EXPERIENCE WITH THE USE OF THE LITTLE/MIRRLEES METHOD FOR AN APPRAISAL OF SMALL-HOLDER TEA IN KENYA*

By N. H. STERN

1. *Introduction*

The significance of a case study for our views on a method of cost-benefit analysis depends on which of the more general arguments concerning the method we find, *a priori*, most convincing. There are at least three main arguments for the use of the Little/Mirrlees method. First, we could claim that welfare maximisation (in the sense of the maximum of some social welfare function) requires public sector efficiency. This claim should be articulated in terms of a specific model, the important assumptions of which concern the specification of which policy tools are available. This optimisation approach to shadow prices in cost-benefit analysis has recently been given a thorough treatment by Diamond and Mirrlees [1]. Their argument for public sector efficiency is essentially that if we have a way of disposing of extra output beneficially we have no reason for not producing more output from given inputs, if this is possible.[1] If we then assume that trade is an activity open to the government, public sector efficiency requires that shadow prices and marginal costs and revenues from trading activities be equated for the public sector. The main plank of the Little/Mirrlees position is thus established. The main assumptions of the model seem fairly weak but experience with case studies can assist our judgment as to whether or not they are weak enough to provide a workable correspondence to real world opportunities.

Secondly, we could argue that for many projects the main inputs and outputs actually are traded on the margin; either directly or because domestic prices do not change (so that demand/supply increments enter foreign trade). The onus on the proposer of this argument is to show that his empirical assertion is justified.

Thirdly, we can claim that, on the whole, there would be a more 'sensible' investment programme if Little/Mirrlees criteria were used than if, say, present policies were continued. This is really a 'catch-all' representation of a collection of informal arguments and thus will mean different things to different people. To some it is merely a restatement of the first argument together with the judgment of the model's applicability. Others might feel that although the qualifications required to the first argument are substantial they are evenly balanced 'either side' of world prices so that the use of the Little/Mirrlees system is likely

* This paper summarises much of the empirical detail of my project report [19] and further attention is paid to theoretical problems encountered and lessons learnt. Detailed acknowledgements can be found in [19] but I should especially like to thank Maurice Scott for helpful advice and encouragement both during data collection and report writing. Special thanks are also due to Dan Etherington for provision of important data and helpful discussions. Data, helpful comments and computational assistance were very generously provided by the KTDA, Ian Little and Sudir Mulji respectively. All errors are mine.

[1] Extensions of the Diamond-Mirrlees analysis to problems with restricted taxation possibilities are to be found in Stiglitz and Dasgupta [21].

to be a step in the 'right direction'. There will be some, however, who will not wish to put the argument in terms of specific models but would just point to the kinds of projects that would be selected by a Little/Mirrlees technique and claim that it is clear that this collection would be preferable to those currently being chosen. This last version of the argument has to be conducted in terms of specific cases. The existence of projects in some 'protectionist' developing countries which add little or even negative value at world prices (see Little, Scitovsky, Scott [12]) would constitute relevant evidence for proposers of this argument.

Different people will attach different weights to these arguments and case-studies are helpful for the understanding of all three. They are, perhaps, of greatest importance for an evaluation of the last version of the third argument. This paper, therefore, gives special attention to a discussion of the important reasons for the differences between an appraisal using Little/Mirrlees shadow prices and one using market prices, the only consistently advanced alternative cost-benefit procedure. We are concerned not only with differences in results and their origin but also with practical problems of application since one argument sometimes advanced in favour of the Little/Mirrlees method is its straightforwardness. The project under examination here is a useful framework for thinking about many of the questions raised in connection with the Little/Mirrlees method since, as well as being agricultural, it includes roads and factories and is of a multi-regional nature.

The next section gives a brief description of the project (in the Kenyan context). The third section contains an outline of the estimation and valuation of inputs and outputs. Attention is focussed on those problems, occurring primarily because of the agricultural and multi-regional nature of the project, which were not given detailed treatment in the Manual.[1] because of its industrial orientation. It is clear, however, that the basic principles of the Manual are, or are intended to be, general.[2] Concentration is on methodology rather than precise details (which can be found elsewhere, Stern [19]) and some familiarity with the main ideas of the Manual is assumed. The 'best guess' result of the evaluation is presented. The fourth section discusses the values to be placed on the standard conversion factor (SCF) and the shadow wage rate (SWR)[3] and their significance for the outcome of the evaluation. In the fifth section we indicate those lessons, gained from the appraisal, concerned with the project itself, including an assessment of the sensitivity of the evaluation to the values and estimations used.

The concluding section deals with the lessons concerned with the method of appraisal. These last two topics are not strictly distinct, of course, and although more attention is devoted to the last section, we should not forget the importance of this project to Kenya and its significance for other countries planning their development.

We shall not be concerned with the relative merits of cost-benefit analysis

[1] We refer to Little and Mirrlees [11] as the Manual.

[2] Indeed, this study was one of a group carried out in 1969 experimenting with the use of the method in an agricultural context; see Little and Tipping [13] and Scott [16], [17].

[3] See [11] Ch. 12.4 for the SCF and Ch. 13 for the SWR.

and economy-wide plans. It is this author's view,[1] however, that it is preferable that large-scale applications of cost-benefit analysis be carried out in the context of a plan and also that plans should be modified in the light of the results of cost-benefit analyses. For example, marginal revenues in a less than perfectly elastic market cannot be estimated without an idea of output levels; but output targets should not imply projects of little value. It is an iterative process and examples of the inter-relationships are to be found in section 3. Other arguments (i.e. those not directed against cost-benefit analysis, *per se*) commonly advanced against the Manual method will be discussed if and as they arise in the course of the examination of the project (see, especially, section 6).

2. *Description of Project*

The project under examination was the Third Plan of the Kenya Tea Development Authority (KTDA). The plan involves the planting of 35,000 acres of tea from 1968–9 to 1972–3. At the time the data were collected (June 1969) over 12,000 of these acres had been planted on schedule. The tea is planted and cultivated by smallholders, on land which they already own, and the area planted usually forms less than a quarter of their total land. The tea gardens are dispersed over a wide area in any region and many districts are involved in the KTDA scheme.

Systematic growing of tea by smallholders began with the First Plan and the creation of the SCDA, the forerunner of the KTDA, in 1961. The SCDA became the KTDA in 1964 when the Second Plan began and by 1968–9—the end of the Second KTDA Plan—38,000 acres had been planted with an average of 0.70 acres per grower. The Third Plan is a 'thickening-up' operation—both in the sense of increasing the tea acreage per grower and of concentrating new growers in already established KTDA areas (it is planned that the average holding in 1972–3 will be 1.09 acres).

The technicalities of tea husbandry and processing are important determinants of the organisation of the KTDA. Tea needs careful pruning and plucking to keep it to a height of three or four feet for convenient plucking. Maturity is reached in roughly nine years from planting and after four years approximately 40 per cent of the mature yield is available. Plucking begins in the third year and continues roughly once a week (more often in rainy seasons) thereafter. The plucked tea must be transported to the factory quickly—within six hours or so. The standard of the tea depends on regular and good husbandry and careful picking and the KTDA has always insisted on high standards. Tea is thus a very labour-intensive crop (current total smallholder labour inputs are around 2,000 hours per acre per year on mature tea) which requires an efficiently organised transport system to take the leaf to the factory.

The KTDA performs four major functions: (i) supplying planting material and fertilisers to the farmer on credit terms, (ii) supervising cultivation in the field and providing training facilities (Field Development Section), (iii) arranging for the inspection, collection and transport of green leaf (Inspection and Collection Section), (iv) procuring proper arrangements for processing and marketing.

[1] It is also the view of the authors of the Manual—see [11] Ch. V.

The factories are independent concerns run by private companies for a fixed fee plus an agreed commission on sales and purchases. The initial purchase price for green leaf from the KTDA is agreed in advance and any profits in the factories after commitments have been met are redistributed *pro rata* to growers. This is termed the second payment and this lump sum at the end of the year has proved an attraction to growers. The price at which the KTDA sells to the factory has hitherto been 40c[1] per pound of green leaf and the first payment to the growers has been 23c per pound of green leaf (4.5 pounds of green leaf are processed into one pound of 'made' tea. Quantities hereafter are in pounds of made tea unless otherwise indicated). The KTDA thus deducts a cess of 17c per pound of green leaf. Second payments vary between factories but the KTDA expects them to average around 5c per pound of green leaf over the next few years. The loan capital for the factories comes partly from the Commonwealth Development Corporation (who, together with the World Bank, also provide loans for the overall running of the project) and partly from the private company (which varies between factories). Interest rates have hitherto been around 8 per cent. Since the KTDA is the sole available outlet for the growers' tea it has been able to exercise tight control and insist on high standards.

Given the importance of the green leaf collection and transport operations of the KTDA it is clear that a reliable road system, passable in all weathers, is necessary. Until recently, the KTDA looked after its main collection roads under a special grant from the government. The state of the roads was causing some concern, however, and in 1969 a consultants' report recommended a large bitumenising programme with a capital cost of £K18m. It was[2] still unclear at the time this appraisal was carried out whether or not this road plan would go ahead and therefore the analysis of the road programme (although part of the project) was kept separate. Better roads make possible larger catchment areas and so bigger factories. We have assumed that the road programme *will* proceed, with a little delay, but have also calculated the effect on the results of assuming a more modest road programme together with more, smaller factories.

It is important to see the project in the context of its position in the Kenyan economy. The annual average growth rate of GDP from 1964–8 was 6.3 per cent,[3] the rate of population growth was around 3 per cent, and population in 1969 around 10.7 million. The 1970–74 Development Plan [8] estimated the working population would grow by 850,000 persons or 3.1 per cent per annum over the period 1968–74. The target increase of wage-paid jobs in non-agricultural activities is 200,000 (which represents an optimistic annual rate of increase of 5.8 per cent). Agriculture, therefore, must absorb a large increase in working population and this is one of the attractions of a labour-intensive crop like tea. Regional disparities in income per head are very marked (see the 1966–70 Development Plan [7]), and the intensity of population pressure also varies greatly—see Etherington [4].

[1] The Kenyan pound is divided into 20 shillings and each shilling into 100 cents. £K, Ksh, c denote Kenyan pounds, shillings and cents. There was no devaluation in November 1967 so £K1 = £1.167 and £1 = £K0.857.

[2] There has now been a decision not to carry out this extensive programme. Selective gravelling will be adopted instead. See KTDA Annual Report for 1969–70 [10].

[3] See [8].

The balance of payments current account has been, roughly, in balance over the last few years and since Kenya can expect a continuation of the net inflow on long-term capital account it cannot be said that she has a severe balance of payments problem (and she did not devalue in November 1967).

The role of tea in the economy is already important and is becoming more so. In 1981–2 KTDA output is expected to be 66 million pounds from 61 thousand acres and thus may well have overtaken estate production. 82 per cent of Kenya's 1967 production was exported and nearly all KTDA production is exported. In 1966 exports of tea earned £K8.7m which was 15 per cent of total domestic exports and 19 per cent of total agricultural exports. Tea ranked second, to coffee at £K18.8m, in Kenya's exports, and may overtake it by 1980. Kenya at present exports 5 per cent of world exports (non-communist countries) of tea, and her production is about 3 per cent of world (non-communist) production. Two-thirds of her exports go to the UK.

In the ten years to 1968 London tea prices (in sterling) fell roughly 20 per cent. To make matters worse there was the November 1967 devaluation of sterling. Kenya has, however, managed to hold her London tea price over this period (although the UK devaluation meant a fall in the Kenyan price) with a combination of increasing quality and a shift in tastes. The depressing outlook for tea prices induced the main (non-communist) producing countries to combine to fix export quotas under the auspices of the FAO through a Consultative Committee. The declared object of the Consultative Committee is to arrest the slide in prices at the 1968 level. It has been agreed that the KTDA third planting programme should be allowed to proceed.

3. *Evaluation of Main Items*

The inputs to the project fall conveniently under four headings: On-Farm, KTDA, Factories, Roads. The evaluation of items in the last three groups is fairly routine, so we concentrate mainly on the On-Farm inputs. The specific problems which were not given detailed treatment in the Manual (because of its industrial orientation) but which are important here are: the value of agricultural labour (hired and non-hired), land and the value of farmers' income.

The time stream of inputs commenced in 1966–7 when preparations started for the planting material for 1968–9. Net benefits were assumed to be constant from 1981–2 when the final year plantings (1972–3) will mature. Present values were discounted back to 1966–7 (the discount rate is discussed in section 3). Units of account were free (uncommitted) foreign 1966–7 exchange in the hands of the government in Kenyan pounds, convertible[1] at the official rate. Internal rates of return were also calculated. Little-Mirrlees shadow prices were calculated by splitting the market price into four components—unskilled labour, skilled labour, tradeable and residual. This technique is briefly described and illustrated by the example of fertilisers in section 3.3. Further detail on all the specific valuations is available in Stern [19].

[1] Convertible into some notional 'average' foreign currency to avoid the complications of particular exchange rate changes.

3.1. *Tea Labour*

The most important of the On-Farm inputs is labour. It is also the input for which we have least information. Two sources were available. The Farm Economic Survey Unit of the Ministry of Economic Planning and Development carried out three surveys in 1962, 1963 and 1964 of inputs into the activities of a sample of farms in Nyeri district (near Mt. Kenya to the east of the Rift Valley). The second source was the data, collected in 1965–6 by D. Etherington, on 48 farms in Kericho and Kisii (to the west of the Rift Valley) and kindly made available by him. The manner in which these sources were used to estimate a time stream for labour input is explained in Stern [19].

We had to decide how to price both hired and non-hired labour. Since there is no reason to suppose that women are more or less productive than men and their wage rate is only slightly less, we did not introduce a different shadow price for female labour. We decided to value hired tea labour at the market wage, deflated by the standard conversion factor (SCF). This is justified by the view that the market wage represents the opportunity cost (at market prices) of their labour. The SCF is introduced since the opportunity cost incurred has to be converted to a shadow price. The relevant figure for the SCF is therefore an estimate of the degree by which market prices overstate foreign exchange opportunity costs for the goods which the labour would have produced. In an agricultural region it is reasonable to assume that some average over agricultural products is appropriate. This argument needs qualification if some of the extra labour is foregone leisure. The SCF is discussed in a little more detail in the next section. We assumed that the market wage measures the opportunity cost since the rural labour market is fairly free. There are several reasons for believing this. Most of the hired workers we interviewed claimed that they had some immediate alternative place to work, *e.g.* with a relative, and that they would not work for less than the wage they were receiving. In other words there was a lower bound to their supply price. In areas where labour was hired by the day, e.g. Nyeri, there were small fluctuations in the wage rate with tea flushes. Farmers in Nyeri said they occasionally had difficulty in obtaining labour. The potential supply in many areas is somewhat limited by an unwillingness to hire other tribes. Finally, there are many unorganised buyers and many unorganised sellers.

Estimates of the actual price were based on the two sources mentioned and our own interviews. It was also assumed that the current real price will remain constant. It seems, on the basis of the same three sources, that real rural wages have not risen very much in the 1960s. Since we are making a projection we work with a constant overall price level and abstract from the problems of inflation. A further (slender) argument (as opposed to extrapolation) for projecting constant wages is that conflicting forces will operate on the wage (for example, rapid population growth exerting a downward influence, and increasing productivity upward) and, in ignorance, we assume they neutralise each other. It should be emphasised that the SWR of the Manual is not applicable to this labour since the SWR is appropriate to situations where the market wage is kept above the marginal product.

Family labour was also valued at the same market wage deflated by the SCF. The justification is that the physical labour performed by the family is similar to that of the hired and most farmers were hiring labour before they started to grow tea. The market wage, therefore, is a revealed value of the family's physical labour. There seem no grounds for using a different valuation from the farmers' own. Any managerial or supervisory element is counted in the price of land (see below). The appropriate value adjustments for the income changes generated by the project are discussed in the sub-section on the 'value of farmers' income' (section 3.4).

Finally we should note the qualifications necessary to this argument in view of the fairly large size of the project. In some areas smallholder tea employment is becoming an important aspect of the local market. The local wage rate may therefore be somewhat higher than it would otherwise have been. In this case the appropriate opportunity cost of labour will be the area under the supply curve between L_1 and L_2 if L_1 is the employment that would have taken place in the absence of the project and L_2-L_1 is the labour generated by the project. $\frac{1}{2}(w_1+w_2)(L_2-L_1)$ would probably be a good approximation to this area—see Fig. 1. In other words we would take the average wage in the two situations as the shadow wage. My view is that the magnitude of the adjustment required (a marking down of the wage, since w_2 is the concept employed above, as it was an estimate of the future wage rate in the presence of the project) is less than the possible prediction errors already involved and is not therefore 'worth the effort'. The downward adjustment becomes smaller still if we note that the Little/Mirrlees method would require an allowance for the cost of the extra consumption involved in the raising of the wage. Without such an allowance the shaded area in Fig. 1 would be counted as project surplus although it is committed consumption (if hired labour consumes all income).

3.2 *Land*

The second main on-farm item is land. The land involved is very specific—a part of the smallholder's plot—and the relevant opportunity cost is the net value of the use to which it would otherwise have been put. We asked this question of the farmers directly. In the great majority of the cases the answer was maize. We therefore valued land by subtracting the total shadow value of the (non-land) inputs, for maize, from the expected shadow value of the output. This was facilitated by maize production cost estimates prepared and kindly made available by A. Y. Allan of the National Agricultural Research Station. This is an example of a situation where it is useful to work within the context of a plan. In the past maize has usually been traded so that the Manual would suggest that border prices adjusted by shadow transport costs (plus for an import, minus for an export) are appropriate. It is important therefore to judge whether or not maize will be imported or exported. This judgment is greatly facilitated by the fact that Kenya's Development Plan 1970–74 [8] predicts that Kenya will be a net exporter. A prediction of the export price less shadow handling costs then gives us the shadow price of maize needed. The opportunity cost calculation gave, at market prices, a rental of 150 Ksh./acre. This compared

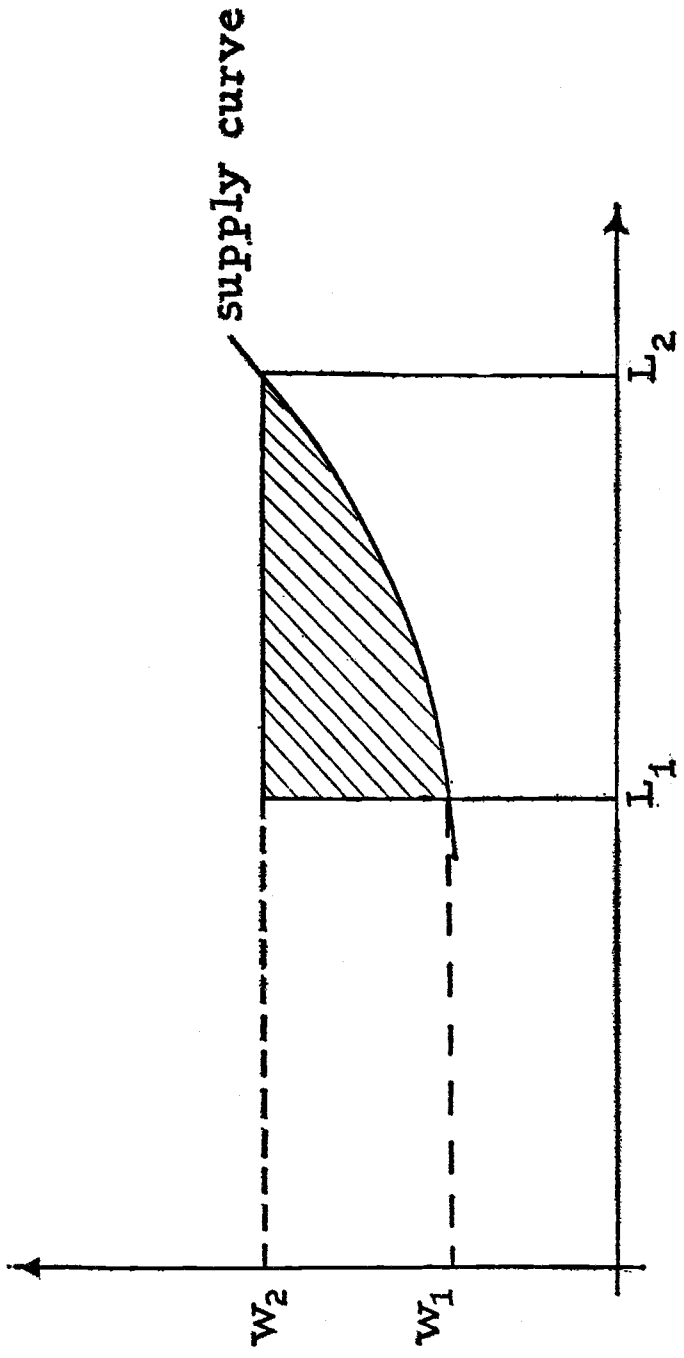

Fig. 1.

with market rents around 100 Ksh./acre. The difference seems reasonable since rented land is often uncleared and usually unadjacent to the plot owned by the tenant. The shadow rent used here thus includes capital in the land (invested in clearing) as well as the managerial element (provided this is equal as between maize and tea).

3.3. *Fertilisers*

We describe the valuation of fertilisers in order to illustrate the way in which, following the Manual method, the shadow prices of traded goods were found. We also discuss non-traded goods. The main fertiliser used by the KTDA on mature tea is 5:1:1, nitrogen, phosphate and potash (NPK). It is imported in bulk, bagged and transported to wherever it is required. Transportation costs were calculated to a point of roughly average (amongst the KTDA areas) distance from Mombasa—Kericho was deemed a suitable representative.

The market price in Kericho was 730 Ksh. per long ton. This market price was split into four components—unskilled labour, skilled labour, tradeable, residual. The shadow price was found by adding the SWR (deflated by the SCF) times the unskilled component, the SCF times the skilled component and one times the tradeable component. Thus items were allocated to the sub-headings according to the deflating factor required rather than strictly according to the name of the sub-heading. For instance, tea labour requires a straightforward SCF and thus was put under the second sub-heading. The c.i.f. import price of NPK per long ton was 500 Ksh. The wholesale margin to f.o.r. Mombasa was 68 Ksh. The transport to Kericho was 43 Ksh. and the retail distributor's margin was 194 Ksh. There was a government subsidy. The shadow price of a long ton is thus: in vector notation with components in the order—unskilled labour, skilled labour, tradeable, residual

$$500\begin{pmatrix}0\\0\\1\\0\end{pmatrix}+68\begin{pmatrix}.165\\.517\\.252\\.066\end{pmatrix}+43\begin{pmatrix}.103\\.104\\.386\\.407\end{pmatrix}+194\begin{pmatrix}.225\\.539\\.187\\.048\end{pmatrix}-75\begin{pmatrix}0\\0\\0\\1\end{pmatrix}=\begin{pmatrix}59.1\\144.3\\570.0\\-43.4\end{pmatrix}$$

The first vector is all tradeable and is the c.i.f. price. The second vector is the wholesale margin to f.o.r. Monbasa. This has been broken down using the breakdowns for the wholesale distributor's margin found by Maurice Scott in his paper [16] on shadow prices in Kenya. Scott's paper gives shadow prices (specifically, the breakdowns into the four components) for many of the important traded and non-traded goods. These breakdowns were particularly useful for many items which entered the analysis but were not important enough to warrant very detailed treatment.

The method by which Scott's shadow prices are calculated gives a second illustration of the advantages of working within the context of a plan. The Manual prescription for the shadow price of non-traded goods is the marginal cost (at shadow prices) at the level of allowed supply. Usually, these are calculated using an input-output table to decompose marginal costs into components that can be shadow priced. The assumption, effectively, is that current average

costs are equal to long-run marginal costs. A development plan giving an idea of potential structural changes can tell us whether or not such an assumption is reasonable.

The third vector is the breakdown of the rail transport from Mombasa to Kericho. This is calculated as follows. The Economist Intelligence Unit survey of transport costs in Kenya found that the marginal cost, at market prices, of NPK fertiliser transport was 26 Ksh. for one ton over this distance. This 26 Ksh. was broken down using Scott's rail transport breakdown and the remaining 17 Ksh. counted as residual. The fourth vector is the retail distributor's margin using Scott's retail distribution figure and the fifth vector is government subsidy.

3.4. *Farmers' Income*

The income of the farmer is changed by the project. The spirit of the Manual is that allowance should be made if any of the surplus of a project is not uncommitted free government income (held to be equal in value to savings). If the income of a person goes up by q as a result of the project and account has not already been taken of this (through *e.g.* the shadow wage, discussed in section 4) then we should charge the project $(1-\lambda)q$ where λ is the value the government places on extra income accruing to this person. If we were following the Manual strictly we should take $\lambda=\sigma+(1-\sigma)\frac{1}{s}$ where σ is the person's marginal savings rate and s is the value of savings in terms of consumption. It is not reasonable, however, to suppose either that everyone's savings are equal in value to free government income or that s is independent of the person being considered, so that it seems more direct to think of λ as the valuation the government puts on an extra unit of income to the person under consideration. One way of making this value judgment more clear is to express it in terms of a utility function. A little light on which function to choose can be cast by the various studies of marginal utilities of consumption (see, for example, Fellner's review [5] in Fellner [6]). The utility function appearing most frequently in these studies is[1] marginal utility of consumption $=C^{-\eta}$, where C is consumption and $\eta=1.5$. This is the function that was used. A more egalitarian position would place a higher value on η. Suppose that on average tea farmers consume A times the poorest person who is taxed $(A>1)$. There is a case for assuming government revenue equal in value to an extra unit of income to this person, because his income is just at that level where the government is ostensibly indifferent to whether or not it makes a transfer from his income to government funds (we abstract from 'incentive' problems). With this assumption we should take $\lambda=A^{-\eta}$ (using the above utility function and supposing all income is consumed). Discussions with the farmers on their personal taxation indicated that 1.5 might be a reasonable guess at A. With the value of η suggested this gives $\lambda=0.55$. For the purposes of the analysis a figure of $\lambda=0.6$ was taken so that 0.4 times the farmers' time stream of increments in income (deflated by the

[1] This value judgment implies, for example, that we value an extra unit of income to X 8(27) times as much as an extra unit to Y if Y is receiving 4 (9) times as much as X.

SCF) was subtracted from the project time stream of net benefits. The effects on the estimated returns to the project are discussed in section 3.10.

The inclusion of a specific value on farmers' income is also useful for the discussion of regional problems (see section 5). Poorer regions should have a higher value of λ and thus, *ceteris paribus*, higher present values would be attributed to expansion in these regions. For this reason sensitivity analysis to λ was carried out and the results are reported in section 5. Further use of a specific weight on income is made in the discussion of uncertainty in section 3.9.

3.5. *KTDA*

The KTDA formulates detailed plans for its own inputs and has an excellent record for fulfilling these plans. The forecasts for the Third Plan period were drawn up in 1967[1] at the time of loan applications to the CDC and World Bank. There were three main problems in the evaluation of KTDA inputs. First, we had to revise the KTDA plans in the light of the assumption that new roads would be built by the late 1970s. Second, we had to formulate assumptions concerning the levels of expenditure that would have occurred in the absence of the Third Plan, *i.e.* what would have happened if the First and Second Plan plantings had been allowed to come to maturity without any further expansion. Finally, after subtracting the second of these schedules from the first we had to convert the resulting time stream of inputs, in terms of local market prices, to shadow prices. For the first of these operations we were considerably helped by the consultants' report on roads—the only major revision involved KTDA Inspection and Collection costs. The Second Plan forecasts of 1964 were useful for the second operation and the final conversion to shadow prices was greatly facilitated by Scott's [16] breakdowns. An example of the use of these breakdowns has already been given (see section 3.3); in this case the application was straightforward. Further details can be found in Stern [19]. Loans for the Third Plan were entered as credits (in foreign exchange) as they occurred and repayment and interest were entered as debits.

An idea of the order of magnitude of these adjustments can be obtained from the following per pound figures for 1981–2 (the year from which net benefits are assumed constant). The costs at market prices of the three main KTDA activities (Inspection and Collection, HQ, Field Development) averaged over *total* tea output (First, Second and Third Plan) were originally expected to be 33.8c per pound. The first adjustment (for better roads) reduces these costs by 11.5c per pound. This is mainly due to reduced Inspection and Collection costs —cheaper vehicles, less wear and tear, and time, etc. The second adjustment— for the difference between 'average' and 'marginal' cost—reduces these costs by 8.8c per pound. The adjustment from market to shadow prices operates on the resulting 13.5c per pound and reduces it to 8.2c per pound. These figures should be compared with a KTDA cess of 76.5c per pound and a cost of the three main activities, averaged over all the First and Second Plan tea, in 1968–9 of 112c per pound. Some conclusions from these figures are drawn in section 5.

[1] These are reproduced in a CDC report of 1967 by Phillips and Cox [15].

3.6. *Factories*

The total increase in annual output attributable to the Third Plan is expected to be about 41 million pounds by 1981–2. This will necessitate a large expansion in processing capacity over what would have been necessary (the total smallholder output in 1981–2 is expected to be 66 million pounds). For the factories, the three operations described in section 3.5 were also applied—revision of the original Third Plan to take into account the road programme, estimation of what requirements would have been without the Third Plan, and conversion of the difference to shadow prices.

The revision for the road programme had already been carried out by the KTDA. This is a large change in plan since improved roads allow much larger factories—up to 6m pound per annum throughput as compared with current largest factories of around 2.5m pound per annum. By mid-1970 there were six factories in operation and four more were due to start in the following six months or so. The road improvement was expected to reduce the factory requirement to 17 altogether compared with the original figure of 32. Most of the extra capacity attributable to the Third Plan was therefore assumed to be in the form of expansions rather than constructions. The conversion to shadow prices was routine using Scott's breakdowns. The total capital cost of the extra factories at market prices attributable to the Third Plan was estimated at £K1.7m. The per pound processing costs (not including factory overheads) were estimated at 56c at market prices. Further details of the formulation of the plans and conversion to shadow prices can be found in Stern [19].

Loans for the capital for factories were entered as benefits at the date of assumed receipt. They were assumed to be perpetuities at 8 per cent and these costs were counted in foreign exchange. Actually the loans will eventually be paid off and as this occurs growers will take up shares in the factories, although the managing agents will continue to run them. Some of the older factories have already sold a substantial quantity of shares to growers.

3.7. *Roads*

The new road programme recommended by the consultants forms an integral part of the final version of the Third Plan and indeed the consultants' study was commissioned with a view to providing a road system that could accommodate the planned expansion. It is correct, therefore, to count the road programme as part of the costs and to include the benefit to other traffic as benefits. The actual calculation of the costs of the road programme and the benefits to other traffic was kept separate, however, for two main reasons. First, the very large size of the items involved would prevent a clear view of the net benefits to the tea parts of the project (hereafter called the main part of the project, as opposed to the road programme). Second, it was unclear whether or not such an ambitious road programme[1] would be adopted and it was therefore desirable to have an idea of the net benefits of the main project without the road programme. The modifications to the main project evaluation required under the alternative

[1] There has now been a decision not to carry out this extensive programme. Selective gravelling will be adopted instead. See KTDA Annual Report for 1969–70 [10].

hypothesis of only minor road improvements were also estimated. Further it is important to view this particular road programme in the light of returns to other possible and actual road programmes in Kenya.

We have indicated, in the two preceding subsections, how the assumptions concerning roads affect KTDA and factory plans. The remainder of the road programme had already been analysed by the consultants. A further treatment was necessary, however, since they had worked in market prices and had used the undesirable technique of cutting off net benefits after a specific date (1991–2). Traffic was projected to grow at 10 per cent per annum with or without the better roads[1] so no benefit to generated traffic was included. The re-analysis carried out for this evaluation was to calculate shadow prices for the three sub-headings (capital, repair and operating cost) and to assume net benefits were constant after 1991–2. This later assumption is fairly crude but probably constitutes a rough approximation to the time path of net benefits which presumably grow at some approximately constant rate for a while before gradually levelling off as the road becomes congested. Certainly it is preferable to a cut-off which assumes zero net benefits after a certain date.

The shadow prices for the three sub-headings were found to be, as percentages of the market price, 85.1, 86.1, 61.4 for capital, repair and operating costs, respectively (using the main SWR and SCF described in section 4). The reason that the shadow price of operating costs is lower than for the other two sub-headings is that there is a large element of residual (tax) in the fuel price together with a large unskilled labour component (drivers). Accounting for these two elements alone takes 20 per cent off the market price. The consequence of going over to shadow prices therefore is a considerable reduction in net benefits. But annuitising the benefits after 1991–2 yields a substantial increase in net benefits over a procedure which cuts off at that date. The results of the road appraisal are given in section 3.10.

3.8. *Tea*

The two important factors involved in the prediction of future Kenya tea prices were mentioned in section 2: the resilience of Kenyan prices to the general fall of the 1960s and the introduction, from 1969–70, of an export quota system to combat the fall. It would perhaps be unreasonable to expect the rise in Kenya's relative price to continue for very long although the underlying factors may continue to operate for a while. It seems, therefore, that we must predict the level of world tea prices and this means a prediction of the future pattern of the quota arrangements.

It does not seem over-optimistic to suppose that the agreement will continue to operate reasonably successfully. The producing countries were encouraged by the price improvements in the first year of its operation (1969–70) and have 'rolled over' the quotas for the following year at the original level. It is, of course, crucial for the success of the project that Kenya's expansion plans be accommodated in the quota arrangements and such accommodation has been agreed in principle.

[1] Since benefits are assumed proportional to traffic this assumption is clearly crucial.

In view of the above arguments it was decided to estimate the future price of KTDA tea at its average 1968–69 level. Since Kenyan exports form a small proportion of the world exports (5 per cent or 6 per cent) it is natural to suppose that Kenya's demand curve is effectively perfectly elastic. The fact that Kenyan tea has become more popular reinforces the 'perfectly elastic' estimate. In any case, if the object over the long run, to hold prices around the 1968 level, is successfully achieved the extra foreign exchange accruing to Kenya as a result of the project is simply price times quantity. The agreement in principle to accommodate Kenya's expansion has not yet met the test of the Third Plan tea coming to maturity but the exercise of the strength of Kenya's bargaining position should ensure a translation of the principle into reality. This strength rests not only on the popularity of Kenyan tea but also on the crucial importance to India and Ceylon of the achievement of an agreement since tea forms such a large part of their export earnings. A further card in Kenya's hand is that she is a lower-cost producer and thus better able to withstand a price war. Her lower costs are due to lower estate wages (including 'fringe' benefits) and much lower smallholder labour costs, together with more modern processing equipment. In spite of his strength it is uncertain whether further smallholder expansion plans (after the Third) would be accommodated in any agreement.

There is one substantial imponderable hanging over all predictions on the future state of the world tea market. This is the position of domestic Indian consumption. In the five years to 1967 Indian domestic consumption was growing at 5.6 per cent (in spite of heavy taxation) whereas her production was growing at around 2 per cent. If this trend continues current (gloomy) price predictions will have to be revised.[1]

Since the KTDA has had 6 factories in operation the average f.o.b. Mombasa price obtained by these factories has been as follows: 1965–6, 4.20 Ksh; 1966–7, 4.13 Ksh; 1967–8, 3.41 Ksh; 1968–9, 3.01 Ksh; 1969–70, 3.11 Ksh. Much of the sharp fall in this average is due to the 1967 devaluation of sterling and the remainder to a larger relative production of factories earning lower prices for their tea. Factories build up a name for quality and this is a crucial determinant of their price. The average KTDA price may therefore improve if the new factories create a good name for themselves.

The price (and marginal revenue) estimate f.o.b. Mombasa was taken as 3.00 Ksh (the 1968–9 figure, effectively) indefinitely. In view of the arguments advanced above and the performance of the KTDA factories hitherto, this does not seem over-optimistic. Indeed, if anything I would guess it errs on the side of pessimism. Further discussion of Kenya's position in the world tea market can be found in Etherington [3] and Stern [19].

Quantity predictions were taken from the KTDA's own estimates. These are derived from the planned acreage and an assumed yield curve over time for ten bushes. Etherington [2] has developed an interesting econometric technique, more accurate than the KTDA's, for future prediction but, at present, the KTDA estimates are the best relevant ones available. The predicted value of one year's Third Plan tea in 1981–2 is therefore 41 million pounds at 3 Ksh per pound, *i.e.* £K6.15m.

[1] See Etherington [3].

3.9. *Uncertainty*

The Manual suggests that no special allowance should be made for uncertainty in the sense that an output (or input) should be valued at $\bar{p}_t\bar{q}_t\bar{R}_t$ where $\bar{p}_t$, $\bar{q}_t$, $\bar{R}_t$ are the expected shadow price, quantity and discount factor (respectively) for year t. The rationale is that the random variables p_t, q_t, R_t can reasonably be assumed to be independent so that the expression above is equal to $E(p_tq_tR_t)$—the expression we wish to capture if we are interested in maximising the expectation of some social welfare function. Since the Manual was concerned with industrial projects this is a very sensible position to take.[1] It is not immediately clear that such a recommendation is reasonable for agricultural projects and in this section we investigate whether it is justified for the main output of this particular project.

Two problems arise. The first—the possible correlation of p_t and q_t—will usually be the problem of whether or not demand is perfectly elastic. We have already argued in this case that demand *is* effectively perfectly elastic so that this problem does not arise. This assumption may not be the case for other countries and/or commodities, e.g. Ceylon and India for tea. The shadow expected value of the output will be less than the product of expected shadow price and expected quantity if shadow price and quantity are negatively correlated.[2]

A slightly more complicated problem, and one that does occur here, is the correlation of the shadow value (x_t) of an output with the discount factor R_t. Suppose the government values income in year t according to the function $v_t(y_t)$ where y_t is income per head so that the discount factor R_t is $v_t(y_t)/v_o(y_o)$. For many agricultural projects in agricultural countries it may well be the case that the output of the project and of the economy as a whole are positively correlated since both depend on the weather. In this case, since v [3] is a decreasing function of y, we have a negative correlation between R and x and $E(xR) < E(x)E(R)$. Such a correlation is highly unlikely for industrial projects. An indication of the degree of correlation between agricultural output and national income for the Kenyan economy is given by the experience of 1965. The growth[4] of GDP from 1964–5 was 0.5 per cent and 1965–6 was 14.5 per cent. The reason was that 1965 was a very dry year with low agricultural production in general and export crops in particular. There was an absolute fall in farmers' gross receipts. 1966 had good weather with record harvests of coffee, tea, cocoa and rice and farmers' receipts rose by 20 per cent. One would expect crops that were more weather-sensitive than average to exhibit stronger correlations. No precise estimate of the correlation for tea is available but the above shows that the problem exists.

We now make a rough estimate of how far the value of output needs to be marked down from $\bar{x}\bar{R}$. We take a very extreme case to find an outside estimate

[1] The output for very large projects may be significantly correlated with national income if the project output forms a significant part of that income. In this case the independence assumption is unjustified. This is noted on p. 200 of the Manual together with the reasonable observation that such projects are rare.

[2] Problems of short-term price fluctuations are ignored here if these are independent of q (for the reasons described above).

[3] t subscripts are now dropped, for convenience.

[4] See [8].

of the adjustment. Suppose that there is a 50 per cent chance of tea output being worth 20 per cent above the expected value for a given year (which occurs when national income is 10 per cent above expected levels) and a 50 per cent chance of deviations the other way. Suppose also that $v(y)=y^{-3/2}$ (see section 3.4). Our deflating factor $\frac{E(xR)}{\bar{x}\bar{R}}$ is then[1] $\frac{\frac{1}{2}(0.8)(0.9)^{-3/2}+\frac{1}{2}(1.2)(1.1)^{-3/2}}{\frac{1}{2}(0.9)^{-3/2}+\frac{1}{2}(1.1)^{-3/2}}=0.971$. This would involve marking down the value of output by 3 per cent and it should be emphasised that the correlation supposed here is only illustrative and is extreme.

There is a second aspect to uncertainty that needs to be quantified. This is risk spreading. For agricultural projects the risk is likely to be borne by the farmers and is unlikely to be spread over the rest of the population.[2] This affects our estimate of the adjustment required for the valuation of farmers' income in terms of government income described in section 3.4. Let us suppose benefits in any year are divided between government and farmer in the proportion $(1-\alpha):\alpha$ (where, for the sake of the argument, take α to be a certain constant). The social valuation of the benefits in a particular year is then $(1-\alpha)xv(y)+\alpha x\lambda(\frac{z}{y})v(y)$ where λ is the value of farmers' income in terms of government income (which we assume takes a special form so that it is a function of the ratio between farmers' income z and national income per head). y and z will be correlated, and further z/y will be above average when y is above average (and vice versa) since the reasons for y's oscillation apply even more strongly to z and risks are not spread. Since λ is a decreasing function of z/y, the effect of the correlation between x and λv is stronger than that of the correlation between x and v alone (λv 'oscillations' are 'sharper' than those for v). In other words this second term ($\alpha x\lambda v$) needs to be marked down for uncertainty even more than the first.

We calculate how much this second term should be marked down in a similar way to our calculation of the adjustment for the first term. Suppose that z is 20 per cent above average in the 'above average' situations of the previous example (similarly 'below average'). In other words the whole of the farmers' income depends on the weather in the same way as tea output does. We use the same valuation function for λ as we do for v, *i.e.* $\lambda(b)=b^{-3/2}$. Then the adjustment required for the second term is (the calculation is similar to the previous one)

$$\frac{E(x\lambda R)}{\bar{x}\bar{\lambda}\bar{R}}=\frac{\frac{1}{2}(0.8)\left(\frac{0.8}{0.9}\right)^{-3/2}(0.9)^{-3/2}+\frac{1}{2}(1.2)\left(\frac{1.2}{1.1}\right)^{-3/2}(1.1)^{-3/2}}{\left(\frac{1}{2}\left(\frac{0.8}{0.9}\right)^{-3/2}+\frac{1}{2}\left(\frac{1.2}{1.1}\right)^{-3/2}\right)\left(\frac{1}{2}(0.9)^{-3/2}+\frac{1}{2}(1.1)^{-3/2}\right)}$$

$$=\frac{1.016}{(1.035)\ (1.019)}=0.963$$

[1] The deflating factor is $\frac{\frac{1}{2}(0.8\bar{x})(0.9\bar{y})^{-3/2}+\frac{1}{2}(1.2\bar{x})(0.9\bar{y})^{-3/2}}{\bar{x}\left[\frac{1}{2}(0.9\bar{y})^{-3/2}+\frac{1}{2}(1.1\bar{y})^{-3/2}\right]}$ and we divide through by $\bar{x}\bar{y}^{-3/2}$.

[2] Considerations of the lack of risk spreading may also be relevant for some industrial projects.

In other words we mark the second term down approximately 4 per cent. The extra adjustment to the second term required to take account of the lack of risk spreading is rather small (an extra 0.8 per cent deflation) and, of course, the effect taken as a percentage of $(1-\alpha)\ xv+\alpha x\lambda v$ is even smaller.

It should be noted that the formulation of benefits used when we adjust for the value of farmers' income as in section 3.4 is $xv(y)-\alpha(1-\lambda)xv(y)$. In other words, our procedure involved an initial valuation as if all benefits accrue to the government followed by an adjustment since some (a proportion α) accrue to farmers. Marking down x by 3 per cent and λ by 1 per cent would have the required risk adjustment effect.[1]

It seems reasonable to suppose that these risk adjustments overstate the actual adjustment necessary, *i.e.* a deflation of the value of tea output by around 3 per cent would be over-adjusting. First, in bad weather years the labour input (mostly plucking) would be less so some input costs would be avoided. Second, the probability distributions hypothesised here are extreme. Third, in bad years it is possibly not the case that farmers' income becomes more valuable (in terms of government income) since government income can be used to help those worst hit. Our conclusions from this analysis are therefore that the adjustments necessary for uncertainty are rather small, though perhaps not negligible, and that the correlation between output and national income seems more important than the lack of risk spreading.

3.10. *The Results*

In this sub-section we present the main results of the analysis. The discount rate (10 per cent), the shadow wage rate (2/3 market wage before deflation by the SCF) and the standard conversion factor ($\frac{3}{4}$) are discussed in the next section. The units of shadow prices are uncommitted foreign exchange in £Km convertible at the official rate[2] discounted to 1966–7. The market price results include a charge for land at 150 Ksh per acre and family labour at the rural wage, as does the 'return to the grower'. The 'main part of the project' excludes roads, and the costs of roads and benefits to other traffic are included in the road plan. Plan A involves extensive bitumenising, plan D slight improvement and plan B no improvement. Relevant items are assumed constant at final levels in 1981–2 for the main part of the project and 1991–2 for the road plan. The results are summarised in Table 1.

TABLE 1

Results	*Present Value £Km*	*Internal Rate of Return %*
Main part of project		
Shadow Prices	12.59	38.8
Market Prices	8.02	22.0
Road Plan A compared with D		
Shadow Prices	2.62	11.9
Market Prices	7.75	14.4
Road Plan A compared with B		
Shadow Prices	2.83	11.8
Market Prices	9.32	14.7
Return to Growers	13.9%	

[1] Note, however, that $\tilde{\lambda}>\lambda\left(\frac{\bar{z}}{\bar{y}}\right)$—see Stern [19].

[2] Convertible into some notional 'average' foreign currency to avoid the complications of particular exchange rate changes.

There are two things to explain about these results. First the difference between shadow prices and market prices and second the difference between the return to the growers and to the project as a whole. The main reason for the difference between market prices and shadow prices is that the costs of the main input, tea labour, are deflated by the SCF of three-quarters whereas the main output, being traded, is not marked down. An idea of the importance of the tea labour is that its present value at market prices is £K7.67m; marking this down by a quarter thus adds £K1.92m to the present value. The remainder of the difference is due to the fact that the remaining shadow prices are all below market prices so that all the other inputs (and in particular land and packing materials) are marked down. Indeed, the SCF at three quarters means that, on average, opportunity costs at 'world' prices are 25 per cent below market prices. This reason for the difference between results with shadow and market prices is absolutely basic to an understanding of the Little/Mirrlees method and will be taken up again in our review of the lessons learnt about the method in section 6.

The results shown include a charge for farmers' income changes at 0.4 (see section 3.4). This charge drops the PV from £K13.04m to the result shown of £K12.59m. Interestingly the charge increases the IRR from 33.0 per cent to 38.8 per cent—the reason is that we are taking off a time stream heavily negative in early years and with an IRR of 13.9 per cent so that we 'gear-up' the IRR.

In section 3.7 we noted that moving to shadow prices reduced the value of saved vehicle operating costs (large elements of taxation and unskilled labour). It is seen that this substantially reduces both the PV and IRR of the road plan. There seems therefore considerable danger of over-valuing roads by using market prices. The danger of making a mistake the other way by cutting off at a future date is illustrated by the increase of the PV from £K—1.09m to £K2.62m at shadow prices, and £K1.78m to £K7.75m at market prices, and the IRR from 8.6 per cent to 11.9 per cent at shadow prices, and 11.9 per cent to 14.4 per cent at market prices, when we change from a cut-off at 1991–2 to assuming constant annual net benefits at the terminal year level (case A—D).

In view of the uncertainty[1] about the eventual construction of the new road programme it is worth checking on the effect on the PV of the main part of the project of alternative assumptions concerning roads. The modifications required to the analysis of the main part of the project if we assume selective maintenance (D) rather than A are as follows. The KTDA Inspection and Collection costs increase by 11.5c per pound (7c at shadow prices). We assume (using the consultants' calculations) a 7 per cent loss in output (from spoilt leaf). These extra current costs have a PV of £K2.57m at shadow prices. The extra capital costs required for more and smaller factories were calculated at a PV of £K1.39m at shadow prices.[2] Therefore the present value of the main part of the project with no new road plan (and case D instead) would be £K8.63m. An alternative way of putting this would be to say the net benefits involved in the main part of the project together with road plan A are £K8.63m to the main part and £K6.58m to the road part where we now attribute to the road plan directly, the savings on the main part due to the road plan. The total is £K15.21m.

[1] See section 3.7.
[2] See [19] for more details.

We now turn to the difference between the return to the grower and the return to the main part of the project. We have already seen that a reduction in IRR from 38.8 per cent to 22.0 per cent is for the transfer from shadow to market prices (with 5.8 per cent caused by the allowance for farmers' income charges). The remaining difference (22.0 per cent to 13.9 per cent) is largely due to charging the Third Plan growers more than the calculated extra cost imposed. We remarked in section 3.5 that the KTDA cess (76.5c per pound made tea) will soon be substantially above the marginal costs of its activities (when the output has built up a little further). Indeed, it has recently been agreed that the cess will be reduced by 1c per pound green leaf (*i.e.* to 72c per pound made tea) from 1st July 1970. The factory pays the KTDA 1.80 Ksh per pound. The factory costs assumed here add at market prices an extra 70.9c per pound (including interest on capital at 8 per cent). At 3.00 Ksh per f.o.b. Mombasa this leaves 49.1c for second payment to growers (see section 2 for description of second payment system). This is substantially above the second payment of 22.5c per pound (or 5c per pound green leaf) estimated by the KTDA. If we assume that the growers do receive this extra 26.6c per pound plus, say, an extra 20c[1] per pound for reduced cess from the KTDA the growers' internal rate of return rises to around 20 per cent, *i.e.* very close to the market rate of return of 22 per cent.

We have now accounted for 'where all the project surplus goes'. The growers' rate of return is around 14 per cent. The difference between this and the market rate of return of 22 per cent accrues (with present assumptions) to the KTDA and factory—with rather more to the factory. This does not mean that the growers are being overcharged but that both the KTDA cess will be reduced and the factory second payment will be higher than currently assumed (if we adjust the value of the project for this increase in farmers' income the estimated PV would be reduced somewhat). The difference between 22 per cent and 33 per cent (the adjustment to shadow prices) can be regarded as largely accruing to the government. The following example clarifies this point. Suppose the SCF is three-quarters, the wage is one and a man is being employed by X—a profit maximiser at market prices—and that X produces an averagely protected commodity. When we withdraw a man from X to work at Y the loss is worth three-quarters at world prices. Suppose, for the sake of the argument, the commodity produced by X is exported and receives its protection in the form of a direct government subsidy, then the government saves a quarter. X has neither made a gain nor a loss since he was paying the man his marginal product at market prices. A similar argument applies if the good is an importable subject to a tariff. Suppose the unit not produced by X is now imported. The consumers and X are just as well off as before and the government receives the extra tariff revenues. This claim needs to be modified, however, since some of the reduction of market prices to get to shadow prices is due to the deflation of the value of unskilled labour, apart from the SCF, so that some benefit accrues to urban workers and their relations (this point is clarified in section 4.1 on shadow wages).

[1] This 20c may well be an underestimate.

4. *The Shadow Wage Rate (SWR) and the Standard Conversion Factor (SCF)*

4.1 *SWR*

The rationale of the Little/Mirrlees formula for the shadow wage $c-(\frac{c-m}{s})$ can be found in the Manual Ch. 13 (where c is the industrial wage, assumed institutional and totally consumed, m is the marginal product in agriculture and s is the value of savings in terms of consumption). We concentrate here, therefore, on methods by which this shadow wage can be calculated and modifications that might be necessary in certain circumstances. It should be emphasised that the SWR is not very important for this project since the important labour item (tea labour) requires only an SCF and not the SWR also. The SWRs calculated here embody only the second major tenet of the Manual—that consumption may be less valuable than savings. The first major tenet of the Manual is the use of world prices and this is embodied in the SCF. The SWRs calculated here therefore need further adjustment by the SCF.

1. *The Manual Method.* The Manual (p. 179) suggests the following formula for the calculation of s in the expression for the SWR: $s=(1+\frac{1}{2}(R-i)^T$. R is the rate at which the present value of a unit of investment at time t falls with t (assumed constant here), the accounting rate of interest (ARI) of the Manual, and i is the rate at which the present value of consumption is falling, the consumption rate of interest (CRI). The Manual adopts the position that although (for a particular developing country) savings may be at present more valuable than consumption ($s>1$) this discrepancy will not continue indefinitely and T is the time until it is thought that savings and consumption will be equally valuable. R is, in principle, the internal rate of return (at shadow prices) of the marginal public project. Such a definition of R is very difficult to use but we can obtain a rough idea of the sort of range in which R will be (see Manual p. 183). Returns to private investment in Kenya are generally high—it seems well over 10 per cent. Road projects, some undertaken, some not, analysed by the Road Research Laboratory show returns well over 10 per cent. (These are, however, in market prices.) These arguments suggest an estimate of R rather above 10 per cent. The Kenya Government, however, could presumably borrow abroad at real (adjusted for inflation) rates of interest around 10 per cent. It seems, therefore, that 10 per cent is a reasonable estimate of the ARI but, if anything, may be on the low side. The results in section 3.10 indicate that acceptance of the project is not sensitive to R so our casual treatment of an important parameter for a general decision rule should not cause us to worry too much, in this case. T was taken to be 30 years but this is little more than a shot in the dark. In principle an optimum growth model is necessary to determine T and I have formulated a very simple one (Stern [20]) but even so any figure is a very rough guess.

'i' gives us a little more to go on. i is the rate at which the present value of one unit of consumption generated by the employment is falling. The two income classes under consideration are urban workers (assume that there are L of them, receiving and consuming c) and agricultural workers (assume there are (N−L) of them receiving and consuming a). We value this situation so: V=

$Lu(c)+(N-L)u(a)$ where u is a valuation function (see Manual p. 255). One unit of consumption is generated by extra employment, l, when l is such that $l(c-m)=1$. The value of such a change we call A and

$$A=\frac{l\partial V}{\partial L}=\frac{u(c)-u(a)}{c-a}\,\alpha+u'(a)(1-\alpha) \text{ where } \alpha=\frac{c-a}{c-m}$$

$i=-A/A$. The formula for $-\dot{A}/A$ is derived in the appendix and is fairly messy. We need a valuation function u(.)[1] and estimates of the levels and rates of growth of a, c, m. The CRI came out to be 4.1 per cent (see appendix). The dominating term was the rate of growth of urban wages—which was taken at 4 per cent—the reason for the domination being that c is well above a and m (3750 Ksh/year compared with 600, 400 respectively). In practice the rate of growth of urban wages may be a good approximation for the CRI.

We can now calculate $s=(1.03)^{30}=2.42$ and the SWR $c-\frac{(c-m)}{s}$ is 63 per cent of the market wage. It should be noted that this calculation has taken specific account of distribution (and how it changes) between urban and rural workers (via the CRI).

2. *The Manual Appendix Method.* The above was based on the assumption that the best use of government income is investment so that the value of consumption in terms of investment is the appropriate measure of the value of consumption in terms of government income. In these circumstances, if it is felt that there is no shortage of investible funds, in the sense that the government feels the consumption-investment balance is about right, this assumption dictates that s should be taken to be unity.[2] There is a strong case for thinking that Kenya is not in a position of shortage of investible funds, in this sense. But it is still possible to adopt the view that government income is more valuable than income to many individuals since it can be used to help those worst off. This idea is involved in the calculation of the SWR using the Manual Appendix method.

The SWR can be understood as the extraction from project surplus less a correction for the value of increased consumption. The Manual method takes this correction as $\frac{c-m}{s}$. An alternative valuation of the correction to c is $\frac{1}{v}\frac{\partial V}{\partial L}$, where v is the 'utility price' of the numéraire, free government income. In other words we take the increase in V, following additional employment, to measure the consumption benefits. We divide by v to convert 'utils' into the numéraire.

This gives an SWR of $c-\frac{1}{v}[u(c)-u(a)+u'(a)(a-m)]$. This is the SWR implicit in equation 23 on p. 257 of the Manual Appendix (hence the title 'the Manual Appendix method'). It is also suggested that a lower bound to v is u'(a). The logic of this is that the government could divert its free income to agricul-

[1] The appendix uses $u'(x)=x^{-2}$—slightly more egalitarian than the function used in section 3.4.

[2] This was the position adopted for Malaya in the study by Little and Tipping [13] of a palm oil estate.

tural workers if it so wished, *i.e.* if it thought v was less than u′ (a). (More precisely, a lower bound to v is u′ (b) where b is the income of the poorest person facing direct taxation.) Using the same figures for c, a, m as previously and a utility function $u'(x)=x^{-3/2}$ (as for sections 3.4 and 3.9) we have an SWR of 75 per cent of the market wage (using the slightly more egalitarian $u'(x)=x^{-2}$— as we did for the Manual method—yields an SWR of 81 per cent). Again it should be noted that we have taken current distribution of income into consideration in the SWR (via the use of the utility function).

3. *The optimum growth method.* In this method we return to an evaluation of investment in terms of consumption. The value of investment is the value of the income stream it generates. The value of extra units of consumption in future years depends on how much we will be consuming in those years; thus, in order to carry out our evaluation we need an idea of the future time path of the economy. We have, in other words, a problem in optimum growth. In [20] I set up this problem as the maximisation of the $\int_0^\infty (L\ u(c)+(N-L)\ u(a))e^{-rt}\ dt$ subject to the constraints of a Cobb-Douglas production function and an institutional wage so that $c \geqq \gamma a$ where γ is a mark-up. With figures based very roughly on the Kenyan economy the initial shadow wage turns out to be 86 per cent of the market wage. Unfortunately, only the simplest of optimum growth models can, given the present state of the arts, be solved numerically, so many rather unsatisfactory assumptions were necessary. This result should therefore be viewed as more tentative than the previous two calculations. This method also takes into account, in the SWR, the distribution of income between urban and rural workers.

All three calculations should be taken cautiously as many of the data and assumptions are crude. For the actual evaluation an SWR (undeflated by the SCF) of two-thirds of the market wage was taken—the first calculation marked up slightly (conveniently) in view of the last two calculations. My view is that the second method of calculation is the most persuasive since although investible funds are not scarce in Kenya there are valuable uses for government income.

4.2. *The SCF*

The most important item that was entered in the column requiring deflation by the SCF was tea labour. In section 3.4 we noted that the appropriate SCF for this labour is an average ratio of shadow prices to market prices where the average is taken over a range of agricultural products representing the foregone output. This average ratio was taken to be 0.75. The arguments for doing this are based on Scott [17] pp. 11, 12 and are given below. The ratio was also used to deflate the skilled labour elements of other inputs. An examination of Scott [16] indicates that this second use is not misleading in that an average ratio over a broad group of industrial products would yield a number near 0.75. Other types of averages for the SCF are also relevant for tea labour, however. For instance, some part of tea labour is presumably diverted from leisure which is in turn evaluated by the farmer in terms of consumption goods. An appropriate SCF for some part of the tea labour would therefore be based on an average over

a consumption basket. That portion of the SWR which counts the benefits of increased consumption also needs such an SCF. Scott will shortly be calculating further SCFs for use in various situations.

There are three arguments for using 0.75 in Scott [17]. First, the ratio of imports of consumer goods c.i.f. to imports including import duty in 1967 was 0.75 (Statistical Abstract [9] p. 69). Secondly, the average ratio of value-added in manufacturing industries at world prices to actual value-added in 1967 was probably around 0.8 (based on Reimer's estimates of effective protection—see [17]). Thirdly, the ratios of shadow prices to actual prices for butter and maize in 1967–8 were 0.80 and 0.69 (maize and milk are the most important agricultural products in Kenya). Protection in Kenya is fairly low compared with some underdeveloped countries and thus 0.75 is higher than the appropriate SCF for these countries.

4.3. *Sensitivity of Results to the SCF and SWR*

Since there is a *prima facie* case for thinking the values of the SCF and SWR important to the result and no certainty about the precision of their estimates (or the value judgments embodied in the SWR), sensitivity analysis is appropriate. Nine combinations of SCF and SWR were tried: the SCF at 0.85, 0.75, 0.65 and the SWR at $\frac{1}{3}$, $\frac{2}{3}$, 1.0 times the market wage (remember this SWR is deflated by the SCF). The results are presented in Table 2.

TABLE 2

(a) *IRRS and PVs of main part project, varying the SCF and SWR*

		SCF					
		0.65		0.75		0.85	
SWR	$\frac{1}{3}$	39.2	£K14.80m	35.2	£K13.61m	31.8	£K12.42m
	$\frac{2}{3}$	36.9	£K14.30m	33.0	£K13.04m	29.6	£K11.77m
	1	34.9	£K13.81m	31.0	£K12.46m	27.7	£K11.12m
		Market prices 22.0%			£K8.02m		

(b) *IRRS and PVs of road project (case A–B) varying the SCF and SWR*

		SCF					
		0.65		0.75		0.85	
SWR	$\frac{1}{3}$	11.3	£K1.88m	11.5	£K2.18m	11.7	£K2.47m
	$\frac{2}{3}$	11.5	£K2.44m	11.8	£K2.83m	12.0	£K3.12m
	1	11.9	£K3.17m	12.1	£K3.47m	12.3	£K3.96m
		Market prices 14.7%			£K9.32m		

It is perhaps fair to say that the main part of the project is more sensitive to the SCF than the SWR—changes across rows are greater than those down columns and the percentage changes in SCF are smaller than those for the SWR. The reason is that the important input—tea labour—is deflated by the SCF. The PV of the road project is rather more sensitive to the SWR than the main project. The reason is that there is a fairly large element of unskilled labour in both the capital cost and operating cost of roads (7.5 per cent and 21.3 per cent respectively).

These results lead us to conjecture about the relative importance of both the SWR and SCF for different types of project. The two main types of project for which the SWR is likely to be important are roads and social overhead capital in general, and capitalised agriculture (estate tea would be very sensitive to the

SWR). Both types are likely to face institutional wages and have a high labour content. Many industrial projects are not sensitive to the SWR since they have a low labour content in costs—see, for example, the Manual, p. 225 with its example of Pakistan Rayon. Many agricultural projects on the other hand will not face the high institutional wages. The precise value of the SCF will probably, in general, be less important than for this project. The Manual recommends the use of the SCF as a short cut and the main examples envisaged were labour and land, which in industrial projects (for which the Manual was written) are unlikely to be very important (see above). It will be comparatively rare that such a large input as the tea labour was here has to be classified in the SCF category. Further the band of possible values of the SCF is likely to be narrower than that of the SWR, since the main calculation for the SCF is an average tariff level whereas the SWR involves us in the difficulties of estimating marginal products in agriculture and making valuations of investment in terms of consumption.

5. *The Lessons concerned with the Project Itself*

The project is clearly a valuable one—IRRs of 38.8 per cent are fairly rare. Credit for this is owing to all concerned: the individuals who conceived the project, the aid giving organisations that backed the idea and above all the KTDA for its efficient organisation and the growers for their enthusiastic and skilful response to a difficult crop. The KTDA has demonstrated clearly for the first time that smallholder tea is not only viable but can be highly successful. Those activities that exhibit economies of scale—processing, transport, education, accounting etc.—have been centralised, and farmers have been helped in carrying out the activity, crucial to good quality and high prices, and one best decentralised, careful husbandry. This expert and tight organisation has been crucial to the success of this project and seems essential to the success of smallholder projects in general (cf. comparative failures in Ceylon, Indonesia etc.). The project also illustrates that the popular notion of the sleepy, slow-reacting peasant farmer is certainly not applicable to the majority of KTDA growers. They have grasped this profitable opportunity with both hands even though a substantial period is required before the returns on their investment come through. The KTDA growers may be amongst the quickest off the mark but many others are not far behind.

We have been able to trace, on specific KTDA cess and factory second payment assumptions, where the main benefits of the project are going (see section 3.10). The (average) growers' return was calculated at 13.9 per cent when we charge for family labour and land, but this figure may well be exceeded (see sections 3.8 and 3.10). Better farmers (some of whom obtain at least twice the average output) will receive much higher returns. The IRR to the cash flow to farmers varies with the proportion of labour hired but is probably, on average, around 42 per cent, in the Kisii area, and 28 per cent in the Nyeri area near Mount Kenya. It is important, however, that care be taken that growers' enthusiasm, vital to the project's success, is not whittled away by falling receipts. The difference between the 13.9 per cent and the 38.8 per cent was allocated in section 3.10 between the government, the factories and the KTDA (in decreasing

importance) and it was indicated that returns under the latter headings will find their way back to the farmers (not only to Third Plan growers, of course).

The project is most sensitive to the values placed on its output, tea, and its main input, tea labour. This sensitivity is illustrated in Table 3.

TABLE 3

Sensitivity to Value of Tea Output and Farm Labour Input

		IRR% Farm Labour						PV £Km Farm Labour					
		0	0.2	0.4	0.6	0.8	1.0	0	0.2	0.4	0.6	0.8	1.0
Tea	0.6	33.0	28.0	23.7	20.0	16.7	13.8	7.36	6.21	5.06	3.91	2.77	1.62
	0.8	44.5	39.4	35.0	31.1	27.7	24.6	13.07	11.92	10.77	9.62	8.47	7.33
	1.0	53.2	48.1	43.7	39.7	36.2	33.0*	18.78	17.63	16.48	15.33	14.19	13.04*
	1.2	60.2	55.2	50.7	46.7	43.1	39.9	24.49	23.34	22.19	21.04	19.90	18.75

Notes

[1] The table gives IRR and PV at shadow prices (discounted at 10 per cent to 1966–7). No adjustment has been made for farmers' income, so best guess is 33.0 per cent IRR and £K13.04m PV, asterisked. The IRR and PV at market prices are 22.0 per cent and £K8.02m.

[2] The row variation shows the value of tea at 0.6, 0.8, 1.0, 1.2 times our best estimate and the column variation charges labour to the project at 0, 0.2, 0.4, 0.6, 0.8, 1.0 times our best estimate.

The issues involved in the estimation of both price and quantity of tea and farm labour are discussed in sections 3.1 and 3.8. Anyone who disagrees with these estimates can examine Table 3 and take their own view of the value of the project. This is, of course, one of the main points of sensitivity analysis—to enable decision makers to put their own figures to variables—especially ethical variables.

The main use of the sensitivity analysis has been to obtain an idea of the differential returns to the project in different regions of Kenya. The main differences between areas, as they affect the appraisal, would be the values of tea output, tea labour, value on farmers' income and value of land. Only the first two were used in the ranking of areas since the values placed on the latter pair were not very critical—see Stern [19].

The regional ranking is based on the simple proposition that expansion is more valuable in areas with higher tea output (and tea prices) and lower value on labour input. A rough rule of thumb (derived from Table 3) for trading-off labour cost against tea output is that a 10 per cent higher tea output than average is worth to the project the same as a 20 per cent lower than average value of tea labour. We assumed that the quantity of labour input was directly correlated with output (regional output variations were based on KTDA projections). The different wage rates assumed for different areas were based on the two labour data sources described in section 3.1, and general discussions in Kenya. They must be very tentative—the arguments supporting the estimates are given in [19]. Higher wage rates are assumed for wealthier regions with lower population pressure and vice versa but unfortunately precise regional statistics are very scanty. The following ranking (Table 4) was derived from these calculations. Table 4 gives the value of the project 'as if' it had all been in an area with the value of labour input and tea output deemed appropriate for the region.

TABLE 4

Value of Project 'as if' in Different Regions

		IRR%	PV £Km
Kisii	(92 , 115)	38.9	17.2
Kericho	(89 , 111)	38.4	16.4
Mount Kenya South	(122 , 111)	33.1	14.7
Meru	(94 , 94)	32.0	11.9
Aberdoes	(103 , 94)	30.6	11.4
Nandi/Kakanega	(69 , 77)	30.1	9.1

[1] The figures in parentheses, as a percentage of the average, are the values used for tea labour and tea output, respectively.

[2] No adjustment has been made for farmers' income changes; the figures are for shadow prices (discounted at 10 per cent to 1966–7); the result for project as a whole is IRR 33.0 per cent and PV £K13.04m.

It is reasonable to ask which of the conclusions concerning the project, described above, were obvious beforehand and thus ask what the appraisal has contributed to our knowledge of the project. The conclusion that the project was a valuable one is fairly clear in Kenya to most of those concerned (this is to be expected, given just how valuable we have shown it to be). We have, however, learnt a good deal more than this. The analysis shows that a substantial proportion of the net benefits are going indirectly to the government and that there is scope, and possibly a need, for increased prices to the grower. It has provided a rough quantification of benefit in different regions which should be helpful for the direction of expansion plans. The study has demonstrated that the correlation between tea output and national income is more important for the evaluation than the absence of risk-spreading but that neither is very important. It has shown that the road plan is a worthwhile addition to the project but that the project is still a good one without the road plan. In other words, if the road budget is fixed it might be worth doing other roads before plan A. If not it is worth doing plan A out of the overall investment budget. The danger of the overvaluation of road benefits because of the high tax on petrol has also been indicated (see section 3.7).

This specific knowledge gained does, I think, justify the effort expended in the economic analysis presented but there is a more general argument than this. There are many views, hunches, and guesses, that appear plausible *a priori*. One of the tasks of the economist is to quantify these arguments in an attempt to sort the more important from the less important, to identify those that are incorrect, and to make the eventual decisions better informed and open to intelligent discussion. A project evaluation with careful statements of value judgments, assumptions, and omissions together with sensitivity analysis to the important variables is a useful way of carrying out part of that task.

6. *The Lessons concerned with the Method of Appraisal*

The big difference between the value of the project at shadow prices and at market prices (see section 3.10) brings out very strongly the basic broad policy implications of the Little/Mirrlees method. The reason for the difference was that most inputs, tea labour being especially important, were deflated by the passage to shadow prices whereas output—being sold at the world price—was not. This deflation, as an average, is expressed in the SCF which plays the role,

adopted in some other suggestions for cost-benefit analysis, of a shadow price of foreign exchange (other analysts might therefore have up-valued the output rather than down-valued the input). The advantage of the Little/Mirrlees method is that the 'foreign exchange effects' are systematically evaluated right through the analysis and not just counted when it is obvious that a particular input or output enters foreign trade. A basic policy implication of the adoption of the Little/Mirrlees method is therefore that more resources should be channelled into producing exportable goods than is apparent from the use of market prices, in countries which currently have protectionist policies. There would be no such recommendation for the production of an import substitute unless the good in question had a lower tariff than average and/or the particular inputs were more protected than average.

This brings us to a problem which is highlighted, but not created, by the use of the Manual. We have remarked (section 3.8) that, at present, it is reasonable to assume that the marginal revenue to Kenya from tea, is equal to the price. This is false for tea producing countries as a whole and, indeed, the quota arrangements were set up precisely because it was thought that the price elasticity of demand in the market as a whole was low (with perhaps negative marginal revenues). If, therefore, we were evaluating the project from the point of view of tea exporting countries as a group, the value of its main output would be very low (possibly negative) and thus the value of the project would very probably be negative.

But we must be careful, here, about the assumptions we make about the behaviour of other suppliers. The above argument assumes that Kenya increases its supply and other countries keep the same supply so that the increment in supply is a net increase for the group. The other extreme case is a perfectly elastic supply of other countries, implying no increase in total supply from the group. The general case is intermediate: $\frac{dy}{dh}=\frac{-\eta}{\eta+\epsilon k}$ where y is the rest of the world's supply, η is the elasticity of this supply, k is the reciprocal of the rest of the world's market share, ϵ is the elasticity of world demand (taken as a positive number) and h is the Kenyan production.[1] The evaluation of the project is then also correct from the point of view of the group of countries as a whole if we assume they have perfectly elastic supply at their marginal cost (so that their net loss is zero on the marginal unit they give up). More generally, if Kenya forces the other countries to reduce their supply by the amount of her expansion the position is the same except that the other countries would lose the surplus over marginal cost on their units given up. It is optimum from the point of view of the group to charge the monopoly price, to allocate production where the costs are least with the gainers paying some agreeable compensation to the losers. Since one would guess that the possibilities of producing synthetic tea substitutes are not large this policy would also prove quite successful in the long run, although care should be taken not to underestimate the long-run elasticity of demand as other beverages may be substituted for tea.

[1] Etherington [3] gives an analysis of Kenya s position in the tea agreement in an oligopolistic framework.

To summarise, the casual use of world prices in project appraisals without any examination of possible supply reactions of other countries runs the risk not only of inaccurate estimates of marginal revenues to the country concerned but, through a sequence of project acceptances, may cause underdeveloped countries to compete damagingly against each other. On the other hand, a careful estimate of other countries' reactions could lead to accurate estimates both of own marginal revenues and losses to other countries and, possibly, to intelligent collaboration to the benefit of the producing countries. Aid-givers, particularly, should be interested in such an analysis. This analysis is necessary whether or not a Little/Mirrlees technique is used and if greater concentration on world trade leads to more analyses of the type described above this should be counted as a benefit of the technique.

Another benefit of the Little/Mirrlees technique is that, properly used, it takes account of how the project costs and benefits are distributed since different weights are attached to different persons' incomes. The Manual suggests a zero value on consumption out of monopoly profits (so that it is counted as a cost). Properly calculated the SWR takes account not only of the value of consumption generated by increased urban employment in terms of government income but also how this is distributed between urban and rural workers (see section 4). This procedure is further illustrated here in the discussion of the difference between results with market and shadow prices (see section 3.10). An extension of the idea was incorporated with the value of farmers' income discussion of section 3.4. These are all examples of the application of Meade's welfare weights [14] on individuals' income. We suggested that for a multi-regional project regional weights were a good idea, although the Manual points to political difficulties of doing this. The usual way of tackling regional problems in a cost-benefit analysis of a single location project is to compare the PV of the project in two different regions and ask the decision maker if any regional considerations should override the PV difference. For a multi-regional project this is less simple,[1] and hence the suggestion for the use of the weights.

No specific account has been taken of any desire to encourage rural programmes in general or smallholdings in particular, *in so far* as this desire is based on considerations *other* than the low wages to peasant farmers at present and the assumption that rapid population growth will keep them low, which is taken into account through the shadow price of farm labour. Account should be taken of any contribution towards arresting the drift to the towns but I would guess that the assumption that the wage rate for tea labour will not rise is unlikely to place the price of labour too high. It is probably confusing, however, to try to incorporate these considerations in a price—they should be indicated in a project report. Neither has any specific account been taken of possible stimulus of entrepreneurial activity towards cash crops or of multiplier effects of the increased incomes of farmers. There seems, at present, little shortage of enthusiasm for cash crops and we should count multiplier effects only if the government wishes, but is unable without cost, to increase the level of demand in rural areas and this project has greater multiplier effects than other projects with similar

[1] The 'as if' technique illustrated in Table 4 could be used here.

capital expenditure. Again, it is perhaps best to mention this in a project report rather than attempt to incorporate it in a price. Moreover, the project looks rather good, without the direct incorporation of these imponderables.

These problems of general policy would be common to any method of cost-benefit analysis. The main differences between an evaluation using the Little/Mirrlees technique and one using market prices has been discussed in the opening paragraphs of this section and in section 3.10 and section 4. It is perhaps worth remarking that the *economic* evaluation using the Little/Mirrlees method takes a little longer than one using market prices. The extra work involved consists of the calculation of the SCF, SWR, shadow prices for non-tradeables, and the more careful classification of expenditure so that appropriate shadow prices can be used. We have seen that this extra time can be cut down considerably if several analyses proceed simultaneously (note the extensive use of Scott's calculations). This extra time is a small proportion of the time spent in analysing a project since a great deal of work is usually involved in initial project design before the cost-benefit analysis begins. I am doubtful, therefore, whether any substantial case can be made against the Manual method (as opposed to any other cost-benefit method) on the basis of difficulty of application.

We conclude with brief remarks on how this project should affect our views of the three arguments in favour of the Little/Mirrlees method described in section 1. We mentioned there that the validity of the Diamond/Mirrlees argument depends mainly on the availability of the taxation possibilities it assumes. There is a fairly wide range of purchase taxation and control of prices via market boards in Kenya so the tools needed for the argument for public sector efficiency are probably there (although taxation of rural labour is not possible). The second argument—that inputs and outputs actually *are* imported or exported on the margin—is probably not valid for this project since the rural labour is non-tradeable and would alternatively produce some commodities which are also non-tradeable (such as leisure). Most light has probably been cast on the third argument in section 1—that the method, on the whole, yields a 'sensible' collection of projects. We have seen that the method attributes a good deal more benefit to projects producing exportables than does a method using market prices—even if the latter is combined with casual allowances for 'foreign exchange effects'.

St. Catherine's College,
Oxford

REFERENCES

[1] P. A. Diamond and J. A. Mirrlees, 'Optimal Taxation and Public Production, I'. *American Economic Review*, March 1971.

[2] D. M. Etherington, 'An Econometric Analysis of Smallholder Tea Production in Kenya', Ph.D. thesis (unpublished) for the Food Research Institute at Stanford University, December 1970.

[3] D. M. Etherington, 'An International Tea Trade Policy for East Africa' (mimeo), Economics Department, University of Nairobi, June 1971.

[4] D. M. Etherington, 'Projected Changes in Urban and Rural Population in Kenya and the Implications for Development Policy', in ed. Sheffield [18].

[5] W. Fellner, 'Operational Utility: the Theoretical Background and a Measure', in ed. Fellner [6].

[6] Ed. W. Fellner, *Ten Economic Studies in the Tradition of Irving Fisher*, John Wiley 1967.

[7] *Republic of Kenya Development Plan* 1966–70, Government Printer, Nairobi.

[8] *Republic of Kenya Development Plan* 1970–74, Government Printer, Nairobi.

[9] *Republic of Kenya Statistical Abstract* 1969, Government Printer, Nairobi.

[10] *KTDA Annual Report and Accounts* 1969–70, KTDA, Nairobi.

[11] I. M. D. Little and J. A. Mirrlees, *Manual of Industrial Project Analysis in Developing Countries*, Vol. II, OECD Development Centre, Paris 1969.

[12] I. M. D. Little, T. Scitovsky and M. FG. Scott, *Industry and Trade in Some Developing Countries*, OECD and Oxford University Press, 1970.

[13] I. M. D. Little and D. G. Tipping, 'A Social Cost-Benefit Analysis of the Kulai Oil Palm Estate West Malaysia'. OECD 1972 (mimeo), Nuffield College, Oxford, July 1970).

[14] J. E. Meade, Ch. III in *The Theory of International Economic Policy, Vol. II. Trade and Welfare: Mathematical Supplement*, Royal Institute for International Affairs, Oxford University Press 1955.

[15] T. Phillips and W. Cox, 'Report on the Operations of the KTDA and on its Proposals for Further Development' (mimeo) CDC, October 1967.

[16] M. FG. Scott, 'Note on the Estimation of Accounting Prices for some Non-tradeable and Tradeable Goods in Kenya' (mimeo), Nuffield College, Oxford, March 1970.

[17] M. FG. Scott, 'Estimates of Accounting Prices for some Agricultural Products in Kenya' (mimeo), Nuffield College, Oxford, August 1970.

[18] Ed. J. R. Sheffield, *Education, Employment and Rural Development*, East African Publishing House 1967.

[19] N. H. Stern, 'An Appraisal of Smallholder Tea in Kenya' (mimeo), St. Catherine's College, Oxford, December 1970. (To be published by the OECD).

[20] N. H. Stern, 'Optimum Development in a Dual Economy', *Review of Economic Studies* (forthcoming).

[21] J. E. Stiglitz and P. Dasgupta, 'Differential Taxation, Public Production and Economic Efficiency', *Review of Economic Studies*, April 1971.

APPENDIX

Modified Manual Method for the CRI (see section 4.1)

We noted in section 4.1 that the CRI is $-(\dot{A}/A)$ where

$$A = \frac{u(c) - u(a)}{c - a}\alpha + u'(a)(1 - \alpha) \text{ where } \alpha = \frac{c - a}{c - m} = x\alpha + y(1 - \alpha) \text{ say.}$$

$$\dot{A}/A = \frac{\alpha x}{A}\left(\frac{\dot{x}}{x}\right) + \frac{(1 - \alpha)y}{A}\left(\frac{\dot{y}}{y}\right) + \frac{x - y}{A}\left(\frac{\dot{\alpha}}{\alpha}\right)$$

Now (i): $\frac{\dot{\alpha}}{\alpha} = \frac{(\dot{c}-\dot{a})(c-m) - (c-a)(\dot{c}-\dot{m})}{(c-a)(c-m)} = \frac{a-m}{c(c-a)(c-m)}\left[\dot{c} - \frac{\dot{a}}{a}\right]$ if $\frac{\dot{a}}{a} = \frac{\dot{m}}{m}$

(ii) $\frac{\dot{x}}{x} = u'(c)\frac{\dot{c}}{c}\frac{u(c)}{(u(c) - u(a))} - u'(a)\frac{\dot{a}}{a}\frac{u(a)}{(u(c) - u(a))} - \frac{c}{(c - a)}\frac{\dot{c}}{c} + \frac{a}{c-a}\frac{\dot{a}}{a}$

$$= \frac{\dot{c}}{c}\left[\frac{u'(c)u(c)}{u(c) - u(a)} - \frac{c}{c - a}\right] + \frac{\dot{a}}{a}\left[\frac{a}{c - a} - \frac{u'(a)u(a)}{u(c) - u(a)}\right]$$

Using the values described in section 4.1 and the function $u(c) = -1/c$ (so that $u'(c) = 1/c^2$) we have

$$\dot{x}/x = -.045; \frac{\dot{\alpha}}{\alpha} = 1.25 \times 10^{-10}; \dot{y}/y = -.026$$

Substitution in (1) gives $-(\dot{A}/A) = .041$.

Note: $\frac{\alpha x}{A}$ is close to 1 since c is much bigger than a and m. Thus (since also $\dot{\alpha}/\alpha$ is very small) $\dot{A}/A$ is close to $\dot{x}/x$.

Also $\dot{x}/x$ is close to $-\dot{c}/c$ since c is much bigger than a and so the CRI ($= -\dot{A}/A$) is close to $\dot{c}/c$, the rate of growth of urban wages.