and SVT's treatment of the savings effect

In order to arrive at UNIDO's or SVT's shadow wage rate, let us simplify equation (9) by assuming that all profits are saved and all wages are consumed ($s_\pi = 1$ and $s_L = 0$). Equation (9) would become:

$$B^{C*}_{T_1} = (P^B_{T_1} - a_{LT_1} w) P_K + a_{LT_1} w - a_{LT_1} P_L \qquad (9')$$

Since (9') is measured in consumption units, we should divide it by P_K and multiply it by β [2] in order to get it into L-M and SVT's numeraire (investment in foreign exchange units). If we also factorize w, we get:

$$\begin{aligned} B^{C*}_{T_1}/P_K &= P^B_{T_1} - a_{LT_1}\, w\, \left(\frac{P_K - 1}{P_K}\right) - a_{LT_1} \frac{P_L}{P_K} \\ &= P^B_{T_1} - a_{LT_1} \left[w\left(\frac{P_K - 1}{P_K}\right) + \frac{P_L}{P_K}\right] \end{aligned} \qquad (10)$$

You may notice that the expression in parenthesis on the right hand side of (10) is SVT's shadow wage rate [3] for m = 0, i.e., there is no marginal product foregone when pulling labor into the project.

Therefore, measuring the benefits of the project in consumption units and handling the savings effect in the benefit-cost analysis as Schydlowsky et al. do [4] is formally equivalent to measuring production in investment units and incorporating the savings constraint into the SWR [5] when one makes the typical labor-surplus model assumption of zero savings out of additional wages and zero consumption out of additional

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[2] See section II-1-2 of this report and recall that $\beta = \frac{1}{P\$} = 1$ by assumption of an undistorted foreign exchange market.

[3] See equation (5) on page 19 of this report

[4] See equation (9) on page 33 of this report

[5] equation (10)

profits. The assumption of $s_\pi = 1$ implies automatically that all output not paid to the workers gets invested, i.e., it is automatically measured in investment units.

III.2.3. A more general case

In a more general case, when $s_\pi \neq 1$ and $s_L \neq 0$, not only would production have to be adjusted to reflect that part of it that will be consumed by the profit owner (in order to have it in investment units), but also it would be necessary to take the difference between the marginal propensity to save out of profits and the marginal propensity to save out of wages in order to include the savings effect into the SWR. This can be shown by looking into equation (9) and arriving at the new SWR when $s_\pi \neq 1$ and $s_L \neq 0$. Reordering (9) and dividing by P_K we get:

$$\frac{B^{C*}_{T_1}}{P_K} = P^B_{T_1}\left[s_\pi + \frac{(1-s_\pi)}{P_K}\right] - a_{LT_1}\left[w(s_\pi - s_L)\left(\frac{P_K - 1}{P_K}\right) - \frac{P_L}{P_K}\right] \qquad (11)$$

Therefore, production should be corrected by the factor $\left[s_\pi + \frac{(1-s_\pi)}{P_K}\right]$ in order to have it in investment units and the difference between savings propensities $(s_\pi - s_L)$ is needed to obtain the SWR.

So far so good, but what would happen if we had a tax on the profits of the project at a rate of t_π?

The total effect of the project would now be:

$$B^{C^*}_{T_1} = (P^B_{T_1} - a_{LT_1}w) \quad (1 - t_\pi)$$ net profits

$$+ t_\pi \, (P^B_{T_1} - a_{LT_1}w)$$ government income (12)

$$+ a_{LT_1}w$$ wages

$$- a_{LT_1}P_L$$ consumption of leisure foregone by workers

To handle the savings effect of the project in the Benefit-Cost analysis (rather than in the SWR), Schy. et al. would compute:

$$B^{C^*}_{T_1} = (P^B_{T_1} - a_{LT_1}w) \, (1 - t_\pi) \, [(1 - s_\pi) + s_\pi P_K]$$

$$+ t_\pi \, (P^B_{T_1} - a_{LT_1}w) \, [(1 - s_g) + s_g P_K]$$

$$+ a_{LT_1}w \quad [(1 - s_L) + s_L P_K]$$

$$- a_{LT_1}P_L \qquad (13)$$

where s_g is the marginal propensity to save of the government. Now, if we assume $s_g = 1$, or, more importantly, make the L-M/SVT assumption that public consumption and public savings (uncomitted income) are equally valuable, and the simplifying assumptions that all profits are saved ($s_\pi = 1$) and all wages are consumed ($s_L = 0$) we would be back to SVT's shadow wage rate. Equation (13) would become:

$$B^{C^*}_{T_1} = (P^B_{T_1} - a_{LT_1}w)\ (1 - t_\pi)\ P_K + t_\pi\ (P^B_{T_1} - a_{LT_1}w)\ P_K + a_{LT_1}\ (w-P_L)$$

$$= (P^B_{T_1} - a_{LT_1}w)\ P_K + a_{LT_1}\ (w - P_L) \qquad (14)$$

Dividing by P_K to measure (14) in investment units and factoring, we get:

$$\frac{B^{C*}_{T_1}}{P_K} = P^B_{T_1} - a_{LT_1}\ [w(\frac{P_K - 1}{P_K}) + \frac{P_L}{P_K}] \qquad (15)$$

which gives again the SVT's shadow wage rate.

It is worth noting that in this case government income, or, what is the same to most practical applications of L-M/SVT's methodologies, government investment, is as valuable as profits because the latter are all invested and there is no difference between the social marginal productivity of government investment as compared to the social marginal productivity of private investment. This is in accord with their implicit assumption of optimality in handling public funds. As a consequence, taxes cancel out in equation (14). They are simply transfers. This is another element of discrepancy with Schy. et al., who assume that both consumption and investment always have different social values even if they are in the hands of the government and are also different from their respective values in the private sector. This originates what Schyd. et al. have called the Shadow Price of Public Funds to which we will refer again in section III.2.4 of this report.

If no simplifying assumptions were made, the effects of the project on the rate of savings are better handled by the benefit-cost analysis of the project, as it is done in equation (13) rather than by modifying the SWR which, in our example, would have the undersirable property of depending even on the specific tax on the profits of the project rather than depending only on the conditions of the labor market. To show this, let us reorder terms in equation (13) and see what the SWR would look like if we had to correct it to include the savings effect. From (13) we have:

$$B_{T_1}^{C^*} = P_{T_1}^{B} \quad (1 - t_\pi) \; [(1 - s_\pi) + s_\pi P_K] + t_\pi[(1 - s_g) + s_g P_K]$$

$$+ a_{LT_1} \left(w[(1-s_L) + s_L P_K] - w(1-t_\pi)[(1-s_\pi) + s_\pi P_K] - wt_\pi[(1-s_g)+s_g P_K]-P_L\right)$$

Dividing by P_K to measure it in investment units and reordering terms, we have:

$$\frac{B_{T_1}^{C*}}{P_K} = P_{T_1}^{B} \; [(\frac{1 - s_\pi}{P_K}) + s_\pi \;) - t_\pi \; (s_\pi - s_g)(\frac{P_K - 1}{P_K})]$$

$$- a_{LT_1} \quad \left(w[\frac{P_K - 1}{P_K}] \quad [s_\pi \; - s_L) - t_\pi(s_\pi - s_g)] - \frac{P_L}{P_K}\right) \qquad (16)$$

Equation (16) shows that: a) To measure production in investment units you not only have to adjust the portion of it that is consumed out of profits $(1 - s_\pi)$, but also the transfer to the government $t_\pi P_{T_1}^{B}$, since some investment will be lost (gained) when the marginal propensity to save out of profits is higher (lower) than that of the government, i.e., $s_\pi - s_g > 0$. (<0) b) To incorporate the savings effect into the SWR, you not only need to adjust for the lower propensity to save out of wages compared to profits $(s_\pi > s_L)$, but also for the difference between the propensity to save out of profits compared to that of government ($s_\pi - s_g$), since the more wages you pay, the less profits and less is transferred to the government at a fixed tax rate on profits t_π.

Therefore, in order to incorporate the savings effects of a project within SWR, not only the value of production should be adjusted according to more general assumptions, but also the resulting SWR would depend on the specific tax on the profits of the project. In other words, a "project specific" shadow wage rate would be needed as opposed to the more desirable property of having a "labor market specific" shadow wage rate.

It is worth noting here that the process of determining the effects of the project on the rate of savings is more complicated than it seems when observing the direct effects only, i.e., those based upon the distribution of income between the different groups given by the cost structure of the project only. Equation (9) shows these direct effects separating the income generated by the project between workers and profits owners. To obtain it, some simplifying assumptions were made to modify equation (6), i.e., no distortions were assumed to exist in the foreign exchange market (P$ = 1) and labor was supposed to be the only cost of production.

When you remove the assumption P$ = 1, since profits are computed at market rather than at shadow prices, you need to clarify what causes the difference between the market and the shadow rate of exchange in order to know what groups are benefiting (bearing the cost) from the additional production (consumption) of foreign exchange by the project. This might be a very complicated process because it will depend upon the nature of the adjustment mechanism in the foreign exchange market.

If all additional foreign exchange were to go only to increasing imports of final consumption goods (as it is assumed by the UNIDO guidelines) and tariffs were the only "distortion" creating the difference between the CIF and the domestic price of consumption imports, government would be the only other group affected. But if in the process of importing those goods, some importers and their employees get a share, their marginal propensities to save would have to be considered.

If a devaluation (revaluation) were needed in order to obtain (absorb) additional foreign exchange (as is assumed by Harberger's SER), the change in the relative prices of traded and non-traded goods would affect both importers and exporters. Their profits and the income generated under their cost structure would have to be determined in order to know what income groups are affected.

If, as Schydlowsky's SER assumes, changes in the overall level of effective demand (income and employment) were needed in order to obtain extra foreign exchange, the marginal propensities to save of those affected by the change in income would need to be considered.

The process becomes still more complicated if we get rid of the assumption that labor is the only cost of production. As is seen in equation (9), the only input-output coefficient needed there was the one showing the direct cost of labor a_{LT_1}, because there were no costs of intermediate inputs. However, when looking at equation (6), which is still oversimplified because it assumes that all intermediate non-traded goods were available at constant marginal costs, the direct and indirect cost of labor A_{LT_1} and the direct and indirect cost of the other traded good $A_{T_2T_1}$ will have to be analyzed and will probably show that many different income groups are affected. Furthermore, since the intermediate goods needed to expand the output of the project are bought at market prices, the difference between them and their marginal costs represent profits which may also belong to many different income groups. All this justifies a completely separate analysis in order to establish the investment-reinvestment process and the income distribution effect generated by a project. To transfer all of these effects to the shadow wage rate is misleading because too much over-simplifying is needed.

III.2.4. A Special Case: The Valuation of Public Funds

Schy. et al. compute a special shadow price to value the transfers from the private to the public sector. It is called P_G, the shadow price of fiscal resources. It intends to show that a shift of a unit of funds between the two sectors may change social welfare due to: a) the fact that the social value of investment is greater than that of consumption causes a transfer from one sector to the other to produce a change in social welfare if both sectors have different marginal propensities to save; b) the social value of public consumption may differ from that of private consumption; c) the social return to investment in the public sector may be different from that of the private sector. This is better seen by examining the meaning of equation (13), which, under extremely simplifying assumptions[6] is equivalent to L-M/SVT.

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[6] See section II.2 of this report.

From (13), we may distinguish

a)	$(P^{B}_{T_1} - a_{LT_1} W)\ (1 - t\pi)\ (1 - S\pi)$	consumption out of profits
b)	$(P^{B}_{T_1} - a_{LT_1} W)\ (1 - t\pi)\ S\pi Pk$	net present value (NPV) of future consumption out of profit savings
c)	$t\pi(P^{B}_{T_1} - a_{LT_1} W)\ (1 - Sg)$	Government consumption
d)	$t\pi(P^{B}_{T_1} - a_{LT_1} W)\ S_g P_k$	NPV of future consumption out of government savings
e)	$a_{LT_1} W\ (1 - S_L)$	workers' consumption
f)	$a_{LT_1} W\ S_L\ P_k$	NPV of future consumption out of workers savings
g)	$-a_{LT_1}\ P_L$	consumption of leisure foregone by workers

Equation (13) shows all the effects of the project on present and future consumption [7] and it is the end of the story to obtain the yearly flow of benefits as Schy . et al. compute them. One should notice that here, as opposed to L-M/SVT, the value of public consumption is different from the value of public investment. To highlight the role of government, sometimes a value for the transfers to (from) the government (PG) is computed separately in order to emphasize that the social yield out of government in-investment may be different than from of the private sector. Therefore, let

[7] One should note that sections a), c), e) and g) of equation (13) could be valued with different income distribution weights. The rest, b), d), and f), represent future benefits, being impossible to say what income groups will benefit from them.

us pull together all private income (Y_p), i.e. profits plus wages and let us call S_p and T_p the marginal propensity to save out of private income (an average between S_π and S_L) and the average rate of taxes on private income (profits and wages) respectively. Equation (13) could then be rewritten as:

$$B = Y_p (1 - T_p) [(1 - S_p) + S_p P_k] + Y_p T_p [(1 - S_g) + S_g Pkg] - C_1$$

$$= Y_p [(1 - Sp) + SpPk] + Y_p T_p P_g - C_1 \qquad (17)$$

where,

Pkg = net present value of future consumption out of one unit of government savings

Pk = net present value of future consumption out of one unit of private sector savings

Pg $= (Sp - Sg) + Pk (Sg \frac{Pkg}{Pk} - Sp) =$ shadow price of fiscal resources (consumption value of public income).[8]

C_1 = consumption of leisure foregone by workers

The purpose of writing equation (17) rather than (15) is to separate all taxes and subsidies that may change due to the project (in this case at a rate T_p only) to show that they may not cancel out as if they were simply transfers when $P_G \neq 0$. Of course, when the social return to capital is the same in both sectors (Pk = Pkg), and both have the same marginal propensity to save (Sg = Sp), PG will be equal to zero and transfers will cancel out.

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[8]Assumes for simplicity that all consumption has the same social marginal utility.

IV. The Total Effects on the Rate of Savings

We have partially discussed the effects of a project on the rate of savings when examining the shadow wage rate in Chapter III. There we assumed that the only existing distortions were those on the labor market because the object was to isolate and compare the resulting shadow wage rate. The effects of a project on the rate of savings, however, depend not only on the different marginal propensities to save out of profit as compared to wage earners, but also on the saving propensities of all those income groups affected by the project, directly and indirectly. The overall process of determining these effects may become extraordinarily complicated, as suggested at the end of Chapter III, justifying a full separated ad hoc analysis which will strongly depend not only upon the cost structure of each project, but also on the adjustment mechanisms of the different markets for which shadow prices were needed. To illustrate this, we will develop in Section IV.2 the relationship between the savings effect and the adjustment mechanism of the foreign exchange market which will help to emphasize the differences created by different assumptions, i.e., partial versus general disequilibrium when estimating the shadow price of foreign exchange. Before that we will analyze the structure of a simplified flow as net benefits to get an idea of the complications to be faced in determining savings effects.

IV.1. Savings effects and cost structure

Let us examine our equation (6) where the yearly flow of net benefits of a project was obtained after deducting all direct and indirect traded and non-traded costs.

$$B^c = (P_{T_1} - A_{T_2T_1} P_{T_2}) P\$ - A_{LT_1} P_L \qquad (6)$$

The yearly flow of benefits generated by equation (6) produces a functional distribution of income as complicated as the parameters $A_{T_2T_1}$, A_{LT_1} and P$ may be.

As an example, let us examine $A_{T_2T_1}$.

$$A_{T_2T_1} = a_{T_2T_1} + a_{T_2N_1}a_{N_1T_1} + a_{T_2N_2}a_{N_2T_1} + a_{T_2N_2}a_{N_2N_1}a_{N_1T_1}$$

$A_{T_2T_1}$ represents the per unit direct and indirect cost of the total amount of T_2 required to produce one unit of T_1 (it comes from the overall structure of an input-output matrix). It is oversimplified in our example because in spite of suspecting that disequilibrium exist at probably all stages of production, with MSB's and MSC's diverging everywhere, we made the assumption that all non-traded goods had to be evaluated on the supply side, so that the marginal cost of producing them was calculated, and because the existence of only one traded and two non-traded inputs were assumed to be required to produce one unit of T_1. Still, it shows that whenever we expand the output of T_1, a direct expansion of the imports of T_2 is needed, depending upon the size of the input-output coefficient $a_{T_2T_1}$. Distorted equilibrium (or disequilibrium) implies that the profits made by the importer of T_2, the wages of the workers he employs and the taxes both pay, are part of the incomes affected for whom we would need marginal propensities to save in order to know the total savings effects. Also, further increases in T_2 imports will be needed because this is required to increase the production of the non-traded goods N_1 and N_2 which are required to produce T_1. The size of these effects will depend upon the magnitude of the corresponding input-output coefficients $a_{N_1T_1}$ and $a_{N_2T_1}$. The expansion of the N_1 and N_2 industries, in turn, will affect the savings effects, depending upon the functional income distribution implied by the cost structure of the N_1 and N_2 industries. This is still oversimplified because it is assumed that both, N_1 and N_2 (actually most non-traded) industries could be expanded at constant marginal costs. Still, even at constant costs, the knowledge of the functional income distribution implied by an expansion through the input-output matrix is very limited.[1]

IV.2. Shadow Exchange rate and savings effects

To understand the cost structure of not only the project but also the non-traded inputs directly and indirectly required by the project is only part of the problem that has to be solved before getting into savings effects. From equation (6) we can see that an understanding of the nature of P$ is also needed. This is not a simple matter of numeraire, but the real output (consumption) created on the supply side of the economy and of a parallel income for some

[1] Pioneer efforts in this sense have been started by Lance Taylor from MIT. See Macro Models in Developing Countries, McGraw-Hill, 1979.

group created on the demand side of the economy. The amount of consumption created and of income generated depends upon the nature of the adjustment mechanism in the Balance of Payments which leads to the absorption of the additional foreign exchange created by the project. The results under partial equilibrium analysis will be quite different from those under general equilibrium.

In order to clarify the relationship between the shadow exchange rate and the savings effects, let us simplify equation (6) by assuming that labor is the only production cost ($A_{T_2T_1} = 0$ and $A_{LT_1} = a_{LT_1}$). Let us also define P\$ = $R\alpha$, where R is the nominal exchange rate and α is the coefficient to adjust R to the value of P\$ (SER). Equation (6) now becomes,

$$B^c = P_{T_1} P\$ - a_{LT_1} P_L = P_{T_1}[R + R(\alpha - 1)] - a_{LT_1} P_L \tag{18}$$

which could be written,

$$B^c = P_{T_1} R - a_{LT_1} w + P_{T_1} R(\alpha - 1) + a_{LT_1}(w - P_L) \tag{19}$$

We therefore have that the total value of consumption created by the project every year, B^c, is composed, on the income side of profits plus wages plus the differential of P\$ above R, net of leisure foregone by workers:

$$\begin{aligned} P_{T_1} R - a_{LT_1} w &= \text{profits} \\ a_{LT_1} w &= \text{wages} \\ P_{T_1} R(\alpha - 1) &= \text{premium on P\$} \\ -a_{LT_1} P_L &= \text{consumption of leisure foregone by workers} \end{aligned} \tag{20}$$

The functional income distribution is therefore affected not only by the project structure of costs but also by the nature of $(\alpha - 1)$ which is certainly different, depending on whether partial or general disequilibrium is assumed in the exchange market as well as by the way the market adjusts.

IV.2.1. The partial disequilibrium framework

When we apply UNIDO's definition of the Shadow Exchange Rate, i.e., the reciprocal of SVT's Consumption Conversion Factor, $\alpha - 1$ has very special meaning, as can be deduced by assuming that all foreign exchange is spent on consumer goods. In order to simplify, let us assume that marginal and average propensities to import consumption goods are equal and that tariffs are the only reason for a difference between the domestic and the CIF value of consumption. In that case,

$$\frac{P\$}{R} = \alpha = 1 + t_c \tag{21}$$

where t_c is the marginal rate of tariffs on consumption imports. Since $(\alpha - 1)$ are tariffs, they correspond to government income. The total effect on savings then would also depend upon the marginal propensity of the government to save and consume. The yearly value of the flow of income, which is exactly equivalent to the value of consumption (B^c) added to the economy, is composed of:

$$\begin{aligned} & P_{T_1} R - a_{LT_1} w && = \text{profits} \\ & + a_{LT_1} w && = \text{wages} \\ & + P_{T_1} R\, t_c && = \text{government income} \\ & - a_{LT_1}\, P_L && = \text{consumption of leisure foregone by workers} \end{aligned} \tag{22}$$

IV.2.1.2. Supply and demand balance; consistency problems

If all the income generated above were immediately spent totally on consumption, there would not be any imbalance problems. Total demand for consumption goods would increase by the same amount as their supply has increased. In the special case at hand,[2] the supply of traded goods increased, creating an inflow of $P_{T_1} R$ in foreign exchange which, if totally devoted to import consumption goods, would increase the availability of them by a total value of $P_{T_1} R(1 + t_c)$, which, in turn, is exactly equal to the value of profits $(P_{T_1} - a_{LT_1} w)$ plus wages $(a_{LT_1} w)$ plus government income $(P_{T_1} R\ t_c)$.[3] If some of these incomes are saved and invested, how could it be that neither domestic supply nor imports of capital goods have changed? Actually, the partial equilibrium approach assumed by $\alpha = 1 + t_c$ (or $CCF = \frac{1}{1 + t_c}$) is very implausible and involves inconsistency in equilibrating the supply and demand for consumption and capital goods.

Actually, if there were no changes in relative prices as a consequence of the project, the availability of consumption goods in the economy should increase to the same value as the total new income that is spent on consumption goods. By the same reasoning, the proportion of this income that is saved should face an equal increase in the availability of equipment to be invested.

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[2]Remember it has been so simplified that no non-traded inputs are assumed.

[3]Consumption and availability of leisure change by the same amount, of course, i.e., $a_{LT_1} P_L$.

In other words, in our simplified case, the supply of consumption goods should increase so as to equate:

$$(P_{T_1} R - a_{LT_1} w)(1 - s_\pi) = \text{consumption out of profits}$$

$$+\ a_{LT_1} w(1 - s_L) = \text{consumption out of wages}$$

$$+\ P_{T_1} R\ t_c(1 - s_G) = \text{consumption out of government income}$$

and the supply of capital goods should increase so as to equate the increase in savings,

$$(P_{T_1} R - a_{LT_1} w)\ s_\pi = \text{savings out of profits}$$

$$+\ (a_{LT_1} w) s_L = \text{savings out of wages}$$

$$+\ (P_{T_1} R\ t_c) s_G = \text{savings out of government income}$$

Therefore, if no domestic activity were created, consumption and capital imports would have to increase and the marginal propensities to consume and save out of the incomes generated by the project would have to be equal to the marginal propensities to import consumption and capital goods respectively. Therefore, the marginal content of imports would have to have capital goods imports or, what amounts to the same, its reciprocal, SVT's Consumption Conversion Factor also needs capital goods in its marginal composition.

Only if there <u>in fact</u> existed more capital equipment to match the above savings would it be possible to shadow price all these savings by P_K, i.e., by the social net present value of the flow of consumption created by one unit of investment. In other words, savings that do not transform into capital equipment do not generate future consumption.

IV.2.1.3. A special case: $s_\pi = s_G = 1;\ s_L = 0$

In the special case where no additional value is given to private savings as opposed to government income, and assuming all public income and profits are totally invested while all wages are consumed at the margin, we will arrive at SVT's treatment of the savings effect as part of the shadow wage rate. The previously noted flow of consumption and savings would transform into:

$$
\begin{aligned}
& P_{T_1}R - a_{LT_1}w && = \text{savings out of profits} \\
& + P_{T_1}\ t_cR && = \text{savings out of government income} \qquad (22') \\
& + a_{LT_1}w && = \text{consumption out of wages} \\
& - a_{LT_1}P_L && = \text{consumption of leisure foregone.}
\end{aligned}
$$

We would also need here that all savings were really able to be transformed into real investment (machinery), in order to say that the consumption value of these savings is equivalent to:

$$[P_{T_1}R - a_{LT_1}w + P_{T_1}t_cR]\ P_K \quad = \text{consumption value of savings}$$

$$= P_{T_1}R(1 + t_c)P_K - a_{LT_1}w\ P_K$$

Now, by adding the effect of the project on consumption we would obtain all the benefits in consumption units at domestic price, B_c,

$$B_c = P_{T_1}R(1 + t_c)\ P_K - a_{LT_1}(wP_K - w + P_L) \qquad (23)$$

These benefits could be transformed into investment in foreign exchange units by dividing by SVT's v, the "value of the numeraire relative to private sector consumption" and multiplying by β, the "Consumption Conversion Factor," therefore obtaining the net social benefits of the project in SVT's numeraire, S:[4]

$$S = \frac{B_c \beta}{v} = \frac{P_{T_1} R(1 + t_c) P_K \beta}{v} - a_{LT_1} \frac{[w(P_K - 1) + P_L] \beta}{v} \tag{24}$$

But since P_K is the net present value of consumption generated by one unit of investment, and since investment is equally valuable in the private and public sector, $P_K = V$. Also, the Consumption Conversion Factor is, by definition,

$$\frac{1}{R(1 + t_c)}; \text{ thus,}$$

$$S - P_{T_1} - a_{LT_1} \left[w(\frac{v-1}{v} + \frac{P_L \beta}{v} \right] \tag{25}$$

which is SVT's simplified case where all profits are invested and all wages are consumed; and, since the numeraire, investment, is held at a premium, all the savings effect is captured into the shadow wage rate, $SWR = w(\frac{v-1}{v}) + \frac{P_L \beta}{v}$ (no marginal productivity is foregone).

Of course, very restrictive assumptions are needed for this expression to be correct. Apart from the assumption that $s_\pi = s_G = 1$ and $s_L = 0$, you need savings to be really worth v units in consumption equivalent, i.e., savings have to be transformed into financial investment and financial investment has to be transformed into machinery. The latter is

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[4]See SVT's glossary of symbols, SVT, pp. 149-150.

not possible unless additional machinery is imported or produced locally, which is not reflected in the computation of the Consumption Conversion Factor.

IV.2.1.4. Project specific shadow prices vs. national parameters

In the above sections we have called attention to the inconsistencies implied by the partial equilibrium valuation of P$ when it is assumed that the project generates both additional consumption and additional savings. To correct this, we may depart from $P\$ = R(1 + t_c)$ and allow increases in both imports of consumption and capital goods (machinery) with the new foreign exchange created. So, the new SER would be:

$$P\$ = m_c P_{m_c} + m_k P_{m_k} \tag{26}$$

where m_c and m_k would represent marginal propensities to import consumption and capital goods respectively and P_{m_c}, P_{m_k} would be the shadow prices of consumption and capital goods. Assuming all capital and consumption goods are traded,[5] the marginal propensity to consume of the project, $(1 - s)$, would be equivalent to m_c, the marginal propensity to import consumption goods and the marginal propensity to save of the project, s, would be equivalent to m_k, the marginal propensity to import capital goods. In other words, the values of m_c and m_k in P$ would be project-specific rather than being "national parameters." The project's functional income distribution would determine m_c (by obtaining a weighted average of s_π and s_L of the project). The traditional treatment of m_c has, however, been to compute it from the marginal propensities to import at

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[5]This assumption will be removed below and it simplifies without affecting the central argument here.

national levels.

This does not present a conceptual problem but an operational one. The users of the "national parameters" in benefit-cost analysis should be careful to use them in the process of computing the effects of the project on average potential consumption. If actual savings and investments are to be computed, an adjustment between national averages and project-specific marginal propensities to import would be needed.

The preceding argument may be summarized as follows: (a) the social value of foreign exchange depends upon what kind of goods are in fact imported. (b) actual imports of capital and consumption goods depend upon marginal propensities to import capital goods (m_k) and consumption (m_c) goods respectively. (c) m_c and m_k should be marginal propensities to import of the recipients of the new income created, i.e., they should be project-specific. In other words, the marginal propensities to save and consume out of the new income generated by the project will determine the marginal propensities to import consumption and capital goods, affecting how the new foreign exchange created will actually be spent.

Under the simplifying assumptions that all the increase in demand for consumption goods created by the project will be reflected in an increase in imports of consumption goods and all the increase in demand for capital goods created by the project will reflect in imports of capital goods, the values of m_c and m_k would be equivalent to the values of (1 - s) and s. In the case illustrated, the shadow price of foreign exchange would require a very simple adjustment to reflect the difference between "economy wide" marginal propensities to import and their corresponding "project specific" values. Let us define $\bar{m}_c$ and $\bar{m}_k$ as the economy wide averages of the marginal propensities to import consumption and capital goods respectively.

The shadow price of foreign exchange, including marginal imports of consumption and capital goods, would be defined as:

$$\overline{P\$} = \bar{m}_c P_{m_c} + \bar{m}_k P_{m_k} = \bar{m}_c + \bar{m}_k P_k \tag{27}$$

where P_{m_c} and P_{m_k} represent shadow prices of consumption and capital goods respectively (P_{m_c} = 1 since consumption is the numeraire here. Also, in the absence of tariffs on capital goods imports, $P_{m_k} = P_k$, the net present value of consumption generated by one unit of investment).[6]

Since the foreign exchange created by the project should be valued in terms of the effective m_c and m_k of the recipients of the new foreign exchange created, it sould be valued by a project-specific P$.

$$P\$ = m_c + m_k P_k \tag{28}$$

To the national parameter $\overline{P\$}$ we should add the difference $P\$ - \overline{P\$}$ in order to correctly incorporate this effect of the savings created by the project on the marginal import content.

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[6] $P_k = \frac{q(1-s)}{i - sq}$ under partial equilibrium analysis and it is a function of all other shadow prices under general distorted equilibrium (since the social marginal productivity of capital (q^{soc}) will be different than the private one (q) reflecting distortions in all markets (foreign exchange, labor, etc.)).

$$P\$ - \overline{P\$} = m_c - \overline{m}_c + (m_k - \overline{m}_k)\ P_k$$

$$= (1 - s) - (1 - \overline{s}) + (s - \overline{s})\ P_k$$

$$= (s - \overline{s})(P_k - 1)$$

$$\therefore \quad P\$ = \overline{P\$} + (s - \overline{s})(P_k - 1) \qquad (29)$$

Therefore, since the marginal propensity of the economy to save as a whole is reflected in P$ by including the average import share of capital goods imports, the excess social value of investment over consumption created by the excess savings of the project over the economy should be added to $\overline{P\$}$.

IV.2.2. The general disequilibrium framework

When savings-investment effects were included in the context of partial equilibrium (disequilibrium) analysis, we found it inconsistent to have a project creating consumption and savings on the income side, without a matching increase in the availability of consumption and capital goods on the supply side. To get rid of the inconsistency, an over-simplified general equilibrium case was analyzed. To that effect, it was assumed that all consumption created by the project would immediately increase imports of consumption goods and all savings would increase imports of capital goods. Therefore, the savings-investment effects of the project were captured by the shadow price of foreign exchange [7] by simply adjusting it to take care of the difference between the economy and the project specific marginal propensities to save.

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[7]Since imports of capital are included in P$, this is not UNIDO's partial equilibrium SER nor SVT's Consumption Conversion Factor anymore.

In a less simplified case, the total amount of consumption and savings created by the new income generated by the project will probably be spent on imported and domestically supplied goods. If non-traded output could be expanded at constant marginal costs, a chain of further expansions will develop until the full effects of the multiplier of domestic expenditures is felt. In the process, not only new consumption and new savings are created which will in turn have to be spent on imported and domestically supplied goods but also additional imports of intermediate goods will be needed to carry out the production expansion. As a consequence, the marginal content of imports will have to include consumption, intermediate and capital goods. The magnitude of these marginal propensities to import will, in turn, be affected by the propensities to consume and save of the different income groups involved.

IV.2.2.1. Project specific vs. national parameters

Schydlowsky et al's general disequilibrium SER reflect the above effects on the marginal imports content as "economy wide" averages. To reflect the specific effects of the project on consumption and savings, a corresponding adjustment to their SER is needed.

To illustrate the above, let us imagine a project that increases the availability of foreign exchange by producing new exports. This will create an impact first on the income of profit ($\Delta\pi_x$) and wage (Δw_x) earners of this export industry. To simplify the algebra, let us assume that the only non-traded activity consists of services composed of wages only. All savings created will therefore have to be spent on importing capital goods and all consumption will be split into domestic services and imports of consumption goods.

The total increase in wages in the economy (ΔW) will then be composed of an increase in wages in the export industry (ΔW_x) plus wages on domestic services (ΔW_d)

$$\Delta W = \Delta W_x + \Delta W_d \tag{30}$$

but,

$$\Delta W_d = d^W \Delta W + d^\pi \Delta \pi_x$$

where d^W and d^π are the proportion of wages and profits spent on domestic consumption respectively.

$$\therefore \quad \Delta W = \Delta W_x + d^W \Delta W + d^\pi \Delta \pi_x$$

$$\therefore \quad \Delta W = \Delta W_x + \frac{1}{1-d^W} (d^W \Delta W_x + d^\pi \Delta \pi_x) \tag{31}$$

Equation (31) indicates that the total increase in wages in the economy will equal the initial increase in wages in the export industry plus the total wages created in the domestic sector. The latter are determined by the proportion of wages and profits in the export industry spent on domestic goods times the multiplier of domestic expenditures. Also, since we have assumed for simplicity that domestic activity consists of only wages, the only profits are those in the export industry,

$$\Delta \pi = \Delta \pi_x \tag{32}$$

On the other side, the increase in imports of consumption goods will depend upon the marginal propensities to import out of wages and profits, m_c^W and m_c^π respectively,

$$\Delta M_c = m_c^W \Delta W + m_c^\pi \Delta\pi$$

$$= m_c^W [\Delta W_x + \frac{1}{1-d^W}(d^W \Delta W_x + d^\pi \Delta\pi_x)] + m_c^\pi \Delta\pi_x$$

and since $m_c = \frac{\Delta M_c}{\Delta Y_x}$, where ΔY_x is total foreign exchange earnings out of the new exports, we have,

$$m_c = \gamma m_c^W + (1 - \gamma) m_c^\pi + m_c^W \lambda^W [\gamma d^W + (1 - \gamma) d^\pi] \qquad (33)$$

where,

$$\gamma = \frac{\Delta W_x}{\Delta Y_x} = \text{marginal proportion of wages in export earnings}$$

$$1-\gamma = \frac{\Delta\pi_x}{\Delta Y_x} = \text{marginal proportion of profits in export earnings}$$

$$\lambda^W = \frac{1}{1-d^W} = \text{domestic expenditures multiplier}$$

Equation (33) indicates that the marginal propensity to import consumption goods out of the new earnings of foreign exchange (or total imports in this case because all foreign exchange is spent on new imports) is a weighted average of the direct imports out of wages and profits created by the export industry plus the indirect marginal imports created by the expansion of the domestic industry (only wages in this case).

A similar reasoning allows us to determine the marginal propensity to import capital goods. Since it was assumed that there was no domestic industry producing them, all savings will be used to import them, so,

$$\Delta M_k = s^W \Delta W + s^\pi \Delta \pi \qquad (34)$$

where, ΔM_k = increase in capital goods imports

s^W = marginal propensity to save out of wages

s^π = marginal propensity to save out of profits

Therefore,

$$m_k = \frac{\Delta M_k}{\Delta Y_x} = \gamma s^W + (1 - \gamma) s^\pi + s^W \lambda^W [\gamma d^W + (1 - \gamma) d^\pi] \qquad (35)$$

Since Schydlowsky et al's SER include imports of consumption and capital goods at the rates $\overline{m}_c$ and $\overline{m}_k$ respectively, both rates representing overall averages for the economy, an adjustment is necessary to reflect the difference between the economy and the project-specific effects on savings and consumption (and through them, on capital and consumption imports).

Let us call $P\$ - \overline{P\$}$ the difference between the SER reflecting project-specific marginal propensities to import and the SER reflecting "economy wide" marginal propensities.

$$P\$ - \overline{P\$} = (m_c - \overline{m}_c) + (m_k - \overline{m}_k)\, P_K \qquad (36)$$

From equation (33), we may deduce the difference $(m_c - \overline{m}_c)$,

$$(m_c - \overline{m}_c) = (\gamma - \overline{\gamma})[m_c^{W} + \frac{m_c^{W}d^{W}}{1-d^{W}} - \frac{m_c^{W}d^{\pi}}{1-d^{W}} - m_c^{\pi}]$$

$$= (\gamma - \overline{\gamma})[(m_c^{W} - m_c^{\pi}) + \frac{m_c^{W}}{1-d^{W}}(d^{W} - d^{\pi})]$$

but since,

$m_c^{W} + s^{W} + d^{W} = 1$, $m_c^{\pi} + s^{\pi} + d^{\pi} = 1$, we obtain,[8]

$$(m_c - \overline{m}_c) = (\gamma - \overline{\gamma})\ [-(s^{W} - s^{\pi}) + \frac{s^{W}}{1-d^{W}}(d^{\pi} - d^{W})] \qquad (37)$$

By the same procedure we obtain,

$$(m_k - \overline{m}_k) = (\gamma - \overline{\gamma})\ [(s^{W} - s^{\pi}) - \frac{s^{W}}{1-d^{W}}(d^{\pi} - d^{W})] \qquad (38)$$

Therefore,

$$P\$ - \overline{P\$} = (\gamma - \overline{\gamma})\ [-(s^{W} - s^{\pi}) + \frac{s^{W}}{1-d^{W}}(d^{\pi} - d^{W})]$$

$$+ (\gamma - \overline{\gamma})[(s^{W} - s^{\pi}) - \frac{s^{W}}{1-d^{W}}(d^{\pi} - d^{W})]\ P_K \qquad (39)$$

$$\therefore \quad P\$ - \overline{P\$} = (\gamma - \overline{\gamma})(P_K - 1)\ [(s^{W} - s^{\pi}) - \frac{s^{W}}{1-d^{W}}(d^{\pi} - d^{W})]$$

$$\therefore \quad (P\$ - \overline{P\$}) = -(\gamma - \overline{\gamma})(P_K - 1)\ [s^{\pi} + \frac{d}{1-d^{W}}(s_W) - \frac{s^{W}}{1-d^{W}}\ ] \qquad (40)$$

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[8] Note that $\frac{m_c}{1-d^{W}} = 1 - \frac{s^{W}}{1-d^{W}}$

Equation (40) tells us that to include the savings effects created by the project, a modification to Schydlowsky et al's SER ($\overline{P\$}$) is needed. This has to take into account the difference between "economy wide" marginal propensities to import and the ones resulting from the project-specific effects on consumption and savings. If the project is relatively <u>intensive in the use of labor</u> ($\gamma > \overline{\gamma}$), a deduction should be made to $\overline{P\$}$ to consider the excess value of investment over consumption ($P_K - 1$) that would have been created by direct savings out of profits (s^{π}) and by the saving the workers would have done out of the expansion of domestic production that would have been created out of the proportion of profits that is spent locally ($\frac{d^{\pi}}{1-d^{w}} \cdot s^{w}$), net of the savings gained by the workers out of the domestic activity generated by the project ($\frac{1}{1-d^{w}} \cdot s^{w}$).

V. Rate of Discount and Project Choice Criteria

The literature on the choice of the appropriate rate of discount is voluminous and full of controversies. As is usual in economics, most of the wrangling dissipates when implicit assumptions are made explicit and an agreement to disagree on value judgements is reached. The intention of this chapter is to help clarify how different implicit assumptions lead several proponents of benefit-cost analysis to select totally different rates of discount. In particular, we will try to establish what assumptions would be needed in order to make SVT's and Schy. et al's methodologies equivalent.

In Chapter II we argued that comparing the SER to conversion factors was not the appropriate comparison. The correct one requires knowing how to use them to obtain the overall picture of the yearly flow of net benefits. The same argument applies here in relation to the rate of discount. To make the right comparisons one should not refer to the rate of discount alone, but to the overall computations needed to obtain a choice criterion. Unfortunately, most proponents of different rates of discount have devoted very little time and space to explaining what to do with the numbers after all flows have been discounted. With very few exceptions, there are no explicit statements on the choice criterion to be followed. As a consequence, a great deal of the comparison task consists of guessing the choice criterion for each methodology. Sections V.1 to V.4 discuss UNIDO, Harberger, SVT and Schydlowsky respectively.

V.1. The UNIDO Guidelines

UNIDO's main point on this topic is its insistence on the need to distinguish between the role of the social rate of discount as a discounting device as opposed to the role of the opportunity cost of investment as a cost. This distinction hits at the heart of the misunderstanding between different methodologies and will be very useful to our comparison of SVT's and Schydlowsky's discounting process.

Discounting has traditionally been used to accomplish a normally conflicting double role: a) it has to reflect the rate of fall over time of the value of the numeraire, whatever the numeraire might be, and b) it has normally been required to be used as a rationing device, a cut-off point reflecting the opportunity cost of investment. It will be argued here, together with UNIDO's point of view, that both roles could not be played simultaneously, without conflict, in a second best world, i.e., where distortions keep the rate of savings short of a certain desired level.

V.1.1. Rate of discount alternatives

Since consumption is UNIDO's numeraire, the social rate of discount should reflect the rate of fall of the value of consumption over time. This function is performed by the social time preference rate, or, in SVT's language, the consumption rate of discount (i). This rate is smaller than the social marginal productivity of investment (q in UNIDO's and SVT's language) for distorted economies where the amount of savings falls short of the desired level of investment. On the other side, if q were the opportunity cost of investment,[1] a project should not be undertaken

[1] It might not be, as we will see later on.

unless it yields at least a rate q. Therefore, if the rate of discount were to be asked to play the role of a rationing device, the net present value of its benefits would be required to be discounted at the rate q. Although the above rule is supposed to ensure the "efficiency" of the investment decision, it affects the "ranking" of projects in a "non desired way" when the flow of net benefits over time is sufficiently different among various projects. This would not matter, of course, if investment funds were overly abundant, because in that case all projects could be done irrespective of their ranking. However, the very nature of the problem arose precisely because investible funds were not enough to finance all desired investments. This is a typical problem of a "second best" world, where the social value of a marginal investment (q) would be higher than the social value of a marginal unit of consumption (i) as far as distortions in the capital market do not disappear (would they ever?).

Therefore, when the availability of savings is limited, there would apparently exist a dilemma as to discounting with the social time preferences rate (i), i.e., respecting the shape of net benefits over time as society would require them to be, versus discounting with the opportunity cost of investment, accepting projects only if they do better than their alternative, i.e., if they yield more than q. This is a false dilemma, however, because there is no need to discount with the opportunity cost of investment in order to be efficient. A cost is a cost; it should be subtracted from the benefits!

V.1.2. The choice criterion

If q were the opportunity cost of investment, we would require from a project that the net present value of its benefits discounted at the social time preferences i (NPV_i) be greater than the net present value of the alternative yielding q, also discounted at the social time preferences. The results are certainly different from those obtained when the benefits of the projects are discounted at q.

So, the investment decision criterion would be:

$$NPV_i = \sum_t \frac{B_t}{(1+i)^t} - I_o \frac{q}{i} \gtrless 0 \qquad (41)$$

where,

NPV_i = net present value discounted at i

B_t = net benefits in year t

I_o = initial investment

q = social marginal productivity of investment

i = social time preferences (consumption rate of discount).

It should be noted that the investment decision criterion expressed by equation (41) assumes that all benefits B_t are measured in consumption units. Also, since at this stage no explicit investment-reinvestment effects have been calculated in obtaining B_t, those effects are also not calculated in the opportunity cost, i.e., the yield q from the opportunity investment is assumed to be consumed immediately, as soon as it is obtained. Furthermore, since q and i are for simplicity assumed constant over time, and q is supposed to be obtained up to year ∞, q/i is the net present value of consumption that would have been obtained from the alternative yielding q if all the initial investment I_o would have been invested elsewhere.

The above criterion is certainly also assuming that the opportunity cost of the project is another investment. That is why the yield of that other investment, q, is the one foregone by the project. This is correct when the investment budget is fixed, i.e., there is no way of increasing the budget as a direct consequence of increasing the amount of projects. Otherwise present consumption and investment would be foregone.[2]

Under the assumptions just enumerated, equation (41) assures that the project is not inefficient (because it is asked to yield more than the alternative) and, what is equally important, it selects projects yielding benefits soon or far away over time depending on what society's preferences over time (i) are.

When the budget is fixed, however, the net present value rule is not to accept a project when NPV > 0, but to accept it if the net present value per unit of investment is greater than a given value N., which exhaust the budget. This is shown by equation (42) which is equation (41) divided by I_o,

$$\frac{NPV_i}{I_o} = \sum_t \frac{B_t}{(1+i)^t} / I_o - \frac{q}{i} \gtrless 0 \qquad (42)$$

Then, by reordering terms, the investment decision criterion with fixed investment budget becomes,

$$\frac{NPV_i}{I_o} = \sum_t \frac{B_t}{(1+i)^t} / I_o \gtrless \bar{N} = \frac{q}{i} \qquad (43)$$

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[2] See section V.2 below

where q/i would be the net present value per unit of investment of the last project to be accepted under the budget constraint.[3]

The results obtained by the investment decision criterion given by equation (43) are certainly different from those which use q (in this case the return of the marginal project) as the discount rate, as in equation (44). In other words, the discount rate cannot be used as a rationing device without altering the results.

$$\sum_t \frac{B_t}{(1 + q)^t} - I_o \gtreqless 0 \qquad (44)$$

The difference between (43) and (44) has not always been recognized due to a misconception similar to the one which arose in the past when economists were arguing whether the internal rate of return was preferable as investment criterion as compared to the net present value in the presence of a budget constraint. One of the conclusions derived from that discussion was that both NPV and the internal rate of return, in spite of changing the ranking internally,would give the same accept-reject decision "assuming that the same opportunity cost of capital or cut-off point is used".[4] This would be fine if your decision were made according to equation (44), i.e., using the cut-off point as a rate of discount. However, if society's preferences over time were at a rate $i < q$, (44) would bias the decision against projects producing benefits far away in time, rejecting projects that should be accepted precisely because their time profile is as required by a low social time preference (or vice versa if $i > q$). Respecting preferences over time requires a decision

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3 Remember that it was assumed here that q is the opportunity cost and that it is a constant obtained up to ∞ and consumed immediately as soon as received. In general, rather than q/i you would have the $\sum \frac{B_t}{(1+i)^t} / I$ of the last project been accepted within the fixed budget.

4 See as an example, World Bank Staff Working Paper No. 239, August 1976, Annex D.

according to equation (43), where both the cut-off point and the social time preferences are respected.

To illustrate the above, let us benefit from the numerical example given by the Bank Staff Working Paper No. 239, Annex D which is reproduced in able V-1 below:

Table V-1

Project	t_o	t_1	t_2	ERR	NPV at 8%
A	-100	120	0	20%	11
B	-100	0	135	16%	15
C	-100	0	117	8%	0
D	-50	52	0	4%	-2
E	-200	5	215	5%	-11

The above example was used to illustrate that, given the time path of benefits, t_o, t_1, t_2, of projects A,B,C,D and E, when the cut-off point is a project yielding 8%, the same accept-reject decision is obtained by calculating the ERR (economic internal rate of return) as by computing NPV discounting with the 8%. The intra-marginal ranking (between projects A and B) is reversed by ERR as compared to NPV 8%, but, since the accept-reject decision is the same, it would be "difficult to see why anybody should want to rank projects."

The above result is a direct application of our equation (44), i.e., if the IRR of the marginal project (q) is used to discount, the accept-reject criterion is the same, even when the intra-marginal ranking is reversed (and beyond the margin too).

However, if social time preferences over time were to be respected, the time profile of benefits should be decided by the social rate of discount i and not q. Discounting by q may well imply that a socially preferred project be rejected as opposed to a socially inferior one that could be accepted. To illustrate this, let us assume that the budget constraint is 200 in the above example. The accept-reject criterion according to ERR or NPV at 16% would still be the same. But let us assume that social time preferences are much lower than the cut-off rate of discount, i.e., $(i = 4\%) < (q = 16\%)$. Let us also modify project C without changing its 8% return, by postponing its benefits, assuming that instead of obtaining \$117 by period t = 2, \$158.70 are obtained by period t = 6. ERR and NPV at 16% still produce the same accept-reject criterion as can be seen below in Table V-II:

Table V-II

Project	t_0	t_1	t_2	t_3	t_4	t_5	t_6	ERR	NPV 16%	NPV 4%	NPV 4% /I
A	-100	120	0	0	0	0	0	20%	3.4	15.4	1.154
B	-100	0	135	0	0	0	0	16%	0	24.8	1.248
C	-100	0	0	0	0	0	158.7	8%	-13.1	25.4	1.254
D	-50	52	0	0	0	0	0	4%	-5.2	0	0
E	-200	5	215	0	0	0	0	5%	-35.9	3.6	1.018

If we followed the argument given by World Bank Staff Paper No. 239, Table V-II would show that a budget constraint of \$200 would indicate a discount rate of 16% if the cut-off point is used as a discount. In that case, both the ERR and $NPV_{16\%}$ rules would recommend accepting projects A and B only (B in the margin). However, since $i<q$, society prefers to wait until year 6 if by so doing enough consumption could be obtained. Respecting social time preferences would indicate accepting first project C and marginally project B.

The rule is: $NPV_{4\%}$ per unit of investment $\gtrless$ $NPV_{4\%}$ per unit of investment of the opportunity cost, in this case the project which, if done, would exhaust the budget, i.e., for a budget constraint of \$200.- in the above example the choice criterion should be to accept a project only if

$$\sum_t \frac{Bt}{(1+i)^t} / I_o \geq N = 1.248$$

It is worth remembering that in the above example all numbers of the flow of net benefits represent consumption, otherwise the future flow should be modified to reflect the future consumption created by the investment-reinvestment effects of each project.

In general, it would be required that the NPV discounted at the social time preferences be greater than the NPV of the opportunity cost (whatever the opportunity cost might be) per unit of the resource being allocated, in this case investment, also discounted at the social time preferences. Only that way both efficiency and time preferences are respected in a second best world where $q \neq i$.

In the trivial case, however, where the opportunity cost is another investment yielding q, but the time horizon consists of only two periods, discounting with the opportunity cost (q) would be correct and would certainly create no "violation" of society's preferences over time.[5] The reason is obvious though: there would be no problem of aggregating consumption over time because everything happens in the same period. The problem of yielding more than the opportunity cost is the only relevant problem. Any rate of discount, including zero, would take care of discounting because there is no problem of discounting. In the two periods case the investment criterion given by equation (41) would

[5] UNIDO, op. cit., p 160.

be,

$$\frac{B_1}{1 + i} - \frac{I_o(1 + q)}{1 + i} \gtrless 0 \qquad (45)$$

which multiplied by $\frac{1 + i}{1 + z}$, gives,

$$\frac{B_1}{1 + z} - \frac{I_o(1 + q)}{1 + z} \gtrless 0 \qquad (46)$$

where z is any rate of discount (including z = 0).

In the particular case where z = q, you obtain the traditional NPV rule where the discount rate is the opportunity cost of investment, q:

$$\frac{B_1}{1 + q} - I_o \gtrless 0 \, . \qquad (47)$$

Decision criterion (47) is correct, however, because discounting is irrelevant and not because the opportunity cost q is the right discount rate. Since everything happens in the second period, both the benefits of the project and the alternative yield of investment (which has to be consumed immediately), there is no intertemporal problem. There is an "opportunity cost" problem though: consumption created by the project per unit of investment, B_1/I_o, has to be greater than the alternative yield 1 + q.

In general, however, there will be a real need of distinguishing between the "aggregation over time" problem and the "opportunity cost" problem.

V. 2. Harberger's rate of discount

The above discussion considered q as the opportunity cost of investment. In other words, investment was foregoing another investment yielding q. That is the situation when facing an institutionally fixed budget for investment or, in case of a perfectly competitive non-segmented capital market, when the supply of savings is inelastic. With a variable budget, however, the total amount of funds available for investment would change in response to changes in the amount of projects available. If, furthermore, increases in the budget were financed through a perfectly working capital market, an increase in the availability of projects would imply an increase in demand for investment which, given the supply of savings, would push the interest rate up until enough people would save more and enough private investors would invest less so that all the initial shift in demand for investment is totally absorbed. This "relative price" adjustment mechanism of the capital market is the one implied by Harberger. As a consequence, the opportunity cost of investment is not only another investment foregone, but also some consumption is foregone (savings increase). Harberger's opportunity cost of investment is, therefore, "a weighted average of marginal rates of productivity of capital in displaced investment activities and marginal rates of time preference of the different groups whose consumption is displaced."[6] This rate would be found in the capital market as a weighted average of gross of tax yield on investment and a net of all taxes yielded on the assets of savers, where the weights are the demand for investment and supply of savings interest elasticities respectively.

If the yield q from the foregone investment were a constant flow up to infinity and immediately consumed as soon as received, the consumption value of it would be q/i. Harberger's opportunity cost of investment would then be $[\Theta \frac{q}{i} + (1 - \Theta)]$, where $(1 - \Theta)$ of the available funds are diverted from consumption and Θ from investment.

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[6] A. Harberger, "On the Guidelines for Social Project Evaluation," symposium on the use of socio-economic investment criteria in project evaluation, Washington, D.C., 1973.

The investment decision criterion given by equation (41) would now transform into:

$$\sum_t \frac{B_t}{(1+i)^t} - I_o[\Theta\frac{q}{i} + (1-\theta)] \gtrless 0 \qquad (48)$$

This, again, is not equivalent to discounting with a "cut off point." The opportunity cost of investment should be treated as a cost and not as a rate of discount.

In the special circumstance, however, where the <u>shape</u> of the flow of consumption over <u>time</u> would not matter, i.e., when the net benefits (consumption) B_t are a constant perpetuity over time, equation (48) would be equivalent to "discounting" with a weighted average of q and i, which is actually Harberger's proposal.[7]

For perpetuities, (48) becomes,

$$\frac{B}{i} - I_o[\Theta\frac{q}{i} + (1-\Theta)] \gtrless 0 \qquad (49)$$

which, divided by the opportunity cost $[\Theta\frac{q}{i} + (1-\Theta)]$ gives,

$$\frac{B}{\Theta q + (1-\Theta)\, i} - I_o \gtrless 0 \qquad (50)$$

which is the traditional net present value rule where the benefits B are discounted by a weighted average of q and i, being Θ and $(1-\Theta)$ the

[7] Except that Harberger proposes the weighted average as a discount rate for any circumstance, not only for perpetuities, which is not appropriate. For a different view, based upon the functioning of the capital market for each period after investment-reinvestment has been taken into account. See L. A. Sjaastad and D. Wisecarver; The Social Cost of Public Finance, J.P.E., vol. 85 no.3, June 1977.

respective weights (interest elasticities of the demand for investment and supply of savings respectively).

If, on the other hand, the public investment budget were variable and financed through taxation, rather than through the capital market, the incidence of taxation would determine who bears the burden and therefore how much investment (a proportion Θ) and consumption ($1 - \Theta$) is being foregone. This is the assumption made by Krutilla and Eckstein.[8]

The above, as in Harberger's case, is correct as a way of determining the opportunity cost of public funds, but not as a rate of discount device. The rate of discount, reflecting the rate of fall over time of the numeraire, consumption in this case, solves a problem of intertemporal aggregation. Computing the relevant opportunity cost of investment solves a different problem, one of efficiency in producing more than the alternative. The relevant alternative in turn depends upon institutional circumstances; for a fixed investment budget, q is the relevant alternative; for a variable budget, a weighted average between q and i is needed, the relevant weights depending upon the institutional circumstances of how the budget is financed. Only under optimality (first best) or when intertemporal aggregation does not matter, like with perpetuities or only two periods with fixed budget, could the opportunity cost (or a cut off rate of return) legitimately be used as a discount rate. "The two problems--opportunity cost measurement and intertemporal aggregation--must be kept separate if correct choices are to be made."[9]

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[8] Krutilla and Eckstein, "Multiple Purpose River Development," 1959, Johns Hopkins Press.

[9] M.S. Feldstein, "The Inadequacy of Weighted Discount Rates," chapter 13 in "Cost-Benefit Analysis, Selected Readings," Richard Layard, editor, Penguin Modern Economic Readings, 1972.

V.3. SVT's discounting process

As consumption is UNIDO's, Harberger's and Schydlowsky's numeraire, the social time preference rate (i) is the correct value to discount for them (the consumption rate of interest--CRI--in SVT's language). As uncommitted foreign exchange in the hands of the government is SVT's (and L-M's) numeraire, their accounting rate of interest (ARI) should reflect the change over time of this numeraire: "Indeed, the proper discount rate to use (the ARI) is the expected rate of fall, as seen from the present, of the value of the numeraire"[10] . . . "The accounting rate of interest (ARI) is defined as the rate of fall in the value of the numeraire, which is public income measured in foreign exchange."[11]

SVT and L-M, however, also ask the discount rate to play the role of a cut off point: "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."[12] "ARI also acts as a cut off, rationing the amount of investment to funds available."[13]

As we have seen above, the double role of reflecting the change over time of the numeraire and that of acting as a cut off point cannot be in general played simultaneously without the risk of making the wrong decision,

[10] I.M.D. Little and J.A. Mirrlees, op. cit., page 72.

[11] SVT, op. cit., page 113.

[12] SVT, op. cit., page 114.

[13] I.M.D. Little and J.A. Mirrlees, op. cit., page 72.

unless optimality is assumed or the timing of benefits is not relevant, i.e., where you have perpetuities or only two periods of time with fixed budget constraint. In case the first role for ARI is taken, the translation from SVT to UNIDO or Schydlowsky et al. would only depend upon what assumptions are made in relation to the discrepancies between the value of public investment and that of private consumption. This is so because SVT (and L-M) make a distinction between committed and uncommitted income, assuming that uncommitted income is optimally spent. Therefore, the government would equate the marginal social value of public funds in all uses. The last one is a very important assumption made by them which justifies why, as opposed to Schydlowsky et al., they do not show any difference between the value of public investment and that of public consumption. Furthermore, in most cases it is assumed that the social marginal productivity of investment in the public sector is equated to the social marginal productivity of investment in the private sector. The only "non-optimality" remaining in L-M and SVT is a difference between the value of private consumption and private investment. This explains why the value of their numeraire, uncommitted income (foreign exchange) in the hands of the government, their V,[14] is the net present value of future consumption generated by one unit of investment, the equivalent to UNIDO's shadow price of investment,[15] and Schydlowsky's Pk.[16]

If the discrepancy between the value of investment and that of consumption remains constant over time, SVT's accounting rate of interest (ARI)

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[14]See SVT, op. cit., page 104.

[15]See Unido, op. cit., chapter 14.

[16]See Schydlowsky.

would be the same as Schydlowsky et al.'s social time preferences rate (i)--consumption rate of interest (CRI), in SVT's language. This could be easily seen by taking any of the definitions of ARI from SVT: "in practice, the following formula may be used . ..."[17]

$$ARI = sq + (1 - s)q/v\beta \tag{51}$$

where s = propensity of the public sector to reinvest out of q

q = marginal product of capital

v = value of the numeraire relative to private sector consumption

β = consumption conversion factor

When the value of v does not change over time,

$$v = \frac{(1 - s)q}{i - sq} / \beta \tag{52}$$

or, what is the same, v is the net present value of consumption created by one unit of investment in foreign exchange units.[18]

Therefore,

$$ARI = sq + \frac{(1 - s)q}{\beta} \cdot \frac{(i - sq)\beta}{(1 - s)q} \tag{53}$$

$$\therefore \quad ARI = i \ (=CRI)$$

In other words, when the value of the numeraire over the value of consumption (v - 1) is constant, the only reason by which the value of v would fall over time is because i > 0, i.e., because the value of consumption over

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[17] SVT, op. cit., page 114.

[18] SVT, op. cit., page 105.

time would be falling (in a proportion given by i).

If, on the other hand, optimality is assumed to exist after t years, the rate of change of v over time may be adjusted to reach the value of one after that period and this change over time should be added to i in order to obtain ARI.

To accomplish the role of a cut off point, however, you need to make the stronger assumption that each year the ARI is selected as to ensure a balance between the supply and demand for public funds and that all additional output of the marginal project be available for investment each year after. "The ARI can be given a simple interpretation provided the assumption is accepted that at the margin all public expenditure is either assigned to investment or to uses that are as socially valuable as investment. In this case the ARI is simply the internal social rate of return on the marginal public sector project, this being the discount rate that ensures a balance between the supply of and demand for public investible resources." [19]

In effect, if the marginal project involves doing one unit of investment in year t, with a yield of q, all available for investment in year t + 1, the benefits of the marginal project would be

$(1 + q_t)V_{t+1}D_{t+1}$ = benefits of marginal projects in year t+1

where, V_{t+1} = present value of consumption generated by one unit of investment in year t+1

D_{t+1} = discount factor for consumption of year t+1

q_t = yield of the marginal project in year t

Also, the cost of one unit of investment devoted to the marginal project

[19] SVT, op. cit., page 142.

in year t would be,

$D_t V_t$ = cost of marginal project in year t.

If the cost of the marginal project is always made equal to its benefit in the margin,

$$(1 + q_t)V_{t+1} D_{t+1} = D_t V_t$$

$$\therefore \quad \frac{V_t}{V_{t+1}} = (1 + q_t)\frac{D_{t+1}}{D_t}$$

but $\frac{D_{t+1}}{D_t} = \frac{1}{1 + i_t}$ by the definition of the consumption rate of discount.

$$\therefore \quad \frac{V_t}{V_{t+1}} = \frac{1 + q_t}{1 + i_t}$$

or

$$\frac{V_t}{V_o} = \frac{\pi(1 + i_t)}{\pi(1 + q_t)} \qquad (54)$$

Furthermore, the investment decision criterion with variable value for V_t and i_t, including investment-reinvestment effects and expressed in the consumption numeraire, would be,

$$\sum_t \frac{B_t[s_p V_t + (1 - s_p)]}{\underset{t}{\pi}(1 + i_t)} - I_o V_o \gtrless 0 \qquad (55)$$

where B_t = net potential consumption created by the project in year t

s_p = marginal propensity to save of the project

V_t = net present value of consumption generated by one unit of investment in year t

i_t = social time preferences of year t

Therefore, from (54), equation (55) may be expressed in the "investment" numeraire as,

$$\sum_t \frac{B_t[s_p + \frac{1 - s_p}{V_t}]}{\pi_t(1 + q_t)} - I_o \gtrless 0 \qquad (56)$$

which is the investment criterion for SVT's with V as a numeraire.

V.4. Schydlowsky et al. investment criterion

In section V.1 we saw that in the absence of rationing, the investment criterion requires simply that the net present value of benefits exceeds that of costs. In the presence of an investment budget constraint, however, there is a need to rank projects according to the net present value of net benefits per unit of investment. The accept-reject criterion is given by the net present value of net benefits, per unit of investment, of the opportunity cost.

In general, however, the net present value should be expressed per unit of resources to be allocated in the investment decision process. These resources are not necessarily real resources, i.e., physical resources like labor, materials, foreign exchange, etc., but financial resources, i.e., money to buy investment goods.

> When financial resources are allocated the volume of real resources used depend on their market price and the same amount of financial expenditure may imply widely differing values of real resource. Thus, for example one million soles of investment spent on hiring unskilled labor implies a very different use of real resources than the same million spent on foreign exchange for imported machinery. Evidently the real investment cost is very sensitive in this case to the mix of real resource on which the financial investment is spent. Correspondingly, whether real or financial resources are allocated is a question of major importance.[20]

Therefore, when the investment budget is determined in monetary terms, the investment criterion would require that projects be ranked according to,

$$\Sigma \frac{B_t[(1 - s_p) + s_p] - I_R}{(1 + i)^t} \; / \; I_F \qquad (57)$$

where I_R = real investment, i.e., physical resources at shadow prices

I_F = financial investment

The accept-reject decision would, of course, be based upon an expression similar to (57) for the opportunity cost of the investment.

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[20] Schydlowsky, "The Design of Benefit-Cost Analysis of Investment Projects in Peru: A Country-specific View," CLADS Discussion Paper Series No. 29, September 1977.

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