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On the Economic Surplus and the Value of Life

by

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INTRODUCTION

the In this paper some elementary theorems of welfare economics and principle of "methodological minimisation" are utilised to suggest that an appropriate measure of the value of human life in cost-benefit studies is, in general, one half of earned income plus some additional supplementary amounts to allow for transfer payments, overtime and other features of everyday life. In advocating this measure a double heresy is committed. First we appear to violate the rules recently set out by Mishan for the methodologically correct procedure (since we agree with Mishan our defence is that this violation is only apparent and not real). Second we include transfer payments which are traditionally disregarded in cost-benefit analysis (our defence here is that the traditional approach is methodologically unsound).

In a recent article, Mishan (1971) has argued convincingly that the methods currently employed for evaluating loss of life or avoidance of death in cost-benefit analysis have been theoretically inconsistent with its Paretian basis. Mishan considered four varieties of approach, identified their methodological inconsistencies and proposed a fifth, correct, approach based upon utility theory. In this article we propose the sixth indicated above which is more akin to the conventional measures, but which does not suffer from their shortcomings. Like Mishan's it is based upon utility theory. The reason for proposing yet another measure lies not in any alleged methodological superiority of our measure over Mishan's, though it is not methodologically inferior, but in its relative ease of application. Other things equal, a cost-effectiveness of cost-effectiveness suggests that a consistent simple measure is to be preferred to a consistent complex measure. In the event, however, other things are not quite equal. In particular, Mishan's measure is more comprehensive than ours and also enables uncertainty to be treated more satisfactorily (at least conceptually). Nevertheless,

our experience indicates that there is a wide variety of circumstance where our simple measure will be preferred on operational grounds to Mishan's more complete one.

To fix ideas it is helpful to recall the four approaches criticised by Mishan and his own approach.

The first method values a person's life at the present value of this discounted future earnings, possibly augmented by some estimate of the value of avoided suffering by the deceased and bereaved (Dawson 1967; Dublin and Lotka, 1946; Fisher, 1909; Hanlon, 1969; Holtman, 1964; Klarman 1965; Nicholson, 1891). This procedure identifies social welfare with net national product which is not, of course the maximand employed in welfare economics.

The second method uses the present value of an individual's gross earnings less consumption expenditures on the grounds that this is what society loses by the death of an individual (Weisbrud 1961). The objections to this approach are that it excludes the individual whose death is averted from "society" which, is at least, as a general rule, inconsistent with the individualistic basis of Paretian welfare economics as conventionally understood. Moreover, in a perfect capital market, the individual's marginal contribution to savings is valued by the rest of society at the present value of the interest it must pay - in equilibrium the rest of society is indifferent between the life or death of a marginal saver. Only if the capital market is so organised as to exploit savers is there any net loss imposed upon the rest of society by the death of a saver. In terms of permanent income, marginal individuals adjust consumption optimally through time with zero net effect on the welfare of the rest of society. If at death there is any planned or unplanned balance remaining of an individual's wealth, that constitutes a transfer from the deceased to the rest of society and is, distributional questions aside, Pareto-irrelevant.

The third method dispenses with direct calculation of loss of potential earnings or spending and suggests that the implicit valuations used by public decision takers in actual decisions involving life-saving investments be used (Fromm 1965; Hitchcock, 1970). Mishan points out the evident inconsistency of much public decision-taking and also the circularity involved in this approach. There is, however, a more fundamental objection still, for non-market choices cannot, in their very nature, duplicate the market choices of individual agents unless the behaviour constraining environment faced by decision-takers in each case is the same. It is, of course, the fact that the subjective costs confronted by decision-takers in bureaucracy and in the market differ and this is the principal ground both for relegating (or promoting) some decisions to the public sector and for recommending the use of economic techniques of appraisal. In a fundamental sense, one cannot have it both ways (Buchanan 1970 pp. 98 - 102). The major use of this approach is to indicate the values implicit in current public decisions (Hawgood and Morley, 1969; Lavers, 1972).

The fourth method is based upon the proposition that the premium a person voluntarily pays to insure his life and the probability of his death occurring can be used to derive the value he places upon his life (Fromm 1965). A major objection to this method is that under insurance provision is made only for the compensation of other individuals in the event of a person's death. Alternative measures, based upon the costs an individual voluntarily incurs in order to avoid death, or reduce its probability (Fromm 1965) have been based upon the implausible assumption that there exists a linear relation between the probability of death and the costs incurred to reduce that probability.

More observations of behaviour in situations where risk reductions may be purchased could, in principle, overcome this problem. However, quite apart from the difficulties involved in obtaining the

necessary data, there are inherent problems concerned with differentials between risks as they "actually" are, and as perceived by the individual.

The method proposed by Mishan is related to the fourth approach and seeks to estimate, through questionnaires - not behaviour - the amount an individual is willing to pay to reduce the risk of death. Problems inherent in the behavioural approach are avoided. For example, objective probabilities can be presented to test individuals and as many observations as are wanted can be obtained without the necessity of relying on information thrown up by the market.

Jones-Lee (1969, 1971) has proposed a method along these lines. Using the Neumann-Morgenstern axiom's he estimated how much an individual would voluntarily pay to reduce the probability of his death by some fixed amount by confronting the test person with a series of hypothetical choices between outcomes involving varying probabilities of his death and the enjoyment of an after tax annual income of £10,000 with no work.

In principle there seems to be no reason why the Jones-Lee/Mishan method should not be used in areas of cost/benefit analysis other than the evaluation of life. Imagine, for the moment that we are considering a study of the building of a dam. The dam will reduce the probability of a flood in any year on a particular farm from 0.02 to 0.01. In the event of a flood the farmer loses his whole crop of value V . The estimate of the value to the farmer of the dam would conventionally be taken as the discounted present value of a perpetual stream of $(0.02 - 0.01) V$ per year. The Jones-Lee/Mishan method, however, might also be applied (i.e. we could ask the farmer how much he would pay to reduce the risk of flooding from 0.02 to 0.01 per year) and lead to different results - results which may be considered superior because they take account of the value of the risk involved per se.

Why then do we not usually use the latter method? The answer is three fold. First, in the presence of fair insurance we would expect the discounted expected income loss figure to be a good approximation to the Compensating Variation (C.V.) the farmer would pay for the building of the dam. Second, there may be difficulties in applying the Jones-Lee/Mishan approach. The farmer may not be able to grasp the significance of small changes in probability. Third, the expected-income-loss method is much less costly as soon as many individuals are involved, because it uses relatively cheap market information. Surveys are time-consuming and expensive.

Loss of life, however, is qualitatively different from loss of a years crop. A man who dies is in no position to claim compensation for the loss of his life from an insurance company, and for this reason we may expect the figure for discounted expected income to be a poor estimate of an individuals C.V. when his life is to be saved.

EARNINGS AND THE VALUATION OF LIFE: A SUGGESTED TREATMENT

In identifying potential Pareto improvements in allocating resources to projects involving the saving of lives or the postponement of death we have set ourselves a number of methodological guidelines. Some of these have already been indicated - for example, the consistency of any method with the Paretian basis of cost-benefit analysis and a preference on operational grounds for relatively simple methods that do not have heavy data collection costs. In addition, we are persuaded that a corollary of a technique devised to identify potential improvements is that the compensating variation (C.V.) is in principle the appropriate measure rather than the equivalent variation (E.V.). The C.V. is the maximum sum an individual will pay for some proposed change in the environment or the minimum sum he will accept to tolerate it. If the sum of C.V.'s to gainers exceeds the sum of C.V.'s to losers a potential

improvement is clearly indicated. The E.V., however, is the minimum sum acceptable to a gainer if asked to forego the proposed change or the maximum sum a loser would pay not to have the change. If the gainers' E.V.'s exceed the losers' E.V.'s all that can be concluded is that there is a net welfare loss in not making the change - not necessarily that there is a net gain in making it. Consequently, our search for an unambiguous warrant for change leads us to think in terms of C.V.'s rather than E.V.'s.

A further corollary of the same requirement is that where latitude exists between alternative empirical measures of gain the smaller estimates should be preferred. Indeed, we shall attempt so to bias our empirical estimate of the C.V. such that the estimate must be smaller than the true C.V. We term this approach "methodological minimisation". The reasons for adopting this procedure are especially persuasive in the valuation of human life, for it must be clear that, if we cannot hope to measure the whole value of a life, then we should adopt a measure that is a certain underestimate rather than one that has an uncertain relation to the true measure. Biassing C.V. measures in this way ensures that, in testing for potential Pareto improvements, changes that appear warranted really are warranted. The procedure does not, of course, imply that changes unwarranted on the calculation are truly unwarranted.

A major benefit to an individual from prolongation of life evidently lies to a degree in his increased wealth from prolonged earning time. This has been recognised in the literature, though the full significance of the qualification "to a degree" has not been appreciated. Equally, this is not the whole benefit. The conceptually correct measure of the benefit from work is not, however, the amount earned but the economic surplus from working. The primary correction that needs to be made to the traditional approach is therefore to find

an appropriate measure of the individual's welfare gain from having the opportunity of an extended period of time over which he can trade leisure for work. The C.V. is the maximum sum he would pay for this option and is the amount he would have to be taxed if he were to be indifferent between having the option and not having it.

Assume initially that there is no income taxation, no overtime, no labour market imperfection and no source of income for the individual other than that offered by the opportunity of trading his labour. The significance of these assumptions will be investigated later. An individual may trade his labour either directly with "nature" - engaging in his own production - or in the market place at the going wage. A third use of his time is, of course, in non-work, here termed "leisure" in the conventional manner.

On these assumptions, if the individual is to live at all he must work, either on his own account or for others. Consequently, at any finite wage, some labour will be supplied and the individual labour supply function must pass either through the origin or to its right (Figure 1.2). In fact, we assume that both the compensated and uncompensated supply curves pass through the origin.

In the absence of a market, an individual is faced with a personal production function such as OE_1L in Figure 1.1, with a Crusoe optimum at E_1 where indifference curve I_1 is tangential to the production function. If a labour market exists he will, in addition, have the opportunity of trading labour time at wages W_1, W_2 , etc. If W_2 is the going wage, he moves to E_2 . By combining work on his own account with work in the market place so that the marginal product of his time is the same in each activity the individual will (up to a limiting wage) maximise his utility. The uncompensated supply curve S is derived by rotating a variety of wage lines around the production function and

locating points $E_1, E_2, \text{ etc.}$, in Figure 1.1 corresponding to $e_1, e_2, \text{ etc.}$, in Figure 1.2. The critical wage rate at which the individual will begin to supply labour in the market is given by the slope of the wage line W_1 at E_1 - his Crusoe optimum. At higher wage rates (e.g. W_2) he will mix market and own account work (e.g. OL_2 on his own account and L_2L_2' in the market). As soon as the slope of a wage line exceeds the (positive) slope of any point on the personal production function, all his labour time will be exchanged in the market (at wage W_3 in Figure 1). At wage rates lower than W_1 he will work entirely on his own account. The uncompensated supply curve between 0 and e_1 in Figure 1.2 is derived from the slopes of the indifference curves passing through OE_1L between 0 and E_1 .¹

$S(I_0)$ is the compensated supply curve derived from indifference curve I_0 corresponding, so far as the work-leisure choice is concerned, to "death". If W_2 is the going wage, the maximum sum the individual will pay to retain the option of trading his labour against "nature" and in the market is yy' in Figure 1.1 corresponding to $OW_2e'_2e'_1$ in Figure 1.2.

The use of net earnings from work in the market will normally clearly overstate this surplus, though it is interesting to note that where work on own account is large relative to work in the market (for example, in low wage economies) there is the possibility that total earnings in the market are exactly equal to the surplus from work - where real earnings on own account (E_0L_2) exactly equal the disbenefit of all work (E_2L_2' less yy'). The measure we propose is to take one half of earnings as a sure underestimate of the total surplus, i.e. E_2H in

Figure 1.1 in the text on

1. It is assumed throughout that work is a "superior bad", i.e., that the normal effect of a rise in income (wage constant) is to decrease the amount of work done.

Figure 1.2. If the value of the total product of work on the individual's own account can be ascertained, one half of the sum of this and market earnings would provide a larger measure, but one that was also for certain smaller than the true surplus.

The proposed approximation will be smaller than the true surplus at all wage rates. It consequently has two major advantages: it is extremely simple to calculate and it has a (qualitatively) known relationship with the conceptually correct measure. In the remainder of this paper we explore the consistency of the proposed measure with respect to changes in the assumptions, investigate some plausible further modifications of the measure to allow for the effects of prolongation of (working) life upon the rest of society and finally present some illustrative calculations and numerical comparisons with some of the other measures that have been proposed and used.

COMPLICATIONS IN THE LABOUR MARKET

Over- and Under-Employment

The argument is occasionally heard that the inability of individual workers to attain their preferred tangencies due, for example, to collective decisions reached by employers and unions, vitiates the kind of analysis used in this paper. Because that we are considering the supply of effort to the whole economy, rather than to any particular sector of it this argument is weakened. Before proceeding with our further reasons for supposing over- and under-employment not seriously to distort the proposed estimate we trace through the logic of the objection.

Figures 2.1 and 2.2 show the indifference map, the compensated and uncompensated supply curves, as before, and equilibrium E_2 under perfect adjustment. Suppose that the individual is now constrained

to providing L_1 time units of labour at W_2 , i.e. he is overemployed, and is confronted with an all-or-none choice of accepting this package or working only on his own account. The maximum amount he will pay for this option and the right to work on his own account is $y''y_1 < yy'$. In Figure 2.2 the individual is at point S and the estimate of his surplus would be $L_2be_o > L_2e_2e_o$, the latter triangle being the empirical approximation under perfect adjustment. The true measure of the surplus under overemployment is $Oe_1' W_1$ which may clearly be larger or smaller than the proposed estimate. Clearly, as the individual is constrained to supply more and more labour at a given wage (as point B moves to the right along W_2 in Figure 2.1) the amount he will be willing to pay for the right to work will diminish while, concurrently, the estimate of the surplus as one half of earnings will increase at the same rate as the amount of labour supplied. Therefore, at some degree of overemployment, the proposed approximation will become an overstatement of the true surplus.

Consider underemployment. Suppose that the individual is now constrained to supply L_1' units of labour at wage rate W_2 . Again the maximum amount he will pay to attain this combination of hours and wage is given by $y''y_1$. Observing the individual at point a in Figure 2.2, the estimate of the surplus would be $L_2ae_o < L_2e_2e_o$. Now L_2ae_o may be smaller than the true surplus with underemployment - indeed we believe that, in general, it will be smaller, but it is not impossible to devise indifference maps which produce the opposite result.

The proposed estimate may thus be either an under or an overestimate where workers may not adjust to their preferred hours of work. The major distortion probably arises with overemployment. In practice, however, the implications of these imperfections are likely to be less serious than appears. Absenteeism and extended sick leave are two time honoured procedures for adjustment towards the preferred

combination where there is overemployment. Moreover, the context in which measures of the value of a life are customarily used are such that only "statistical individuals" - modal persons - are of concern. Consequently, insofar as trade unions strike bargains that are satisfactory for the majority of their members, there is a presumption that the representative individual is in equilibrium. If there is a normal distribution of preferences about the wage bargain actually struck, the distortion due to the overemployment and underemployment of workers in the tails of the distribution implies that there is still some distortion, but less than there is for any representative overemployed or underemployed individual. As Friedman has observed (Friedman 1962) there also exist incentives for employers to suit work schedules to workers preferences for by so doing it is cheaper to attract labour of the appropriate quality. In short, we are fairly confident that the leeway already inherent in the proposed measure permits some marginal distortion such as is likely, in practice, to occur, without seriously undermining the validity of the measure.

OTHER IMPERFECTIONS

Perhaps the most frequent kind of labour market imperfection consists in wages that are set above or below the value of the marginal product of labour. With wages everywhere set equal to the value of the marginal product, a worker's death causes no net reduction in the social value of production. If wages are higher than the value of the marginal product (due to union power, for example, or external social costs of production) then society gains (to the extent that it was hitherto "exploited") from the removal of a marginal worker and the proposed estimate of social benefit from the postponement of death is, in net terms, possibly too large. Conversely, if the value of the marginal product is higher than the wage (due to employer power, for example, or

external social benefits of production) society loses from the removal of a marginal worker to the extent that he was hitherto "exploited".

In specific cases studies it may be desirable to devise shadow prices that reflect, so far as is possible, these distortions. For the purposes of this paper, however, we make the empirical assumption that for a modal worker, such distortions are negligible.

OVERTIME

The implications of overtime working for the proposed model are derived in Figure 3, with a standard wage at W_1 and an overtime rate of W_2 . He supplies L_1L_2' of overtime. The maximum amount that he would pay for the package indicated is yy' , measured in Figure 3.2 by $Oew_1 + aee'b$. An estimate of the surplus taken as one half of earnings is $L_2ae_0 + L_1a'b$. While L_2ae_0 is certainly smaller than the surplus from normal hours, it is clear that the estimate of the surplus from overtime $L_1a'b > aee'b$, the true surplus, according as $L_1da > ce'a'$. In general the sizes of these areas are not calculable in practice. Consequently to make some allowance for overtime and also to maintain the position of "methodological minimisation" we propose to use the sum areas $L_2ae_0 + aa'b$, viz one half of normal earnings plus one half of overtime earnings less the amount that would have been earned had normal time rates applied. This estimate is certainly smaller than the true surplus.

UNEARNED INCOME

The existence of unearned income effectively shifts the origin of the personal production function above the origin. It has no effect on the appropriate measure of the surplus from work and constitutes an unambiguous gain to an individual whose life is prolonged. However,

insofar as the unearned income would accrue in full to other individuals in the event of his death, there is a transfer which is Pareto irrelevant and may be left out of consideration.

THE UNEMPLOYED

In deriving a minimum value for life which may be used in Cost/Benefit analysis it is obviously desirable, so far as is possible, to take into account those members of society who are not employed. That is not to say that they necessarily do no work, but merely that they do not enter the market for employment. These Unemployed fall into the following categories: Housewives; Registered Unemployed; the Retired; the Sick; and Children.

(i) Housewives

Most women enter the labour market before they become housewives, that is they sell their labour. If they then become full-time housewives it is an implication of utility-maximising behaviour that their welfare gain from being a housewife must exceed that from selling their labour on the market. We may calculate, on our earlier reasoning, that in minimum estimate of the maximum amount they will pay for the ability to be able to work when they are selling their labour in the market, is half their earned income. Clearly, if the welfare from being a housewife exceeds that from working in the market, causing a woman to switch from work in the market to housework, the amount she will pay in order to be able to keep working at home will not be less than the amount she would have paid to be able to work in the market. Therefore we may use one-half of the potential earnings of the marginal housewife (defined with respect to women who stay in the market) as our estimate of the housewife's C.V. for having her ability to work retained.

The basis of this method of shadow pricing the services of housewives is not, of course, new (Weisbrod, 1961). It is strictly valid, however, only if the costs of moving into paid employment are not raised by marriage. In one important respect these costs are raised, for a necessary (not sufficient) condition for a housewife who is a mother to work in the market place is for the surplus from work to exceed the cost of, say, a baby minding service. In principle, adherence to methodological minimisation requires that such costs be netted out of the estimated potential surplus if the lives of women with children below school age are included in the calculation.

(ii) The Registered Unemployed; The Retired and the Sick.

The most common treatment of these groups when lives are being valued is to ignore them. Typically all people in these groups are receiving benefits from the rest of the population - unemployment benefit, retirement pension, sickness and supplementary benefit etc. Traditionally these payments have been treated as transfers which are to be excluded from cost/benefit analysis. The argument is that the pensioner who dies loses the money he would have received in benefit, while the rest of society no longer has to pay it, and therefore there is no net loss or gain. If the individual who dies is excluded from the cost/benefit definition of society, there is even a profit to be had from the death. An old age pensioner who dies no longer draws his pension.

The viewpoint taken in this paper is that the main reason benefits are paid is that the people who pay gain utility from helping their less well-off brethren. There are, of course, other possible explanations. First, the political power of the unemployed or potentially unemployed may be such that they can force society to transfer income to them. Second, the paying of social security taxes may be, as the name implies, regarded as a form of insurance. The people who pay may themselves be one day unemployed.

The first argument may have some substance, but the poor are notoriously poor in the particular respect even of claiming existing rights, let alone fighting for new ones to be established against the general will. The second explanation does not seem to be complete either, because people pay for benefits to others when the chances of their ever being dependent upon benefits themselves are remote in the extreme. Even if the importance of benefits is viewed less in terms of the actual recipients than in view of the potential recipients, or simply general availability, levels of benefits are presumably in principle related to the levels preferred by those financing the benefits.

Assuming they receive utility either from aiding less fortunate or, more selfishly, from feeling personally insured, donors will continue increasing the amount they pay until the utility gained from the marginal penny's effect (actual or potential) is equal to the utility of the penny. There will, therefore be a welfare surplus which accrues to the donors on all intramarginal payments. We cannot estimate the size of this surplus but we know that an underestimate of the utility gained by the donor is the amount of benefit paid. The recipient in his turn is better off by the amount of income he is given. Thus, if the life of a recipient of benefit is saved, the donor has to part with his money, but is more than compensated by seeing his fellow human being cared for. The recipient is better off by the amount of benefit he is receiving, and this is just the maximum amount he will pay to be able to draw the benefit. Therefore a minimum estimate (a minimum because the donor gains some unmeasurable welfare surplus from the existence of social security) of the net welfare gain from saving the life of a recipient of benefit is the amount of benefit paid.

This result is so much at odds with the tradition of treating such payments as pure transfers that we puzzled over it for some time. The main reason for puzzlement, however, should not be how one can assign positive net social worth to such transfer payments, but how one could assign a zero net social value. No social gain implies no motive for economic action. It seems to us to be quite clear that transfers are explicable by usual utility maximising behaviour. Doubts may be entertained whether the political mechanism works in such a way as to bring benefits into line with the preferences of a modal voter, but there is a presumption from modern theories of political action that it will tend this way (Downs 1957, Tullock 1972, Hochman and Rodgers 1969) and no evidence that we are aware of that it does not. Consequently, we see no reason in general for systematically accepting the signals indicated by market transactions while systematically ignoring those indicated by the political process.

(iii) Children

If the life of a child is prolonged, a minimum estimate of the gains which accrue to him are the present value of all the transfers made to him in the extra life, and the present value of the surpluses on all expected future earnings. The treatment of children in this paper therefore involves no additional concepts to those already developed with regard to those in work and those receiving benefits from the rest of society.

TAXATION

Removing the assumption of no tax raises the question of whether gross or net earnings are the appropriate base for deriving the estimate of the economic surplus. If gross earnings are used there is the implication that an individual is no worse off by virtue of paying

income tax - for example, because he values the publicly provided goods and services he enjoys as least as much as the private goods he would otherwise have purchased. Use of net earnings implies extreme fiscal illusion (or coercion). The methodology of the proposed measure suggests that it would be appropriate to use earnings net of tax as the basis for calculation on the grounds that whatever net benefit is received through fiscal processes is definitely minimised by assuming all tax payments to be dead weight losses. In this manner we side step the necessity for making arbitrary assumptions about the allocative and distributional impact of the budget, whether balanced or unbalanced, and about the extent to which the relations of each individual with the fisc are optimal.

In the provision of genuine public goods, where the tax contribution of a marginal individual is unlikely to be related to either his or society's marginal valuation of the good, there is clear scope for net gains or losses to accrue to society. In this paper we sidestepped these issues entirely (a) on the grounds that although we exclude the individual's valuation of public goods in the absence of a sensible measure this is consistent with methodological minimisation (income tax payments are already, of course, deducted in their entirety from earnings) and (b) on the grounds that his contribution to the financing of public goods in excess of his own valuation is, in the context of the whole of society reasonably taken as entirely marginal.

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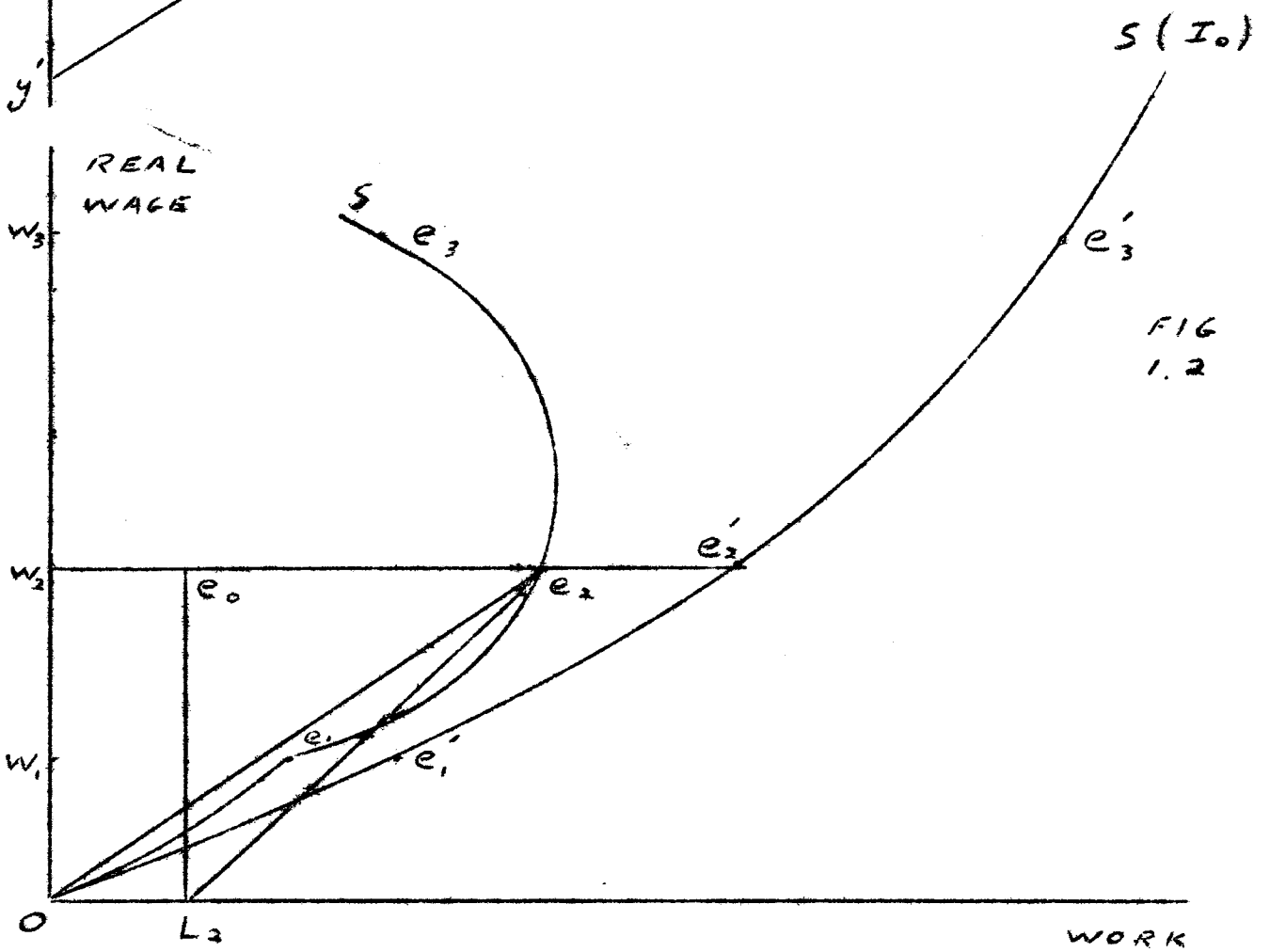
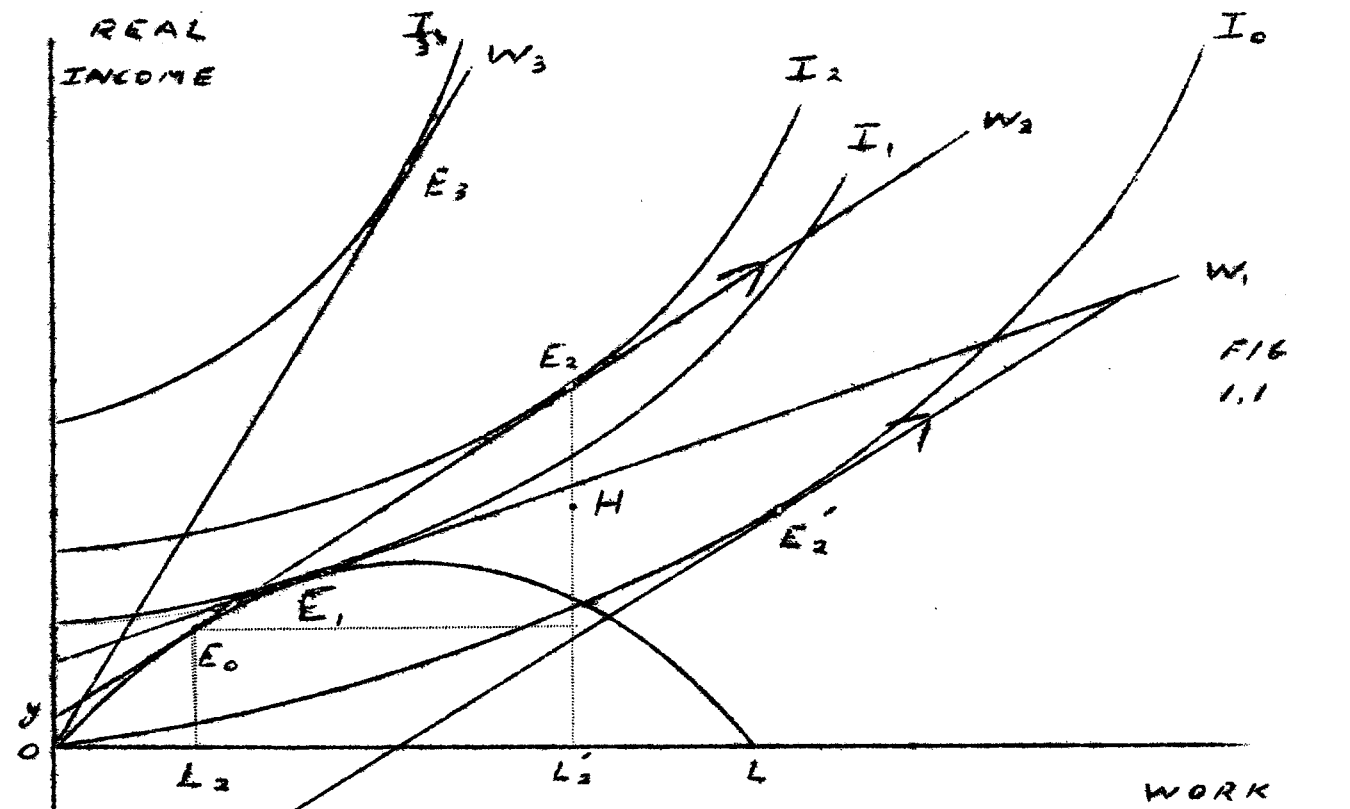
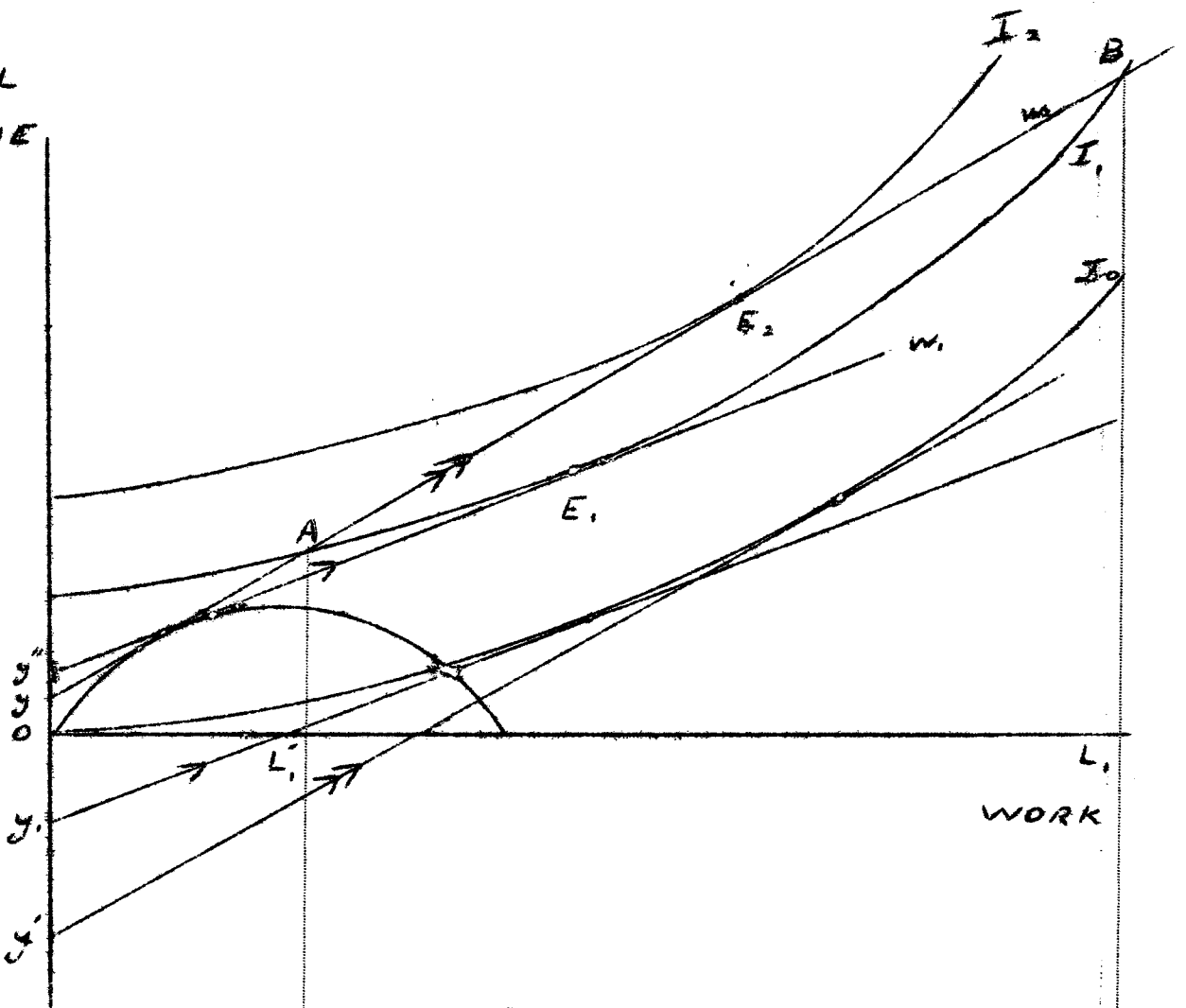


FIGURE 1

REAL
INCOME

FIG 2.1.



REAL
WAGE

FIG 2.2.

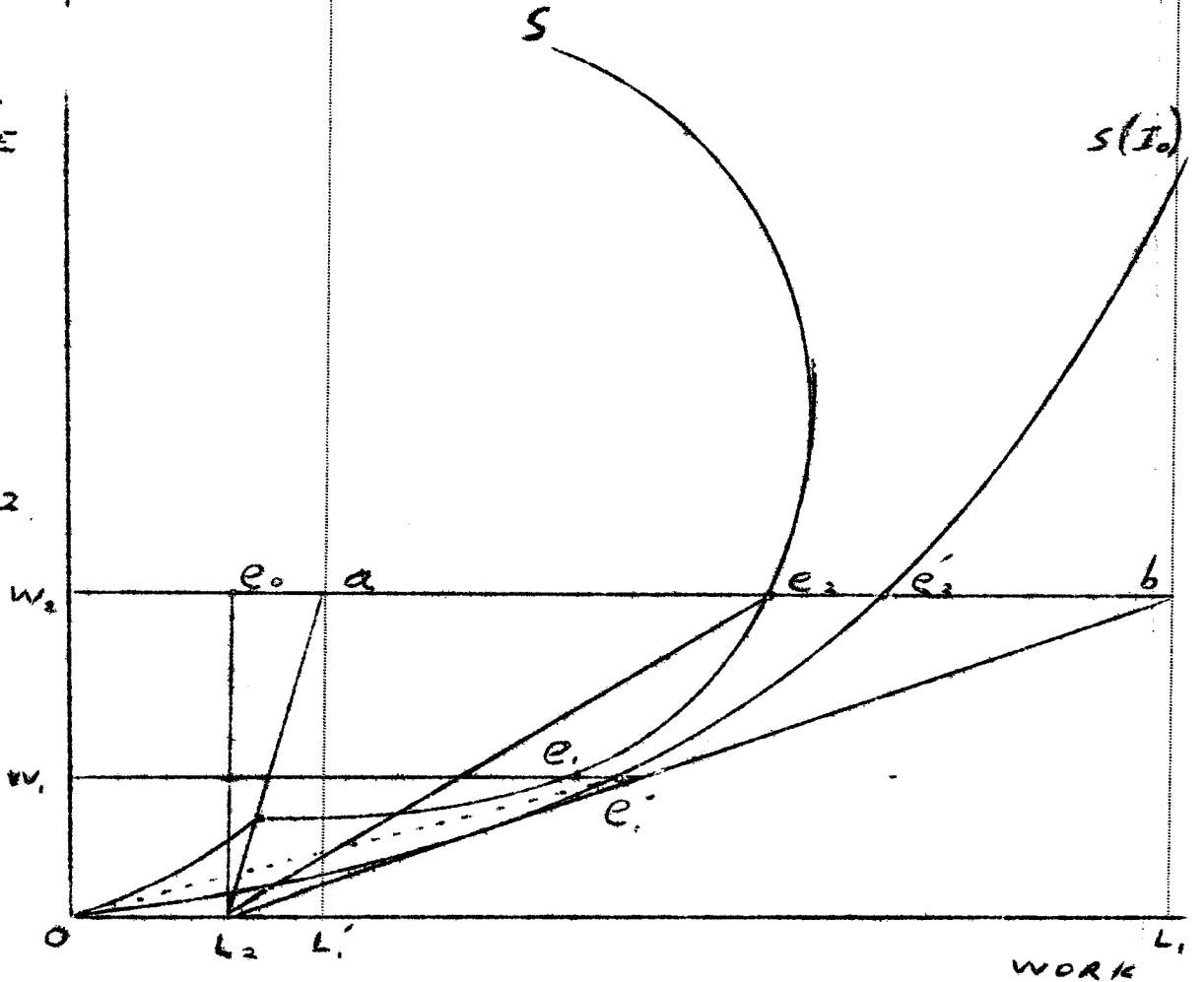
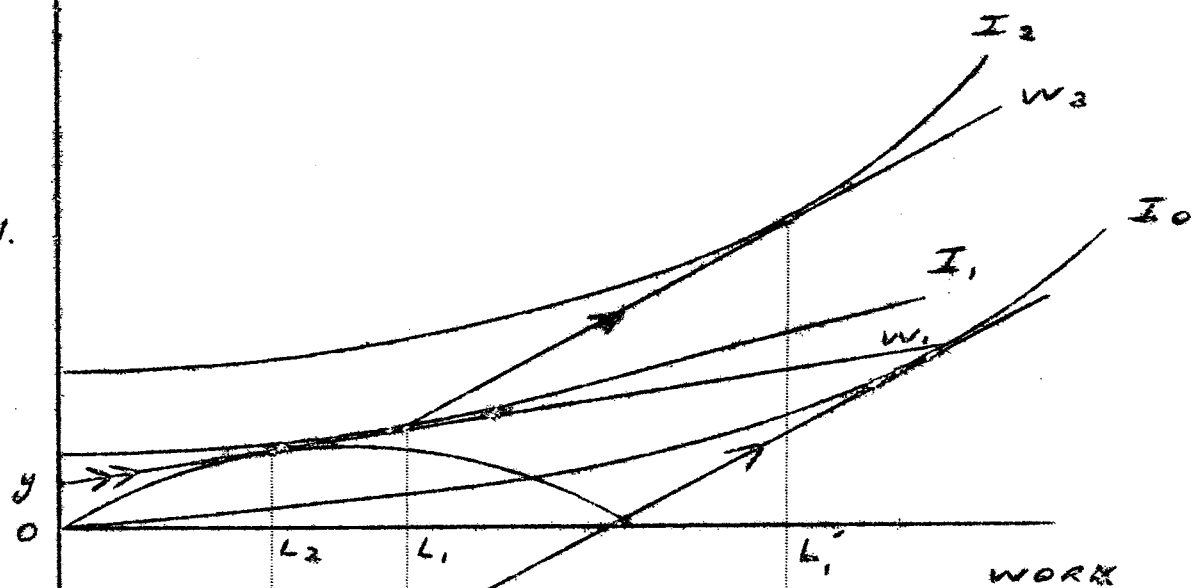


FIGURE 2

REAL
INCOME

FIG 3.1.



REAL
WAGE

FIG 3.2

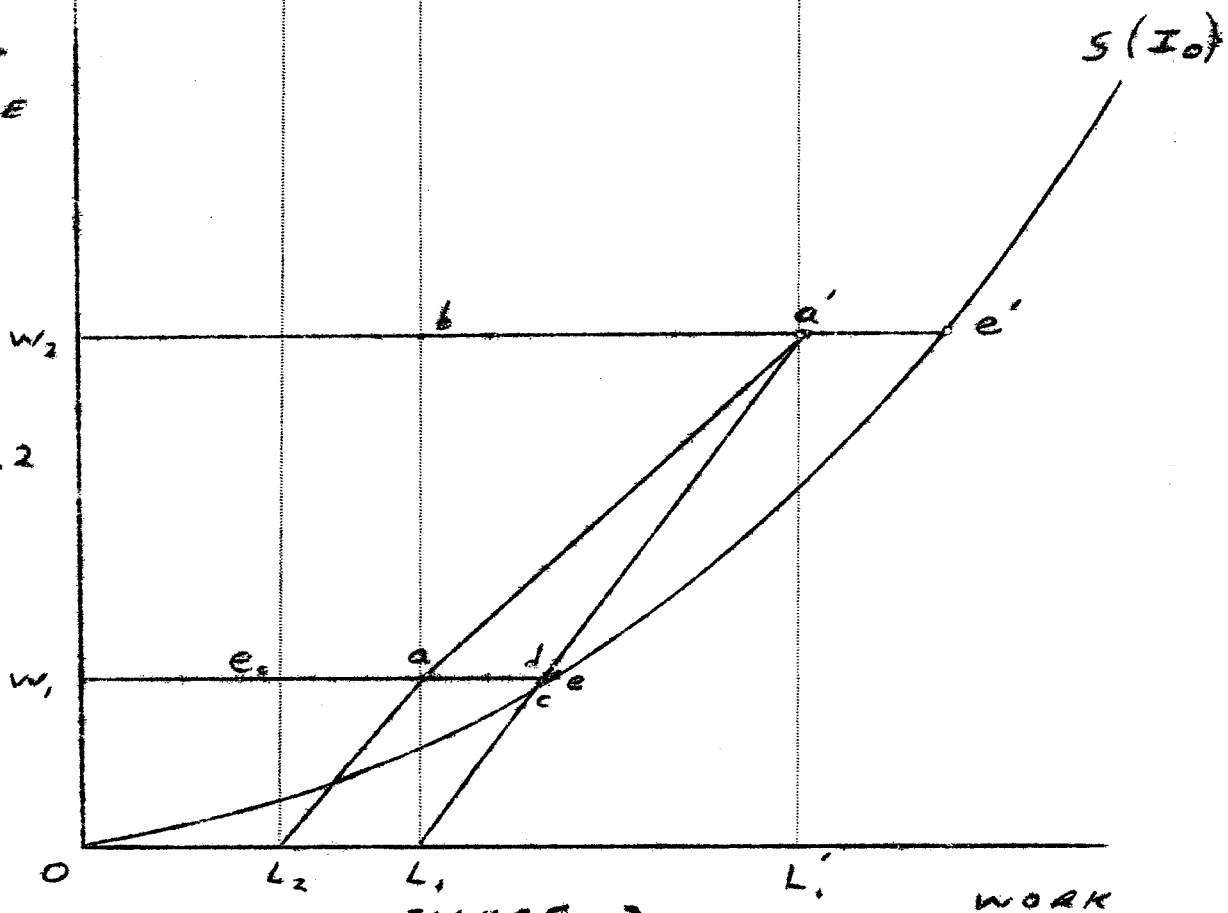


FIGURE 3

WORK