PUBLIC INVESTMENT : SOME MEASURING INSTRUMENTS

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INTRODUCTION

In the exercise of synchronizing projects formulation to achieve certain national objectives, investment decisions should be guided by some cost and benefit measurement instruments. This is particularly important in view of scarcity of some resources for balanced development of an economy. The basic purpose of application of measurement tools in public investment decisions is to rationalise the guidelines for investment in which specific use of inputs with alternatives uses should be determined in the optimum possible scale. A planner has to take into consideration the economic and social effects of the investment decisions as pre-determined values. Therefore it is an *ex ante* process. Investment projects appraisal is an area of experimentation while evaluation is an area which acquires experiences or is the *ex post* consideration. The basic purpose of this paper is to familiarise the readers with some of project appraisal, widely applied in public investment decisions. The aim here is to make preliminary but reasonable acquaintance of the basic elements of social cost- benefit analysis as well as initiate a meaningful step towards advanced learning/discussion in the subject.

BASIC INSTRUMENTS

The basic instruments concerning measurement of public investment include costs and benefits.

COSTS

(a) **Private cost and social cost**: Cost of transporting goods for a farmer is a private cost while the depreciation of road may be the social cost. In the construction of a hydro-electric project, the number of households to be displaced/resettled and the hardship associated with it may be the social cost.

(b) **Marginal/incremental cost**: When a project activity expands, some additional costs are incurred. For Example, if output is increased from 100 units to 101 units and the cost may increase from Rs. 310 to Rs. 314, then the marginal cost of producing one additional unit of output would be Rs. 4.00.

(c) **Opportunity cost**: Resources have to be utilised where gains would be maximum. For example, land can be used to produce crop A or crop B. The return for crop A is Rs. 200 and for crop B is Rs. 150, which means the land is used for crop A. If the yield of crop A declines to Rs. 125 then it is wise to use land for growing crop. B. Thus the concept of opportunity cost is important in making rational decisions about public investments e.g. in irrigation projects with alternatives like dam construction. digging

tubewell, multipurpose project including irrigation, Education project (free education to poor household children: opportunity cost of school education) or working in the farm/looking after the cattle) etc.

BENEFITS

Private and social benefits: Main distinction here is between the gains achieved by private individuals and the benefits accruing to the society. For example, a good housing scheme would improve the health of the people and increase labour efficiency in the society. There are direct and indirect benefits which should be valued in same *numeriare*.

INTANGIBLES

Tangible benefits can be measured in monetary units. For example, benefits in crop production through irrigation project, electricity units sold by hydro-electricity project etc., can be measured. But due to construction of reservoir. Local population may be affected by malaria disease for which monetary measurement is very difficult to make. This is an indirect cost. For benefits, external economies generate some benefits for which an estimate may be made. Inclusion of benefits and costs arising from indirect sources are always debatable.

INTEREST RATE AND DISCOUNT RATE

Projects have their time-dimension. For example, consumption of Rs. 100 today is not the same as consuming the same amount few years later. It involves sacrifice to present consumption for which a premium should be added, called interest rate. Interest rate is thus the quantification of time preference of present over future, In case of discount rate. We *look present from the future*. For example, with 5% interest rate, the future value of Rs. 100 is Rs. 105. If we look from the future to the present, the present value of Rs. 105 of the future is Rs. 100, or, the present value of Rs. future at 5% interest is Rs. 95.23.

$$Calculation: Rs. \frac{100 \times 100}{105} = \frac{10000}{105} = 95.24 \quad or \quad \frac{100}{105} = 0.9524$$

If the present value of Rs. 105 (of the future) is Rs. 100., the present value of Rs. 100 (of the future) is Rs. 95.24. The discount rate is also called the "present worth factor". Or, at 5% interest rate if Rs. 95.23 is deposited at the bank today, one year after the amount would Rs. 100. This is the present value of Rs. 100 next year, discounted at 5% interest rate.

This distinction between present and future consumption arises because future consumption is generated at the cost of sacrificing some of the present consumption in the form of investment for future income.

SHADOW PRICES/ACCOUNTING PRICES

As the market imperfections may not reflect true scarcity of some resources, e.g. foreign exchange, shadow prices are used. The market price of foreign exchange based on supply and demand is called the shadow price of foreign exchange. The

effect of using shadow price would be to encourage production of important substitutes or exportable and to discourage expenses involving foreign exchange. In labour surplus economy, economists may argue that the shadow price of labour should be almost zero, therefore, labour intensive projects should be favoured.

NET PRESENT VALUE (NPV)

When discount rate is used, which quantifies the preference for present consumption over future, it reduces costs and benefits for different years. The surplus of income over cost reduced to present period provides an indicator to make investment decisions.

Years (1)	Total Cost (2)	Total benefits (3)	Net benefits (colm 3x2) (4)	Discounting factor (10%) (5)	Net Present Value (NPV) (Colm 4x5) (6)	(7)
1	50	-	-50	0.909	-45.5	-86.8
2	50	-	-50	0.826	-41.3	117.6
3	-	40	40	0.751	30.0	
4	-	60	60	0.683	41.0	
5	-	75	75	0.620	46.6	
Total	100	175	75		117.6 -86.8 ------ 30.8NPV	

Discount factor: Divide 1 by 1.10 as 10% interest. Then

$$\frac{1}{1.10} = 0.909, then \ \frac{0.909}{1.10} = 0.826 \ and \ so \ on$$

Formula for NPV calculation

$$V_o = V_t \left[\frac{1}{(1 + r)^t} \right]$$

Where

Vo = NPV

Vt = Net benefits flow

$$\frac{1}{(1 + r)^t} = \text{Discounting factor}$$

Net benefits x discounting factor = NPV

UNIDO standard formula for calculating NPV = $\sum_{t=0}^{T} \left(\frac{V_t - C_t}{(1 + r)^t} \right) - K$

Where,

Vt = Annual flow of social benefits; Ct = Social cost of variable inputs:

r = discount rate at which future benefits and costs are discounted

K = Fixed cost of investment

But this is absolute figure, If NPV is higher than zero, then investment in the project is worthwhile. The selection process of project should be arranged in terms of *descending* NPV. But NPV does not provide us with information on rate of return on investment. For this we used another indicator called Benefit Cost Ratio (BCR).

BENEFIT COST RATIO (BCR)

To obtain the benefit cost ratio, the present value of benefit (NPV) is divided by present value of cost, The ratio between the two gives us Benefit cost ratio, i.e. benefit per rupee of cost. Figures in the are calculated for this

$$Benefit\ Cost\ Ratio = \frac{Pr\,esent\ Value\ of\ Benefits}{Pr\,esent\ Value\ of\ Cost} = \frac{117.6}{86.8} = 1.35$$

If BCR is more than 1, an investment in project is worthwhile. Projects with highest BCR are selected from descending order. In a single project, the rule is to select the project if its BCR is higher.

The major problem with NPV is which discount rate to chose ? This problem is solved through iteration process, described in the computation of Internal Rate of Return.

INTERNAL RATE OF RETURN (IRR)

IRR is another measure of using discounted cash for arriving at the worth of project. If finds out that rate of return at which NPV = 0 or BCR = 1. The IRR itself is a discount rate which represents the average earning power of money in a project life.

Year	Total Cost	Total Benefit	Net Benefit	DF 10%	NPV (Colm 4x5)	DF 15%	NPV (colm 4x7)	DF 25%	NPV (Colm 4x9)
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
1	150	-	-150	0.909	136.4	0.869	-130	0.800	-120.0
2	5	25	20	0.826	16.5	0.756	15.1	0.640	12.8
3	5	50	45	0.751	33.8	0.658	29.5	0.512	23.0
4	5	75	70	0.683	47.8	0.572	40.0	0.409	28.6
5	5	125	120	0.621	74.5	0.497	59.6	0.328	39.4
Total	170	275	105	-	36.2	-	13.9	-	-16.2

IRR = Lower Discount Rate + Difference between higher & Lower discount rates

$$x = \frac{NPV \ at \ lower \ Discount \ Rate}{Absolute \ Difference \ between \ NPV \ at \ two \ discount \ Rates}$$

$$IRR = 10 + 15(25 - 10)\frac{36.2}{36.2 + 16.2} = 10 + 15(.690) = 20.34 : IRR = 20\%$$

IRR is derived through iteration process, discount rate is raised or lowered to arrive at a state where NPV becomes zero. There may be a number of combinations of discount rates other than 10, 15 and 25.

However, IRR itself does not, on its own provide a criterion for selection of projects. It also has to be compared with market rate of interest. or social rate of interest. In this case, following investment decisions can be applicable:

(a)   Select a single project if (IRR) (r*) is greater than market rate of interest or social discount rate, social opportunity cost (r)

(b)   In case of more than one projects, rank the projects in descending order of values of IRR (r*) and select that set of projects for which r* is greater, subject to available fund.

The Selection of IRR for the Projects can be represented through diagram also.

r* = IRR

r = Social rate of discount/Market rate of interest
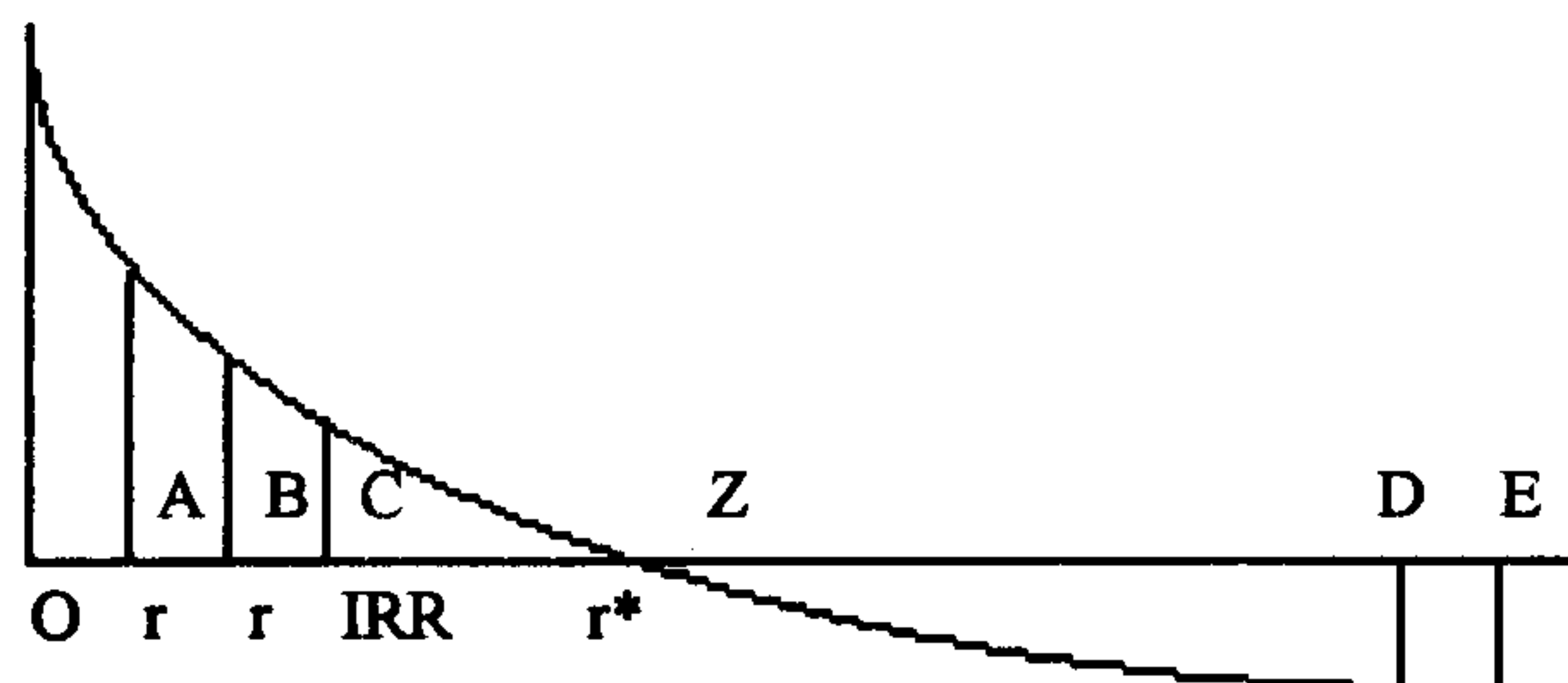
At Or* discount rate, NPV because zero which is our IRR. All projects are within the range of OZ, that is ABC are selected and the projects beyond OZ are rejected as NPV become negative, which means, the investment is not recovered which amounts to a loss to the individual or society.

SHADOW/ACCOUNTING WAGE RATE (AWR)

The argument is that no output is foregone when is used in the project in a situation of mass unemployment. Because the opportunity cost of labour would be zero and market wage paid to the workers would bear no relationship to the opportunity cost. Even with seasonal employment, the output foregone in employing a worker from rural area is less than market wage. While estimating the shadow

price of labour, in order to reflect its true value, the life-span of a project is also important. Because, the situation of labour supply may not be same for 25 or 30 years. In general, the output foregone in rural areas would be between zero and MP of labour.

The output foregone is the cost of labour in economic sense. Economic Wage Rate (EWR) includes cost of consumption of labour while receiving wage and, therefore, claims on limited resources. This means future consumption is foregone. So the workers' present and future consumption foregone should be estimated to arrive at social wage rate. The shadow wage rate calculation for development projects (applied in most fisheries projects in India, irrigation projects in the Philippines etc.) consider mainly certain factors.

Crucial factors such as output foregone, other costs (Cost of transferring Labour from one to another location, disutilty of work/loss of leisure, increase in consumption of labour in new employment etc.) The increase in consumption of labour in new employment has greater significance in calculating AWR because it shows premium on consumption vis-a-vis on saving.

Accounting Wage Rate (AWR) = m+s (I-i)w

where m = Marginal product in present employment

s = Saving rate from profit

I = Accounting Price for Investment

W = Market/ Project Wage Rate

S (I=i) = Measure of society's loss due to premium on saving as compared to consumption, or value of W would be if it was return to capital instead of labour.

AWR reflects social loss by employing an additional worker on a new project. Marginal product foregone, disutilities of moving, premium placed on saving etc, are included in this loss. Based on the loss, AWR can be calculated for a project. When market wage rate (W) is very low in a labour surplus economy, the AWR could be quite high/approaching the W. Based on calculation of average Agricultural product in Ratnagiri district of India at Rs. 2/day and Marginal Product of Rs. 1. Value of S = 0.3 and accounting price for I = 1.5, the AWR arrived for the project, as ratio of W was 0.65 for male and 0.43 for female workers (Cost-Benefit Analysis of Ratnagiri fisheries Project made by SN Mishra and John. Beyer, from Pitale: project Appraisal Technique, 1982, See Selected Reference).

SENSITIVITY ANALYSIS

In order to arrive to the degree of uncertainty about the project, e.g. the cost of raw materials may increase, or the supply may be delayed etc., the decision-maker has to make alternative calculations of costs/benefits of a project. The sensitivity

analysis, however, does not provide correct answer, but with information helps to arrive at the decision. Because various elements are interdependent. Also if a certain variation from estimated cost may affect IRR calculation and the analysis may not like to go beyond the point which affects the IRR. The cost/benefit flow data need to be modified in the stream for project life e.g. 10% increase in cost of imports or a 15% decline in income from the project with the necessary modification in the data, new NPV and IRR are calculated for the same method, but incorporating sensitivity analysis.

BRUNO RATIO

This implies the domestic cost of saving a unit of foreign exchange. The ratio of the cost of domestic resources (e.g. labour, materials, capital) used by a project to foreign exchange rate is recommended,. If both domestic resources and foreign exchange are expressed in the same currency, a ratio of 1 is the nominal cut-off point. Ratios higher than 1 or greater than the exchange rate imply protection to the project for its survival.

SWITCHING VALUE

The value that reverses the ranking of two alternative projects is called switching value or the "Weight value". For example, project A produces shoes with modern equipment highly capital intensive with small number of workers, while project B consists a net-work of small shoe production units which employ large number of small craftsmen in total, with small amount of capital. If the income going to the poor is given an weighage of 1.5., project A may be having higher rate of return. But if income going to the poor is given a weighage greater than 1.5., project B may show higher return. Thus, 1.5 becomes the switching value.

FINANCIAL AND ECONOMIC ANALYSIS

Public investment appraisals are done for efficient use of resources. Here, the two factors lead to the distinction between financial analysis and economic analysis. They are: Exclusion/Inclusion of some costs and benefits in the appraisal of projects: Valuation of Cost and benefits at market prices or shadow prices.

A project incurs expenses on capital investment, in machinery, equipment, operation and maintenance cost, purchase of raw materials, payment of wages and important of goods and services. This category is called use of resources/generation of goods and services. Another category includes: Direct taxes on profit, sales tax, octroi, and all other taxes, fees, subsidies, loan repayment interest, depreciation duties, export/import duties *etc.* This category is called payments which do not involve use of resources (costs) or do not generate resources (benefits). Hence, there are two types of costs and benefits, one which involves the use/production of goods and services and another which does not involve use of resources but is the transfer of resources from to the government. Presentation of specific distinctions of these are made in the following points.

Financial Analysis		Economic Analysis	
1.	All costs and benefits are measured in *money* unit.	1.	Wherever possible costs and benefits are *quantitied*. If not *qualitative* statements are made.
2.	*Micro-Level* Analysis	2.	*Macro level* Analysis
3.	Taxes, duties, fees are *included* on cost side as these are financial costs of project. Subsidy in included in benefit as it is the financial benefit to the project.	3.	Taxes, duties, fees, local taxes, subsidies are transfer payments, As they do not use resources or generate output, they are *excluded* from cost and benefit sides. Opportunity cost is taken into account in economic analysis.
4.	All costs and benefits are measured at *Market prices*	4.	Market prices of goods and services may not reflect true values, thus they may be modified through *Shadow prices.*
5.	The objective of project is to maximise *profit*	5.	The objective of a project is its contribution to the achievement of national objectives, e.g. *increase in income. employment, poverty reduction* etc.
6.	Interest rate is *excluded* to avoid double counting	6.	Interest rate is *excluded* to avoid double counting.
7.	Depreciation *excluded* as it is not the financial cost.	7.	Depreciation is *excluded* as it is taken care by the rate of return.

An illustration of the difference between financial analysis and economic analysis shows that:

	Analysis	Project A	Project B
		IRR	
1.	Financial Analysis	13%	19%
2.	Economic Analysis with adjustment for transfer payments	17%	6%
3.	Economic Analysis with Adjustment for transfer payments and shadow prices	24%	10%
4.	Bank's lending rate	15%	15%

In the above illustration, if financial IRR is taken into account, project B is acceptable as IRR is 90% which is higher than bank's lending rate. In case of project A its financial IRR is 13%. less than bank's lending rate. The economic analysis of the project after making adjustment for transfer payment reveal that in the case of project B, government subsidy of a substantial amount was making it more attractive. If subsidy is taken out of calculation of benefits, the use of resources indicate that its capacity to generate benefit is very weak. Also, Project B is already

enjoying a tax holiday and import duty exemption. If the project is granted tax exemption and relief of 50% on import duty, it will be financially viable. A further analysis of projects using shadow wage/exchange rate may indicate, economic rate of return of project A increases further. Hence, in the above illustration, through project B is financially viable, it is not economically viable. In the case of project A., it is economically viable but financially not viable, but can be made financially viable by giving certain concessions on tax and import duties. Thus project A may be recommended for acceptance with certain taxes and duties considerations.

BRIEF ON UNIDO & LITTLE-MIRRLESS (L+M) METHODS OF PROJECT APPRAISAL

The two methods most frequently used in project appraisal are UNIDO and Little-Mirrlees Methods developed in the early 1970s and published in 1972 and 1974 respectively (See selected references). The basic features of these two methods and a numerical presentation of NPV calculation using the methods are presented in this section.

UNIDO METHOD

Price or Numeriare is expressed in *domestic prices* with adjustment for divergence between private cost and benefit in UNIDO method. Here consumption is measured in domestic currency.

L+M METHOD

Price or numeriare is expressed in world prices, or the 'numeriare' is the dollar, foreign exchange. Domestic and foreign resources are made comparable by giving value at world price to everything (Border prices in general). The import is expressed in Freight on Board while import is expressed in cost, Isurance and Freight.

Calculation of NPV by using the UNIDO and L+M method*:

- Assumptions:

(1)   World Prices measured in $, Domestic Price in Rs.

(2)   Shadow exchange rate is Rs. 1.25 or $ 0.8 over Office Exchange Rate.

(3)   Standard conversion factor for converting non traded goods into word prices, (FOB) Prices at 0.8 or 1.25.

(4)   All output is exported with annual value of $ 3000.0

(5)   Foreign exchange component in investment $ 1000.0

(6)   Local components in investment (for non-traded goods) Rs. 1000.0

(7)   Traded inputs of $ 100 and non traded inputs (land, unskilled labour, water etc.) Rs. 1000.0

		Year			L+M Method	Year		
	UNIDO Method	0	1	2		0	1	2
	(Price=Rs.)				(Price = $)			
1.	Cost of Investment (K)							
	a. Foreign Component	1250				1000		
	b. Local Component	1000			b. Local component	800		
	Rs. 1000 x				Rs. 1000 x			
	conversion				conversion			
	factor of 1.25				factor of 0.8			
2.	Input cost (C)							
	a. Traded Inputs		1250	1250	b. Non-traded		1000	1000
	b. Non traded inputs		1000	1000	inputs (Rs. 1000		800	800
	(Rs. 1000 x				x conversion			
	conversion				factors.8)			
	factor of 1.25)							
3.	Benefit Flow (V)		3750	3750			3000	3000
4.	Net Benefit	-2250	1500	1500		-1800	1200	1200

* Adapted from A.P= Thirwall: 1983 Growth and Development. ELBS/ Mcmillan. London.

From the above table. using the formula (See A.6. Section)

$$NPV = \sum_{t=0}^{r}\left(\frac{Vt - Ct}{(1 + r)^{t}}\right) - K$$

the NPV derived from UNIDO and L+M Methods can be expressed as:

From UNIDO Method : $\frac{1500}{(1.1)} + \frac{1500}{(1.1)^{2}} - 2250 = Rs.353.2$

From L+M Method: $\frac{1200}{(1.1)} + \frac{1200}{(1.1)^{2}} - 1800 = \$282.6$

COMPARATIVE CONCLUSIONS

(a)   Both approaches single out values of foreign exchange, saving and unskilled labour as source of distorted price mechanism. So both use accounting prices to correct these distortions.

(b)   Both methods use discounted cash flow and calculate NPV.

(c)   Both methods advocate explicit allowance for inequality and distribution considerations in project choice through shadow wage. However, in UNIDO, this is done through greater weight to increased consumption for poor than rich which reduces present value of lost consumption. In L+M approach, distribution considerations are dealt with by working out value of standard of living of particular extra workers employed. Extra consumption of the rich may be given no future value and treated as cost to favour labour intensive projects.

USE OF COMPUTER IN COMPUTATION OF VALUES FOR PROJECT APPRAISAL

(a)   The microcomputer *Software* for financial and economic analysis of development projects is known as *costben* or *costtab* developed by the Information and Technology Facilities Department of the World Bank and Investment Centre of the Food and Agriculture Organization. The IBM or compatible micro-computer with a hard-disc and 640 of internal memory under DOS 2.1 or higher version can utilize the package. The package also gives modules for computation e.g. Highway project for Gambia. Technical Training for Bangladesh etc.

(b)   Also to compute values separately for different components of Project Appraisal, e.g. NPV, IRR etc. *Lotus Worksheet* or *Windows Excel* also have formula facilities. For example, in Lotus (123), the computation of IRR is carried out through/IRR with a guess value for IRR given to the computer. The result for IRR is obtained for the cash flow data entered to the computer.

(c)   Gittinger (See selected reference) also gives methods for calculating discount rates, capital cost recovery etc. using simple calculators with memory functions.

(d)   The discount rate tables for development projects cash flow analysis are available in most of the publications on cost-benefit analysis.

PROJECT APPRAISAL : THEORY AND PRACTICE

During late 1960s, considerable development of methods of social cost benefit analysis was observed. In 1970s, these methods were applied. There were massive public sector investment booms in many developing countries. But much of the investment yielded little. Thus, the methods proposed raised wide debate and discussion among economists, though the methods were considered practical.

(a)   **Resons for decline of interest in Shadow prices and CBA in World Bank**

- Actual prices should coincide with shadow values. For public sector projects, a good guideline is to make prices coincide with their shadows.

- Structural adjustment loans and non project loans e.g. development finance corporations account for increasing proportion of World Bank lending.

(b)   **Nature of Projects**

- A review of 2000 projects financed by the World Bank during 1968-1980 with re-estimation of Economic rate of return suggest following basic conclusions.

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- In case of health and education, no economic rate of return is estimated. For example, in Brazil in most cases, the World Bank loan included very few projects with cost benefit analysis. Similar trend was observed also in other countries.

- Cost benefit and rate of return calculation seem to be the most useful instruments in case of large Capital-Intensive Public Investment Projects. A minimum rate of return criteria, say 10 percent will help to screen out a number of projects with low IRR.

- National parameters, such as discount rates and shadow wage rates should be updated. Use of single accounting rate of interest unvarying by time and country is misleading for parameter estimation. In most cases, as the rate is always 10%, the parameter can substantially vary. Little and Mirrlees argued that some of the methodological components recommended by them for project appraisal were either neglected or inadequately used.

- Many environment sensitive projects have controversial cost and benefit valuation. Environmental audit components differ in magnitude with more subjective arguments. This biasness in terms of social cost and benefit valuation is in itself a subjective judgement.

CONCLUSION

Good project appraisal is an essential part of public investment and should be done by planners with their own incentives. Environment for sound project appraisal, and both the favourable intellectual and the political organisational conditions etc. are vital for a sound public investment projects appraisal.

WORKS CITED

Bruno, M. (1972), "Domestic Resource Costs and Effective Protection: Clarifications and Synthesis." *Journal of Political Economy*, 80:1:16-33 Jan./Feb. 1972.

Gittinger, J.P. (1982), *Economic Analysis of Agricultural Projects.* Washington D.C.: Economic Development Institute, World Bank.

Little, IMD and Mirrlees, J.A. (1990), Project Appraisal and Planning: Twenty Years on in *Proceedings of the World Bank, Annual Conferences on Development Economics.* Washington D.C.

------------, (1974), *Project Appraisal and Planning for Development Countries.* London: Heinemann Educational Books.

Pitale, R.L. (1987), *Project Appraisal Technique.* New Delhi: Oxford and IBH Publishing Co. Pvt. Ltd.

UN, (1978), *Guide to Practical Project Appraisal.* New Delhi: Oxford and IBH Publishing Co. Pvt. Ltd.

UNIDO (1972), *Guidelines for Project Evaluation.* Project Formulation and Evaluation Series No. 2, New York: Industrial Development Organisation, United Nations.