The Social Cost of Labor and the Rate of Return on Investment - A Simple Example

Imagine an extremely simple economy, composed of 1,000 identical one-acre farms, each owned by one landlord. The sole product is wheat, which is produced from land with the aid of labor, according to the following production relationship:

Input of Labor per farm (man-years)	Output of Wheat per farm (bushels)
1	50
2	90
3	120
4	140
5	150

There are 3,400 agricultural workers, each with identical skills. If there is perfect competition among landlords and among workers, it is clear that, in equilibrium, 600 farms will each employ three men, and 400 farms will each employ four men; the wage rate will be 20 bushels per annum[I]; and each landowner will receive a rental income of 60 bushels per annum. The output, and its division for each type of farm, will be as follows:

Farm	Output	Wages	Rent
Three-man	120	60	60
Four-man	140	80	60

Now suppose that the country consists of two provinces of equal size, and that in one province the Peoples' Progressive Party has come to power and established a legal minimum wage of 35 bushels per year. Again,

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[I] Or fractionally less, since landowners will require some net return from employing the fourth man, whose marginal product is 20 bushels.

assuming competition among landowners and workers, a new equilibrium will emerge, as follows:

Province I (Minimum wage, 35 bus/yr.)

500 two-man farms, employing 1,000 men, with wage rate 35 bushels/year, and rent 20 bushels per farm.

	Output	Wages	Rent
Two-man farm	90	70	20

It will not be in the interest of a landowner to employ more than two men, since the marginal product of a third man, 30 bushels, is less than the legal minimum wage.

Province II (No minimum wage)

100 four-man farms, employing 400 men, and 400 five-man farms, employing 2,000 men, with a common wage rate and rent of ten bushels per year[I], and 100 bushels per year, respectively.

	Output	Wages	Rent
four-man farm	140	40	100
five-man farm	150	50	100

The only type of investment undertaken in the country is the clearing of virgin land for cultivation. Land, capable of being cleared with greater or less difficulty, is available in both provinces. Naturally, the easily-cleared land will tend to be cleared first; also clearing activity will tend to be concentrated in Province II, since labor is cheaper and land more valuable there. As clearing proceeds, the cost of clearing will rise, since the remaining land will be less suitable. Investors will

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[I] Or fractionally less (see preceeding footnote).

not invest in land development in Province I if the rate of return is less than that obtainable in Province II, and vice versa. Hence, if clearing is being done in both provinces (which we assume to be the case), it can be assumed that the same rate of return will prevail in both provinces. Suppose this to be 10 per cent. Given the wage rates prevailing in each province, and assuming that clearing is accomplished by labor alone, the investment opportunities existing in the two provinces must be as follows:

Province I

An acre of land can be cleared by 5.7 men working for a year. The investment opportunity looks as follows:

	Cost	Receipts	Net Income
Year 1	200 [5.7 x 35]	-	-200
Year 2	70	90	+ 20
⋮	⋮	⋮	⋮
Year ∞	70	90	+ 20

Rate of return: 10%

Province II

Clearing has extended on to such unfavorable land that 100 men are needed to clear one acre in a year. Costs and returns are as follows:

	Cost	Receipts	Net Income
Year 1	1,000 [100 x 10]	-	-1,000
Year 2	40 (or 50)	140 (or 150)	+ 100
⋮	⋮	⋮	⋮
Year ∞	40 (or 50)	140 (or 150)	+ 100

Rate of return: 10%

The Federal Government of the country controls some unalienated, uncleared land in each province. It is estimated that the land in Province I

could be made suitable for cultivation by the employment of 14 men for a year, while the land in Province II would require 18 men for one year. The Government is considering developing these tracts (each of 1 acre) for settlement by private settlers. The Treasury has produced "financial" analyses of the two settlement schemes, as follows:

Province I	Cost	Receipts	Net Income
Year 1	490 (14 x 35)	-	-490
2	70	90	20
⋮	⋮	⋮	⋮
∞	70	90	20

Rate of return: 4%

Province II	Cost	Receipts	Net Income
Year 1	180 (18 x 10)	-	-180
2	40 (or 50)	140 (or 150)	+100
⋮	⋮	⋮	⋮
∞	40 (or 50)	140 (or 150)	+100

Rate of return: 55.5%

The schemes are proposed as suitable projects for financing by the World Bank, which dispatches an appraisal mission comprising an agriculturalist, an engineer, two economists, a financial analyst, a mission leader, and a loan officer. One economist, noting that any addition to or subtraction from the demand for labor in either province results ultimately in men leaving or returning to 5-man farms in Province II, where their marginal product is 10 bushels/year, decides that labor

throughout the country should be priced at a shadow wage of 10 bushels. He prepares the following economic analysis of the two schemes.

Province I

Cost of clearing: 14 man-years @ 10 bus.	=	140
Annual cost of cultivating, year 2 to year ∞ 2 man-years @ 10 bus.	=	20
Annual value of output, year 2 to year ∞		90
Net annual benefit		70

Internal rate of return: 50%

Province II

Cost of clearing: 18 man-years @ 10 bus.	=	180
Annual cost of cultivating, year 2 to year ∞ 4 (or 5) man-years @ 10 bus.	=	40 (or 50)
Annual value of output, year 2 to year ∞	=	140 (or 50)
Net annual benefit		100

Internal rate of return: 55.5%

He concludes that both projects have a high rate of return relative to the opportunity cost of capital, and that, if a choice has to be made between them, the Province II scheme has the higher rate of return.

The second economist, who has a penchant for general equilibrium analysis and is also (necessarily?) an optimist, takes the view that the shadow price of labour should measure what its value would be if the country followed optimal policies. The only major non-optimal policy is the minimum wage law in force in Province I; hence he tries to estimate what would happen if this distortion were to be removed. This requires

him to estimate the total labor force and land stock, and the wheat production function. His calculations are greatly facilitated by the extreme simplicity of the economy, and, in the circumstances it is perhaps not surprising that he arrives at the correct answer, viz. that shadow price of labor (the equilibrium wage rate) would be 20 bushels per year. He also correctly notes that with a market wage of 20 bushels applying to the whole country, the intensity of land use would be equalised in the two provinces at 3 or 4 man-years per acre. Hence his economic analyses of the projects are as follows:

Province I

Cost of clearing: 14 man-years @ 20 bus.	= 280
Annual cost of cultivating, years 2 to ∞ 3 (or 4) man-years @ 20 bus.	= 60 (or 80)
Annual value of output, years 2 to ∞	= 120 (or 140)
Net annual benefit	= 60
Internal rate of return: 21.4%	

Province II

Cost of clearing: 18 man-years @ 20 bus.	= 360
Net annual benefit (as for Province I)	= 60
Internal rate of return : 16.7%	

Faced by irreconcilable differences between his two economists, the mission leader is forced to adjudicate. He leans towards the second economist's analysis, (a) because he finds rates of return of 50% uncomfortably high to be believed, and (b), because, being a man of sterling common sense, he can't understand how, of two projects producing

identical areas of land of identical quality, the one requiring the larger labor input should show the higher rate of return. But on the other hand, he can't swallow the second economist's assumption that the two areas will be farmed at the same intensity, since he observes different intensities in the two regions at present, and has no reason to believe that the minimum wage law in Province I will be repealed. He proposes a compromise: price labor at 20 bus/year, but assume that existing differences in cropping intensity will continue. The assumptions result in the following analyses:

Province I

Cost of clearing: 14 man-years @ 20 bus.	= 280
Cost of cultivating, year 2 - ∞ : 2 man-years @ 20	= 40
Value of output, years 2 - ∞	90
Net annual benefit	= 50

Internal rate of return: 17.9%

Province II

Cost of clearing: 18 man-years @ 20 bus.	= 360
Cost of cultivating, years 2 - ∞ 4 (or 5) man-years @ 20 bus.	= 80 (or 100)
Value of output, years 2 - ∞	= 140 (or 150)
Net annual benefit	60 (or 50)

Internal rate of return: 16.7% or 13.9%

Discussion

The first economist's assumption regarding the shadow wage rate, and his calculated rates of return are correct, given that the minimum wage legislation in Province I will remain in effect. The Province II project is superior to the Province I project, despite its higher initial cost, because the land made available will be cultivated at a more appropriate - and higher - intensity.

The second economist's analysis is correct given his assumption that the minimum wage legislation will be repealed. But since there is no warrant for this assumption, the analysis is inapplicable to the existing situation.

The mission leader's approach, like most compromises, is internally inconsistent, and wrong.

The question remains, should either or both projects be implemented? Are rates of return of 50 and 55.5% high enough? What should be the cut-off rate of return?

It is known that private investments in the country earn 10% at market prices. If there are no distortions in the capital market, 10% will represent the marginal rate of time preference of consumers. However, 10% does not necessarily represent the social marginal productivity of capital, since we know that in Province I the private cost of labor used in investment projects exceeds its social cost.

It will be recalled that in Province I private investors are clearing land which requires only 5.7 man-years per acre to clear. At the minimum wage of 35 bus/year this activity gives a return of 10%. To calculate the social rate of return on this investment, we revalue labor at the shadow wage of 10 bus/year, as follows:

	Cost	Receipts	Net Income
Year 1	57 (5.7 x 10)	-	-57
Year 2	20	90	+70
	⋮	⋮	⋮
Year ∞	20	90	+70

Rate of return : 123%

It is clear that if either of the appraised projects were to be implemented at the expense of private investment in Province I, a social loss would result. On the other hand, in Province II, the private and social rates of return on land clearing coincide at 10% (since the market and shadow wage rates in that province are the same), and if labor were to be diverted from these private projects to the Government's projects, the outcome would be socially beneficial. A third possibility, is that the government projects be implemented at the expense of current consumption, for which the marginal rate of time preference is 10%. In this case, too, implementation of the Government projects would increase the net social product.

If the Government could control all investment in the economy it should cease further investment in Province II and channel all investment into clearing the easily-cleared land still available in Province I, in which case neither of the two appraised projects should be undertaken. But if it cannot or will not exercise this degree of control, the best it can do is to ensure (a) that within its own investment program it chooses projects having the highest possible rates of return, and

(b) that it does not implement projects whose rate of return is less than the rate that the resources required would earn in the private sector. In our example, the opportunity cost of capital to the government depends on the extent to which an expansion (contraction) in government spending results in a contraction (expansion) in private investments in Province I, private investments in Province II, and private consumption. The appropriate discount rates for these three activities are 123%, 10% and 10% respectively, and hence the opportunity cost of capital is a weighted average of these three interest rates. If, for example, it was believed that the three activities would suffer equally, the cut-off rate of return would be 48%. It this was the belief of the appraisal mission, the appropriate recommendation would have been acceptance of both projects.

Factor Substitution

We will now complicate the situation a little by allowing for the possibility of substituting machines for labor. Specifically let us suppose that machines can be rented from abroad at an annual cost (including operating costs other than labor) of 75 bushels, and that a machine plus operator can perform the work, both in cultivating and in clearing, of four men. With a minimum wage of 35 bushels in Province I, landowners there find it profitable to rent machines, and dismiss half of their labor force, retaining one worker per farm to operate the machine. Province I will then contain 500 mechanized farms, each employing one worker, each producing 140 bushels, paying out 110 bushels in cost (35 to the worker, 75 for the machine) and yielding an annual rent of 30 bushels.

The 500 dismissed workers will seek employment in Province II, but, at the going wage rate, only 100 of them can secure jobs on 4-man farms. We assume that 10 bushels per year represents the minimum wage at which men are willing to work: hence wages cannot be depressed further, and 400 men will remain unemployed.

In Province I, land clearing will now be done by machine. It will be recalled that at the minimum wage of 35 bushels but without machines, the most difficult land that would be cleared and show a rate of return of 10 per cent in this province was that requiring 5.7 man-years per acre to clear. Using mechanized methods, clearing of such land shows a higher rate of return, as follows:

Cost of clearing : 1.42 machine + operator years @ 110 bus. per year	= 157 bus
Annual cost of cultivating : 1 machine + operator year	= 110 bus
Annual value of output	140 bus
Net annual income	= 30 bus

Rate of return : 19%

If, because of its increased profitability, clearing is extended to more difficult land, and the rate of return reduced to 10%, the marginal investment opportunity in Province I will look as follows:

Cost of clearing : 2.73 machine + operator years @ 110 bus. per year	= 300 bus
Net annual income	= 30

Rate of return : 10%

We turn now to an appraisal of the two Government projects in this new economic environment. Although any labor employed on the projects will come from the unemployed, the shadow wage rate remains at 10 bushels

per year, since, by assumption, this is the workers' minimum supply price. Hence, the analysis of the Province II project remains unchanged. It can be assumed that the settler on the Province I project will employ machine technology for cultivation, since this is more profitable at market prices. This will alter the net benefit stream. However, the clearing operation, to be performed by government, may employ labor-intensive or mechanized methods, and hence we will prepare two appraisals to cover both alternatives:

Province I Project (a) Labor-Intensive Clearing

Cost of clearing: 14 man-years @ 10 bus.	= 140
Annual operating costs : machine, 75, operator, 10	= 85
Annual value of output	140
Net annual benefit	55

Rate of return : 39%

Province I Project (b) Machine Clearing

Cost of clearing: 3.5 machine + operator years @ 85 bus.	= 298
Net annual benefit	= 55

Rate of return : 18.5%

Hence the Province I project is now considerably less attractive than the Province II project, particularly if machine methods of clearing are employed.

The social opportunity cost of capital will also be different in the new situation since the social rate of return on the marginal

private investment in Province I will have changed as follows:

Cost of clearing:	2.73 machine years @ 75	= 205
	2.73 man-years @ 10	= 27
		232
Annual cost of cultivating : 1 machine year @ 75 plus 1 man-year @ 10		= 85
Annual value of output		= 140
	Net annual benefit	= 55

Rate of return : 23.7%

If we make the same tentative assumption as before, viz. that the social opportunity cost of capital is a simple average of the social rate of return on private investment in Province I, the rate of return on private investment in Province II, and the marginal rate of time preference, the social opportunity cost of capital is 14.6%. If this assumption is correct, both projects meet the acceptability criterion.

This example illustrates the general point that, while market over-pricing of an input will restrict private investment using that input to projects with a high social rate of return, this effect will be ameliorated if other inputs can be substituted for the overpriced one.

Mr. Jean Baneth March 29, 1973

Ross Parish

The Shadow Wage Rate and the Cut-Off Rate of Return on Investment

I have had some further thoughts on the above subject, and attach an additional section to be added to my note, The Social Cost of Labor and the Rate of Return on Investment - A Simple Example. By introducing a second investment activity that is land-intensive, I show that the overpricing of labor in the market can result in some investments having a lower social than private rate of return. A general statement of my point of view follows:

If labor in some country, sector, or region is overpriced, demand for substitute resources will be greater, and for complementary resources less than it would otherwise be. Whether the prices of these resources will be affected will depend on their conditions of supply: if supply is less than perfectly elastic, the price of labor substitutes will be higher and of complements lower than if labor was priced at its social opportunity cost. Furthermore, the prices of these resources will exceed or be less than their social opportunity costs. Thus the price of a labor substitute will be determined by the market value of the labor it displaces, whereas its social value should reflect the lower social value of the displaced labor. Conversely, the social value of a resource that is complementary with labor will exceed its market value, since the net value-added attributable to a unit of the resource will be greater when the associated labor input is rewarded at its social cost than when it is rewarded at its market price.

These discrepancies between the market and shadow prices of resources will lead to divergences between the private and social rate of return on investments. Investments that are intensive in labor or labor substitutes will show higher social than private rates of return, and the converse will be true for investments that are intensive in labor complements. The opportunity cost of diverting resources from private investment is an appropriately weighted average of the social rates of return on the affected private investments. It would seem that such an average could lie above or below the average private rate of return. Hence, if conditions are such that it is thought appropriate to shadow price labor at less than the market wage, it does not follow automatically that a cut-off rate of return based on going private rates of return should be adjusted upwards.

In practice, the principal resources whose market prices will be below their social value as a result of the overpricing of labor are likely to be land and other fixed assets. The prices of many investment goods, both labor substitutes and labor complements, will be unaffected, because they are traded goods. These goods, plus labor, are generally much more

significant components in the typical mix of resources used in investments than land or fixed assets. It is therefore probably true that, generally speaking, the overpricing of labor in the market will mean that private rates of return on investment will understate the social rates of return.

Enclosure

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Enclosure 1

A Second Investment Activity

Suppose that in addition to land clearing, another type of investment, viz, construction of playing fields, is undertaken in our imaginary country. A wheat farm (1 acre) can be converted into a playing field by four men working for one year, and it can be maintained thereafter by the employment of one man on a half-time basis. Playing fields yield income from user fees and admission charges to spectators. Sports are a relatively new activity in the country, and the first playing fields that were opened yielded very high rates of return. However, as more fields have been opened, average receipts per field have been reduced so that new fields can be expected to yield a rate of return on investment of 10%. In Province 1, a playing field investment opportunity looks as follows:

	Costs			Receipts	Net Income
	Rent	Labor	Total		
Year 1	20	140	160	---	- 160
2	20	17.5	37.5	53.5	+ 16
•	•	•	•	•	•
•	•	•	•	•	•
•	•	•	•	•	•
∞	20	17.5	37.5	53.5	+ 16

Rate of return: 10%

We suppose that because of the high cost of land, playing field construction in Province II has ceased.

The social rate of return on investment in playing fields in Province I can be calculated as follows:

	Costs		Receipts	Net Income
	Rent	Labor		
Year 1	70	40	---	- 110
2	70	5	53.5	- 21.5
•	•	•	•	•
•	•	•	•	•
•	•	•	•	•
∞	70	5	53.5	- 21.5

Rate of return: - 20%

The rate of discount to use in project appraisal is now either 123%, 10% or -20%, or a weighted average of all three, depending on whether, or to what extent, resources for the project are obtained at the expense of land clearing in Province 1, land clearing in Province II (or consumption in general) or playing-field construction in Province II. It is quite conceivable that the social rate of discount will be less than the private rate.

The raising of the wage rate in Province I has resulted in a fall in the price (annual rental value) of land. Both changes have adversely affected the private profitability of land clearing. However, while the higher cost of labor has made the construction of playing fields more expensive, the fall in land rent has reduced the annual cost of owning a playing field, and this second effect outweighs the first, so that the private profitability of investing in playing fields has risen.