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THE EFFECT OF SOCIAL SECURITY BENEFITS ON LABOR SUPPLY

by
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THE EFFECT OF SOCIAL SECURITY BENEFITS ON LABOR SUPPLY

by
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I. INTRODUCTION

Retirement from the labor force, until relatively recently, was regarded as a more or less automatic step at or near age 65, due either to deteriorating health and the other debilitating effects of age, or job termination by employers. Accordingly, social security income was regarded as replacement income for lost earnings. Older persons who maintained their earning power were considered ineligible for social security benefits, and the programs of most countries carried provisions for reductions in benefits for earnings over a given, and usually low, maximum.[1]

The increasing incidence of early retirement -- complete or partial withdrawal from the labor force at ages when health and loss of earning power are not yet major factors -- has required a reexamination of the labor supply behavior of the older population. Several factors in addition to health and age have been suggested as influential in the retirement decision, among them the amount and conditions of receipt of social security income. There has been increased support recently for the view that social security income may act not only as a replacement for earnings lost due to involuntary retirement but may in fact induce withdrawal from the labor force. Some recent research has provided a basis for this view. International comparisons have produced inverse correlations between the level of social security benefits relative to wages and the participation rates of the population eligible for social security.[2] In the U.S., social security recipients were found to have increased their earnings in response to increases in the earnings maximum, and eligibility for social security benefits was found to be a significant factor in the retirement decisions of older males.[3]

The growing belief that social security benefits may influence labor supply has led policymakers to examine provisions for social security more carefully. In particular, the reduction in benefits for earnings over a maximum for certain age groups, known as the earnings test, has come under review. The matching reductions in benefits for excess earnings employed in many social security programs constitute an implicit tax on earnings of 100%. The distorting adverse effects which such rates are presumed to have on work incentives, seem to take on increased importance as the age of retirement declines, and the older population grows in relative size due to increases in life expectancy.

In response, many countries have reduced the implicit tax rates in their programs. The U.S. rate of 100%, for example, was reduced in the mid-sixties to a two-tiered rate system of 50% and 100%, and more recently, a 50% rate was instituted at all earnings levels.

It is not at all certain, however, that the effect on labor supply of tax rate reductions will be that anticipated by policymakers. There have been, in fact, few careful analyses of the influence on labor supply of social security benefits.[4] This is in sharp contrast to the research effort devoted to the financing of social security systems, to the impact of social security on private savings or to the effects of benefits in other transfer programs.[5]

The present study offers a detailed theoretical analysis of the labor supply effects of social security benefits. The receipt of social security income can be expected to influence the labor supply of the eligible population in very direct ways. The benefits increase the individual's income, and the earnings test places a tax on his earnings. The paper demonstrates that the effect on aggregate labor supply of a reduction in the implicit tax rate can not be predicted a priori, since some workers who opt to forego benefits altogether under a higher tax rate may choose to reduce their labor in order to receive some benefits under a lower tax.[6] In addition, it is demonstrated that labor supply will remain unaffected, as long as the implicit tax rate remains above a critical level.

The following section analyzes the labor supply behavior of the individual eligible for social security income, the amount of which is conditioned on his earnings. The third section employs a Cobb-Douglas utility function to illustrate the labor supply behavior of individuals, using the Israeli social security system parameters (assuming zero non-wage income), and under alternative rates for the implicit tax on earnings. The fourth section analyzes effects of variation in non-wage income (other than benefits), under the Israeli system (for males aged 65 - 70 and females 60 - 65), where a maximum on non-wage income is also in effect, but the implicit tax rate on earnings is 100%. It is shown that when the earnings maximum, or disregard, is zero, the benefit constitutes an alternative fixed cost of labor force participation, which causes a reduction in labor supply through an increase in the reservation wage.

The implications of this model for estimation will be analyzed in a subsequent empirical investigation.

II. THE MODEL

We adopt the following definitions and assumptions:

K = social security benefit [7]

M = earnings disregard: the maximum earnings allowed before reductions in social security benefits

X = consumption (other than leisure), measured in units of money

t = the implicit tax rate on earnings, where $0 \leq t \leq 1$

W = hourly wage rate (assumed given and independent of hours worked)

T = maximum number of available hours

L = hours of leisure

H = hours of work

The individual's utility function is $U(X, L) = U(X, T - H)$, which is assumed to have the usual convenient properties, with both X and L normal goods.

In the absence of a social security program, the conditions for optimality, for given wage $\overline{W}$ and non-wage income $\overline{Y}$, are:[8]

$$(1) \qquad \begin{aligned} X &= \overline{Y} + \overline{W}H \\ \frac{\partial U/\partial L}{\partial U/\partial X} &= \overline{W}. \end{aligned}$$

Conditions (1) yield the (normal) <u>supply of labor</u> (for wages above the reservation wage):

$H^*(\overline{W}, \overline{Y})$, satisfying $H^* > 0, \frac{\partial H^*}{\partial \overline{Y}} < 0$, and $\frac{\partial H^*}{\partial \overline{W}} > 0$ by assumption.[9]

The <u>indirect utility function</u> $U^*(\overline{W}, \overline{Y})$, is the corresponding maximum level of utility, i.e.,

$$(2) \qquad U^*(\overline{W}, \overline{Y}) = U\left[\overline{W}H^*(\overline{W}, \overline{Y}) + \overline{Y},\ T - H^*(\overline{W}, \overline{Y})\right].$$

U^* satisfies: $\frac{\partial U^*}{\partial \overline{W}} > 0$; $\frac{\partial U^*}{\partial \overline{Y}} > 0$; $\frac{\partial U^*}{\partial \overline{W}} \Big/ \frac{\partial U^*}{\partial \overline{Y}} = H^*$.[10]

Under a social security system, with benefit K, earnings maximum M, implicit tax t, and zero other non-wage income (by assumption), the budget constraint becomes segmented (Figure 1), such that:

$$X = \begin{cases} \text{(a)} \quad WH + K, \quad \text{for } WH \leq M \quad \text{(case 2 in Fig. 1)} \\ \text{(b)} \quad WH + K - t(WH - M) = (1-t)WH + (tM + K), \\ \qquad\qquad \text{for } M \leq WH \leq M + \frac{K}{t} \ (\text{i.e., } 0 \leq t(WH - M) \leq K) \quad \text{(case 4 in Fig. 1)} \\ \text{(c)} \quad WH, \quad \text{for } WH \geq M + \frac{K}{t} \quad \text{(case 5 in Fig. 1)} \end{cases}$$

(b) implies that we may view the individual whose earnings are in the range where the implicit tax is effective as having a wage of $W(1-t)$ and non-wage income = $tM + K$. The budget constraint may be summarized as follows:

$$(3) \qquad X = WH + \text{Max}\left\{0,\ K - t\ \text{Max}(0,\ WH - M)\right\}.$$

The segmented budget constraint implies a segmented labor supply function of the individual, and requires us to define the supply curve separately for each wage interval corresponding to each of several cases.[11] The critical values defining these wage intervals are found as solutions to the following five implicit equations:

$$(4) \qquad H^*(W_1,\ K) = 0,$$

where W_1 is the reservation wage: the minimum wage at which the individual (receiving benefits K) enters the market. W_1 gives tangency between the indifference curve and the no-tax segment at $H^* = 0$. (See Figure 2).

$$(5) \qquad H^*(W_2,\ K) = \frac{M}{W_2},$$

where W_2 is the wage which gives tangency between the indifference curve and the no-tax segment at the earnings maximum (such that $W_2H^* = M$). (See Figure 2).

$$(6) \qquad H^*(W_3(1-t),\ tM + K) = \frac{M}{W_3},$$

FIGURE 1 : The Segmented Budget Constraint Under Social Security Benefits

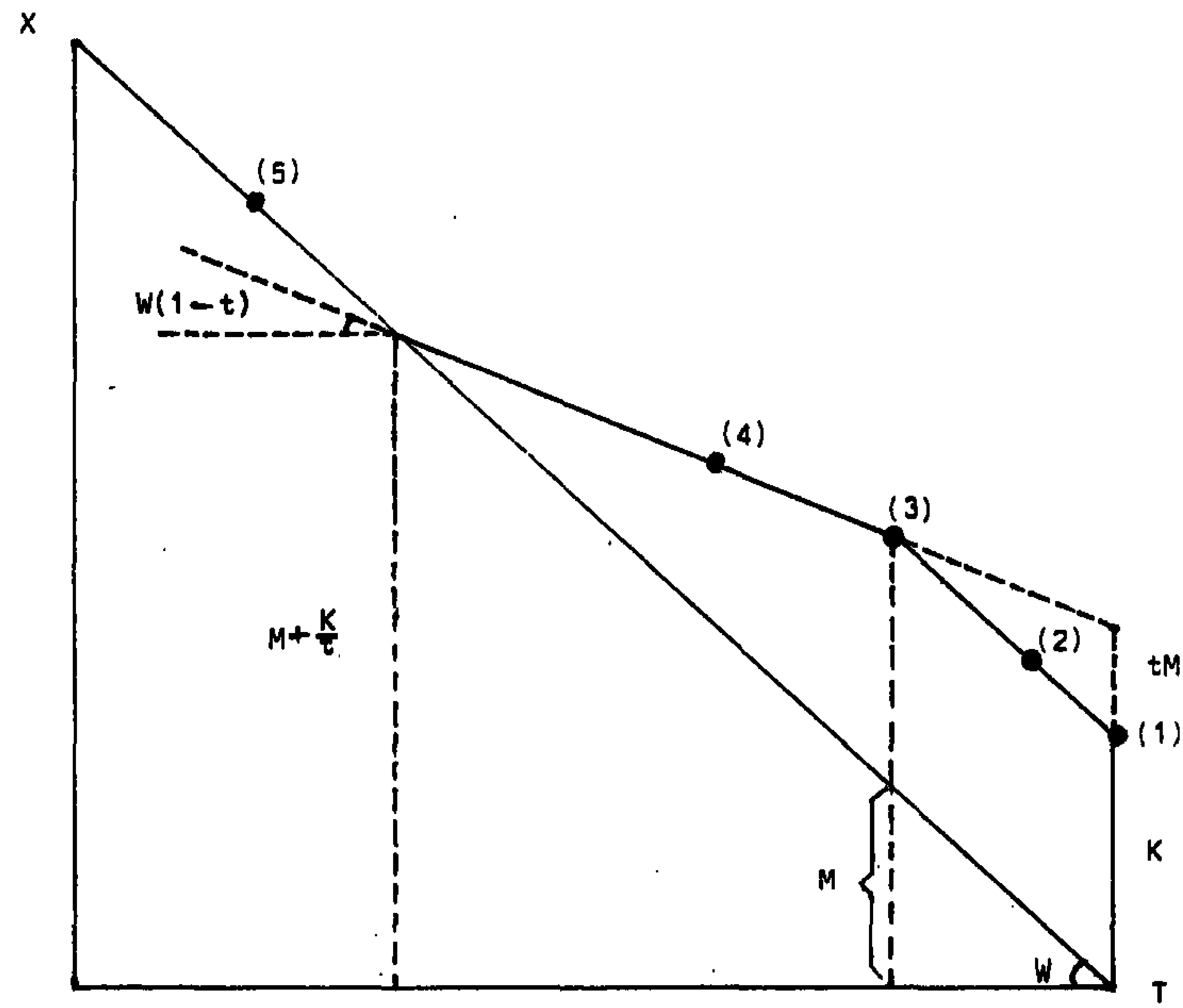
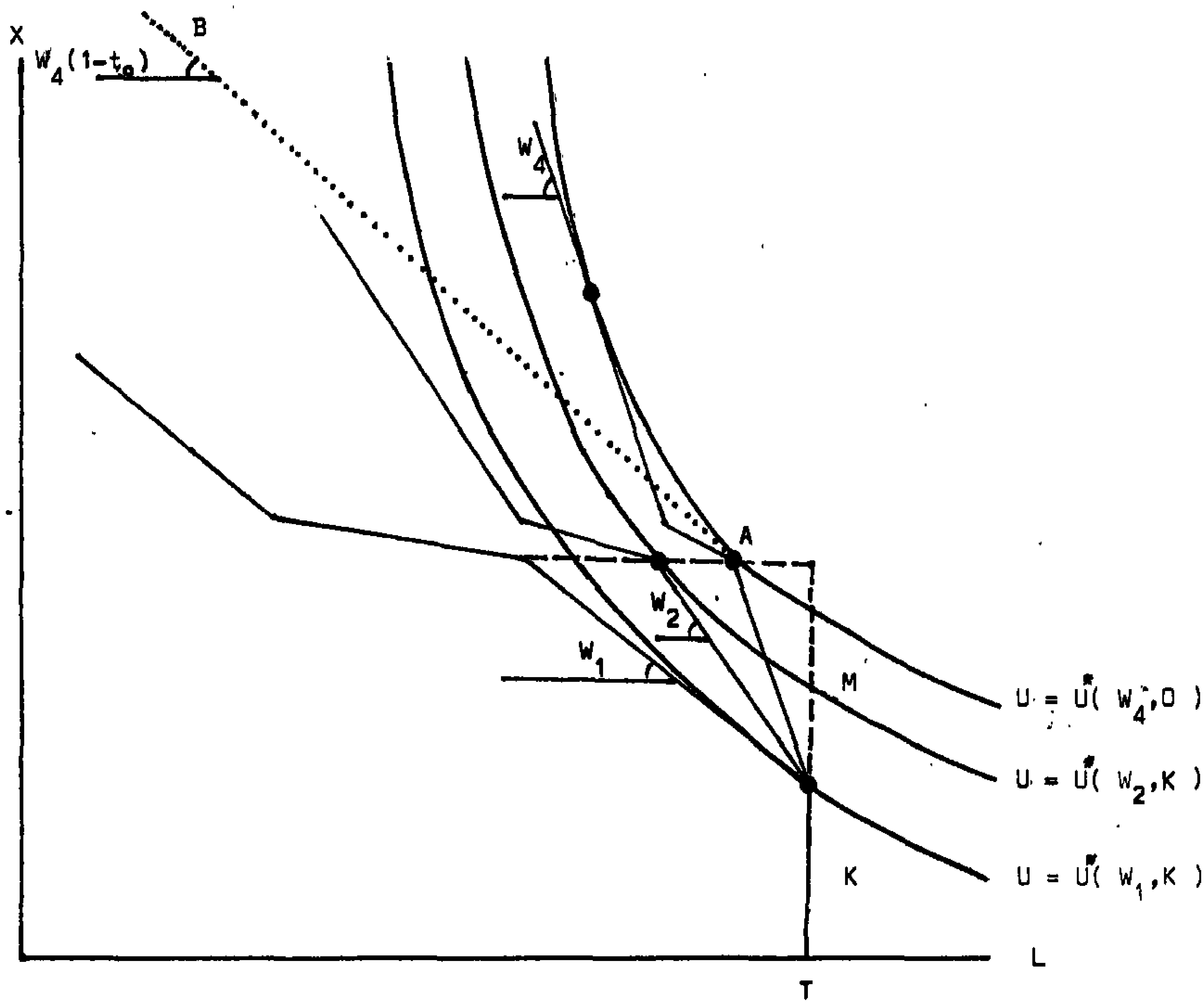


FIGURE 2 : Critical Wage Rates Under $t > t_o$.



where W_3 is the wage which gives tangency between the indifference curve and the tax segment at the earnings maximum (See Figure3). The slope of the tax segment is $W_3(1-t)$, and the individual behaves as if his non-wage income were $tM + K$. (See Figure 1).

$$(7) \qquad U(M + K, T - \frac{M}{W_4}) = U^*(W_4, 0),$$

where $U^*(W_4, 0)$ is the indirect utility function (Equation 2), corresponding to $\overline{W} = W_4$ and $\overline{Y} = 0$. W_4 is the wage at which the consumer is indifferent between remaining at the corner solution corresponding to the earnings maximum, with income $M + K$ and hours of work $\frac{M}{W_4}$, or opting out of the social security system by foregoing the benefit K, and working $H = H^*(W, 0)$ hours, corresponding to the tangency solution on the $\overline{Y} = 0$ budget line. (See Figure 2).

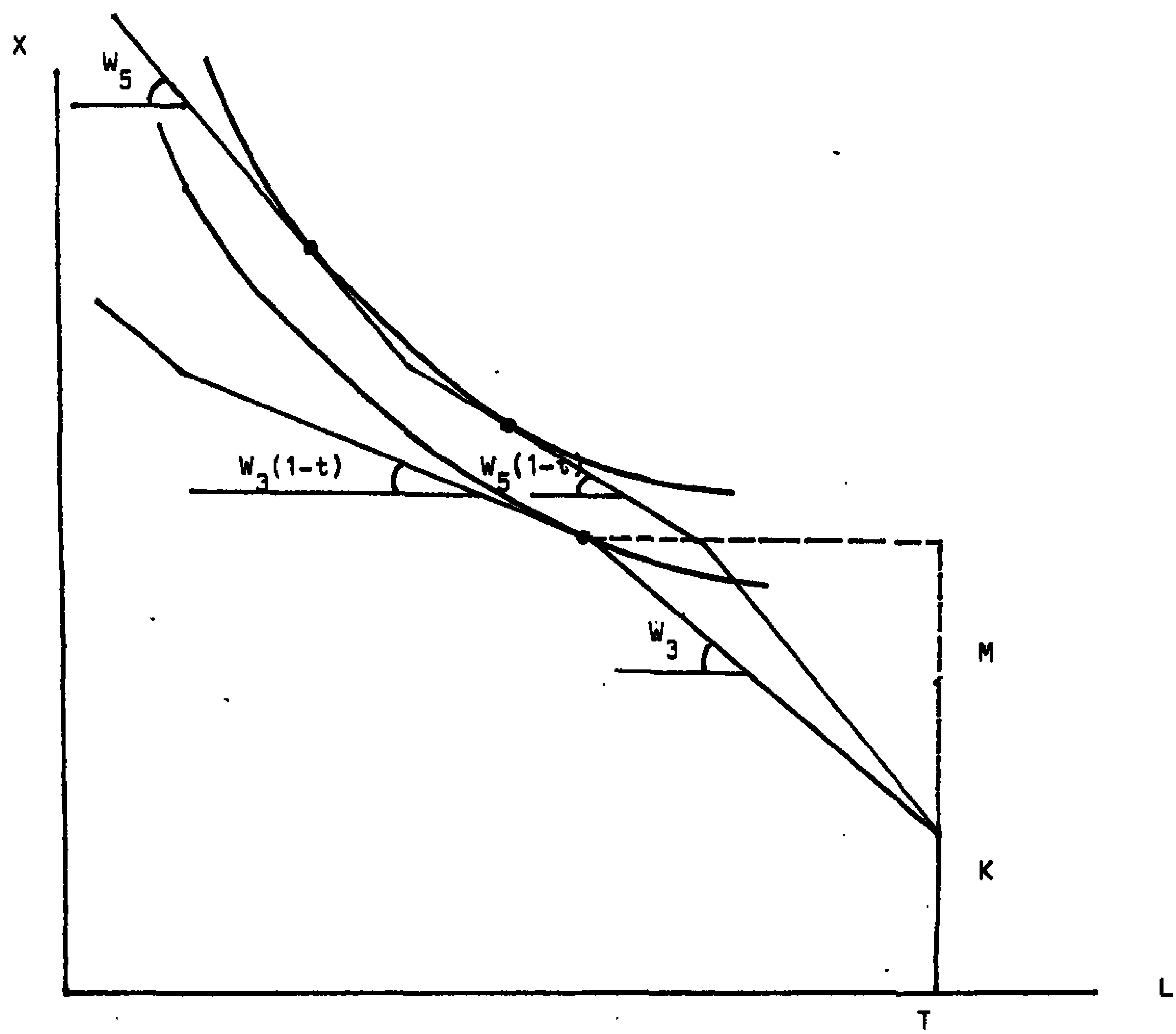
$$(8) \qquad U^*(W_5(1-t), tM + K) = U^*(W_5, 0),$$

where W_5 is the wage at which the individual, once on the tax segment, is indifferent between remaining there or opting out of the system by working more and foregoing all benefits (See Figure 3).

We proceed to define the supply curve over its entire range. It may be shown that: $W_1 < W_2 < W_3$; $W_2 < W_4$; $W_3 < W_4 < W_5$, for $0 < t < t_o$ (where t_o is a critical rate such that $W_3 = W_4 = W_5$; see below, and see Appendix for proofs). It is demonstrated that the supply curve will take on two basic forms, depending on the value of t. For t greater than the critical value t_o, the tax segment is not effective, and the individual moves directly by a discontinous "jump" from the corner solution at the earnings maximum to a point outside of the social security system, where he foregoes the benefit K. Wages W_3 and W_5 are not relevant in this case. For cases where t is less than t_o, he moves on to the tax segment from the corner at W_3, and at some wage W_5 (higher than W_4) becomes indifferent between remaining on the tax segment, or moving out of the system, implying a discontinuity of the supply curve at W_5.

Define $W^* = \text{Min}\ (W_3, W_4)$. The supply of labor is then given as follows:

FIGURE 3 : Critical Wage Rates Under $t < t_o$.



		Point in Figure 1.
(9)	$H = 0, \quad \text{for } W \leq W_1$	1
	$H = H^*(W, K), \quad \text{for } W_1 \leq W \leq W_2$	2
	$H = \frac{M}{W}, \quad \text{for } W_2 \leq W < W^*$	3
(10)	If $W^* = W_3 < W_4$, then	
	$H = H^*(W(1-t), tM + K), \quad \text{for } W^* \leq W < W_5,$	4
	and $H = H^*(W, 0), \quad \text{for } W > W_5$	5
(11)	If $W^* = W_4 < W_3$,	
	$H = H^*(W, 0), \quad \text{for } W > W^* = W_4$	5

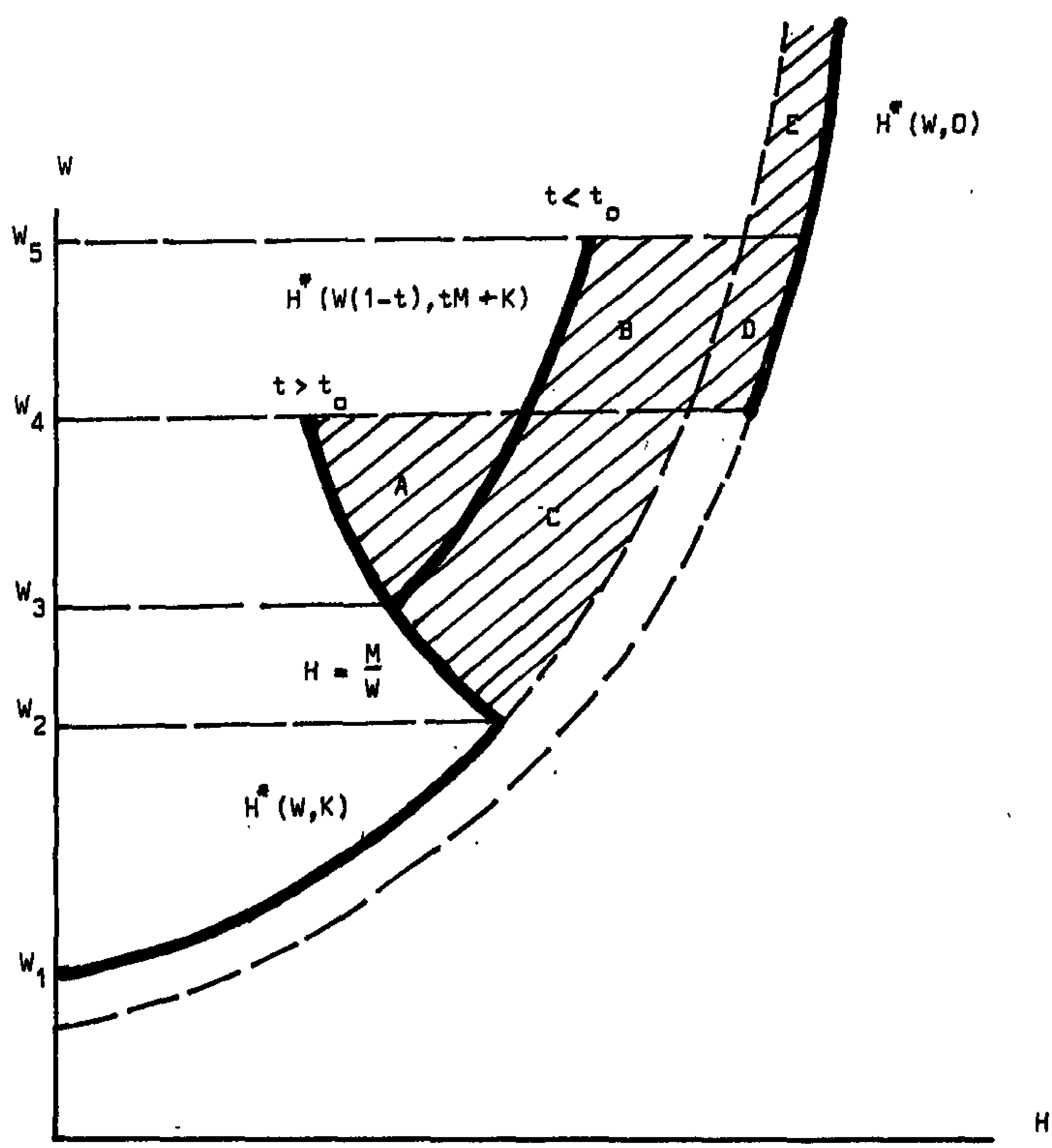
We now determine W^*. Define t_o as the tax rate which gives $W_3 = W_4 = W_5$. A geometric definition of t_o is provided in Figure 2, where the dotted line A - B, which is tangent to the indifference curve $U = U^*(W_4, 0)$ at the corner A, has a slope $-\frac{\partial X}{\partial L} = W_4(1-t_o)$. Substituting W_4 in Equation (6), which defines W_3, gives an implicit equation for t_o:

$$(12) \qquad H^*(W_4(1-t_o), t_oM + K) = \frac{M}{W_4}.$$

Then it may be shown that, for $t < t_o$, $W^* = W_3 < W_4 < W_5$, and for $t > t_o$, $W^* = W_4 < W_3$. This follows since W_3 is an increasing function of t (See Appendix (i) for proof), while W_4 is independent of t. Thus, if at t_o, $W_3 = W_4$, then for $t > t_o$, $W_3 > W_4$.

The labor supply curve is shown in Figure 4. The supply curve is initially positively sloped over the range where the effective tax rate is zero (earnings below the maximum M); optimal hours of work are a function of the wage (higher than the reservation wage W_1) with $\bar{Y}$ equal to the social security benefit K. At the corner solution wage W_2, the supply curve bends backward and becomes a rectangular hyperbola, where earnings WH are always equal to the maximum M, corresponding to the corner solution at (3) in Figure 1. For $t > t_0$ (and thus $W_3 > W_4$), this section continues until wage W_4, at which the individual is indifferent between remaining at the earnings maximum, or increasing his earnings above the maximum and foregoing the social security benefit. For wages above W_4,

FIGURE 4 : The Labor Supply Curve Under Social Security Benefits.



he moves onto the continuation of the supply curve $H^*(W, 0)$ which would have been in effect in the absence of social security.

For $t < t_o$, such that $W_3 < W_4$, the individual moves from the earnings maximum on to the tax segment, at wage W_3, where his labor supply is given by $H^*(W(1-t), tM + K)$. He proceeds along the tax segment until his rising wage reaches the level W_5, at which he is indifferent between remaining on the tax segment, or opting out of the system, to the supply curve $H^*(W, 0)$.

Thus, for any social security system which imposes reductions in benefits for earnings over a given maximum, i.e., where the implicit tax is positive, the supply curve exhibits both a backward-bending section and a discontinuity.

The income and tax effects of social security benefits, when benefits are conditioned on earnings, are discernible from Figure 4. At any given wage, the "income effect" is measured as the horizontal distance between the upward-sloping supply curves $H^*(W, 0)$ and $H^*(W, K)$, which differ only by the effect of income K (and on which $t = 0$). The "tax effect" is the horizontal distance between the actual segmented supply curve, and the "no-tax supply curve" $H^*(W, K)$.

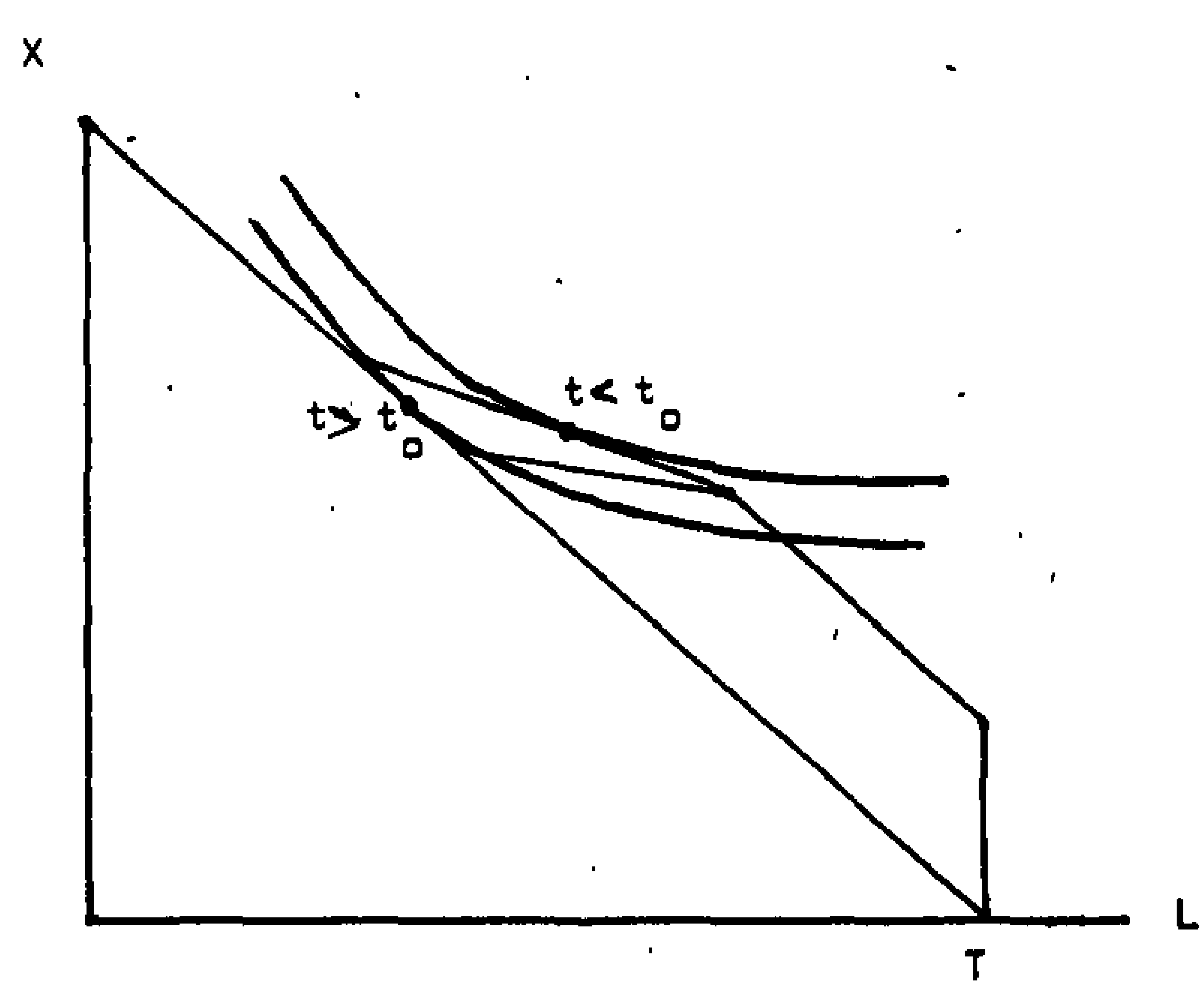
Two implications of the model are readily apparent. The tax effect does not vary for changes in the tax rate in the range above the critical t_o. In other words, reductions in t to a rate greater than t_o will have no effect on labor supply.

Secondly, a reduction in the tax to a rate smaller than t_o may lead to an increase or decrease in hours of work for the individual, depending on his wage. A decrease in the tax for those in the wage range W_3 to W_4 increases hours of work (from the corner $H = \frac{M}{W}$ to the tax segment). For a wage above W_4 but below W_5, the individual who had foregone the social security benefit under $t > t_o$, now reduces his hours of work by moving along the tax segment of the supply curve (See Figure 5 below).

Thus, while both the income and wage effects of a reduction in the tax rate tend to increase labor supply for any individual who is a recipient of benefits, the reduction in the tax may bring into the system and reduce the labor supply of individuals who, under the higher tax, would have foregone the benefit. For these individuals, the optimal point under the reduced tax corresponds to a lower wage and a higher income than the corresponding optimal point outside of the system under the higher tax.

In the aggregate, the effect of a reduction in the social security implicit tax to any t below t_o depends on the distribution of wages in the relevant wage ranges. If all individuals have the same labor supply curve, and if the wage distribution is uniform between W_3 and W_5, then the aggregate effect of a reduction in the tax rate to t ($0 < t < t_o$), depends on the size of area A relative to B + D in Figure 4. The effect of complete elimination of the tax, when initially $t > t_o$, depends, under similar assumptions, on the size of area A + C relative to D + E, and, when initially $t < t_o$, on area B + C relative to E. <u>In other words, it is possible, and quite probable, that a reduction in the tax or its elimination may lead to a reduction rather than an increase in the aggregate labor supply.</u>

FIGURE 5 : An Effect of a Reduction in the Implicit Tax Rate.



III. THE MODEL ILLUSTRATED WITH A COBB-DOUGLAS UTILITY FUNCTION AND ISRAELI PARAMETERS.

We can exemplify the basic features of the model by use of a simple Cobb-Douglas utility function:[12]

$$(13)\qquad U(L, X) = L^{\alpha}\cdot X = (T - H)^{\alpha}\cdot X, \quad \text{where } \alpha > 0.^{13}$$

Deriving the first-order conditions for maximum, as given in Equation (1), for the particular form (13), and solving for H yields the labor supply equation:

$$(14)\qquad H^*(\overline{W}, \overline{Y}) = \frac{T}{1+\alpha} - \frac{\alpha}{1+\alpha}\cdot\frac{\overline{Y}}{\overline{W}},$$

where $\frac{\partial H^*}{\partial \overline{W}} = \frac{\alpha\overline{Y}}{(1+\alpha)\,\overline{W}^2} > 0$ and $\frac{\partial H^*}{\partial \overline{Y}} = -\frac{\alpha}{1+\alpha}\cdot\frac{1}{\overline{W}} < 0.$

Using (14), we can derive solutions for the five wages defined implicitly in (4) - (8).

Substituting (14) into (4), (5) and (6) gives explicit solutions for W_1, W_2 and W_3, respectively:

$$(15)\qquad W_1 = \frac{\alpha K}{T}.$$

$$(16)\qquad W_2 = \frac{\alpha K + (1+\alpha)M}{T}$$

$$(17)\qquad W_3 = \frac{\alpha K + (1+\alpha - t)M}{(1-t)T}.$$

It is easily verified that $W_3 > W_2 > W_1$. The implicit equations for W_4 and W_5 involve the indirect utility function $U^*(\overline{W}, \overline{Y})$. Substituting (14) into (13) gives, after some algebraic manipulations, the particular form of the indirect utility function as follows:

$$(18)\qquad U^*(\overline{W}, \overline{Y}) = \alpha^{\alpha}(1+\alpha)^{-(1+\alpha)}(\overline{Y} + \overline{W}T)^{1+\alpha}\,\overline{W}^{-\alpha}.$$

When $\overline{Y} = 0$ and $\overline{W} = W$ (i.e., outside the benefits system), maximum utility U^* is proportional to the wage rate W:

$$(19)\qquad U^*(W, 0) = \alpha^{\alpha}(1+\alpha)^{-(1+\alpha)}\,T^{1+\alpha}\,W,$$

and along the tax segment, when $\bar{Y} = tM + K$ and $\bar{W} = W(1-t)$:

$$(20)\qquad U^*(W(1-t),\ tM + K) = \alpha^{\alpha}(1+\alpha)^{-(1+\alpha)} \left[(1-t)WT + (tM + K)\right]^{1+\alpha} \left[W(1-t)\right]^{-\alpha}.$$

Substituting (19) and (20) into (7) and (8), respectively, gives the implicit equations for W_4 and W_5 as follows:

$$(21)\qquad (M + K)(T - \frac{M}{W_4})^{\alpha} = \alpha^{\alpha}(1+\alpha)^{-(1+\alpha)}\ T^{1+\alpha}\ W_4.$$

$$(22)\qquad \left[(1-t)W_5T + (tM + K)\right]^{1+\alpha} (W_5(1-t))^{-\alpha} = T^{1+\alpha} W_5.$$

Assigning values of $\alpha = 2$ and $T = 24$,[14] and using the approximate daily values of the social security benefit and earnings maximum in Israel in 1971 (i.e., K = 6, M = 12 IL/day), we can simulate the supply curve of labor for those eligible for social security and in the ages affected by the earnings test, who have zero non-wage income Y.

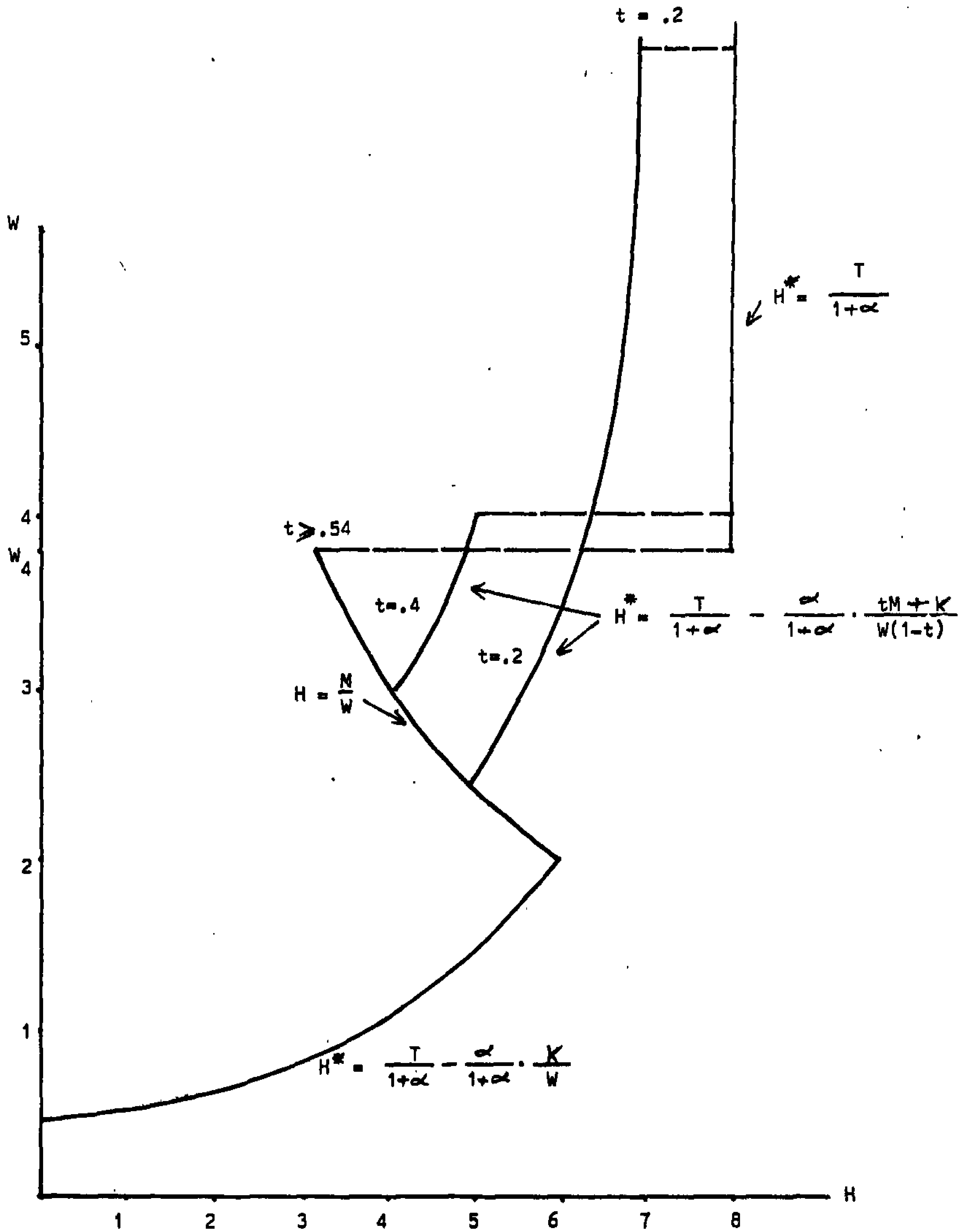
The critical wage rates computed under these assumptions from equations (15), (16), (17), (21) and (22) for various tax rates are as follows (approximately):

W \ t	t = .2	t = .4	t = 1. ($t \geq .54$)
W_1	.5	.5	.5
W_2	2.0	2.0	2.0
W_3	2.4	3.0	-
W_4	-	-	3.8
W_5	6.8	4.0	-

The implicit tax rate in the social security system in 1971 was 100%. The value of t_o was computed to be .54,[15] implying that a reduction in the 100% tax to any rate equal to or above .54 would have had no effect, in this case, on the supply of labor. Hours of work for any wage rate W are found by substituting (14) into expressions (9) - (11). The supply curves are depicted in Figure 6.[16]

The labor supply curves corresponding to tax rates below t_o ($t = .4$ and $t = .2$ in Figure 6) indicate that a reduction in the tax rate limits the tax effect below the opting-out wage W_5, but increases W_5, and thus reduces hours worked for wages in the range between the two levels of W_5. The net aggregate effect, as discussed above, depends on the relative magnitudes of the two effects, as well as on the wage distribution.

FIGURE 6 : Labor Supply Under Cobb-Douglas Utility and Various Tax Rates (Y=0).



IV. THE CASE OF POSITIVE NON-WAGE INCOME UNDER THE ISRAELI SYSTEM.

Until now, the analysis has omitted a second, and complicating, feature of the social security system in Israel. In addition to the maximum on earnings, there exists a maximum on the amount of non-wage income which recipients may hold.[17] Moreover, the maximum on earnings is a function, over certain ranges, of the amount of non-wage income. The value of the social security benefit K, at $H = 0$, also becomes a function of non-wage income. The implicit tax rate $t = 1$ applies above the relevant maximum.

Incorporation of these features into the model provides a family of supply curves of various forms for different levels of non-wage income.[18]

We analyze below the effect of variations in non-wage income Y, under this system. The definition of the earnings maximum, and of the benefit K (at $H = 0$) are expanded to account for their variation as functions of Y. Define these new variables as M^* and K^*, respectively, and the maximum on non-*wage income as* M_y. *The following cases may be identified:*

a) $M^* = M;\ K^* = K$ for $Y \leq M_y$.

b) $M^* = M - (Y - M_y);\ K^* = K,$ for $M_y \leq Y \leq M_y + M$.

c) $M^* = 0;\ K^* = K - (Y - M_y - M),$ for $M_y + M \leq Y \leq M_y + M + K$.

d) $M^* = K^* = 0,$ for $Y \geq M_y + M + K$.

These may be summarized in single expressions as follows:

$$(23)\qquad \begin{aligned} M^* &= \mathrm{Max}\left\{0,\ M - \max(0,\ Y - M_y)\right\} \\ K^* &= \mathrm{Max}\left\{0,\ K - \max(0,\ Y - M_y - M)\right\}. \end{aligned}$$

It should be noted that both M^* and K^* vary continuously with Y.

For non-wage income Y below the maximum M_y, the values of the earnings maximum M^* and the social security benefit K^* are M and K, as before. For Y greater than the meximum M_y, but less than the sum of the earnings and non-wage income maxima, $(M + M_y)$, the benefit K^* remains = K as before, but the earnings maximum M^* is reduced by the excess of Y over the earnings maximum M_y. This reduction in the earnings maximum occurs until non-wage income is equal to the sum of the two maxima. At that point $M^* = 0$; but K^* remains $= K$. For $Y > (M + M_y)$, the benefit K^* itself is reduced by the excess of Y over the sum of the two maxima, until the point where the benefit equals zero.

Substituting M^* and K^* into (3), the budget constraint becomes:

$$(24). \quad X = Y + WH + \text{Max}\left[0, \left(K^* - \text{Max}\left\{0, WH - M^*\right\}\right)\right].^{19}$$

For the case of $t = 1$, we can incorporate the new values, M^* and K^*, into the three relevant implicit wage equations. Modifying equations (4), (5) and (7) to account for the presence of non-wage income Y and for the modified values of K^* and M^*, gives:

$$(25) \quad H^*(W_1, Y + K^*) = 0.$$

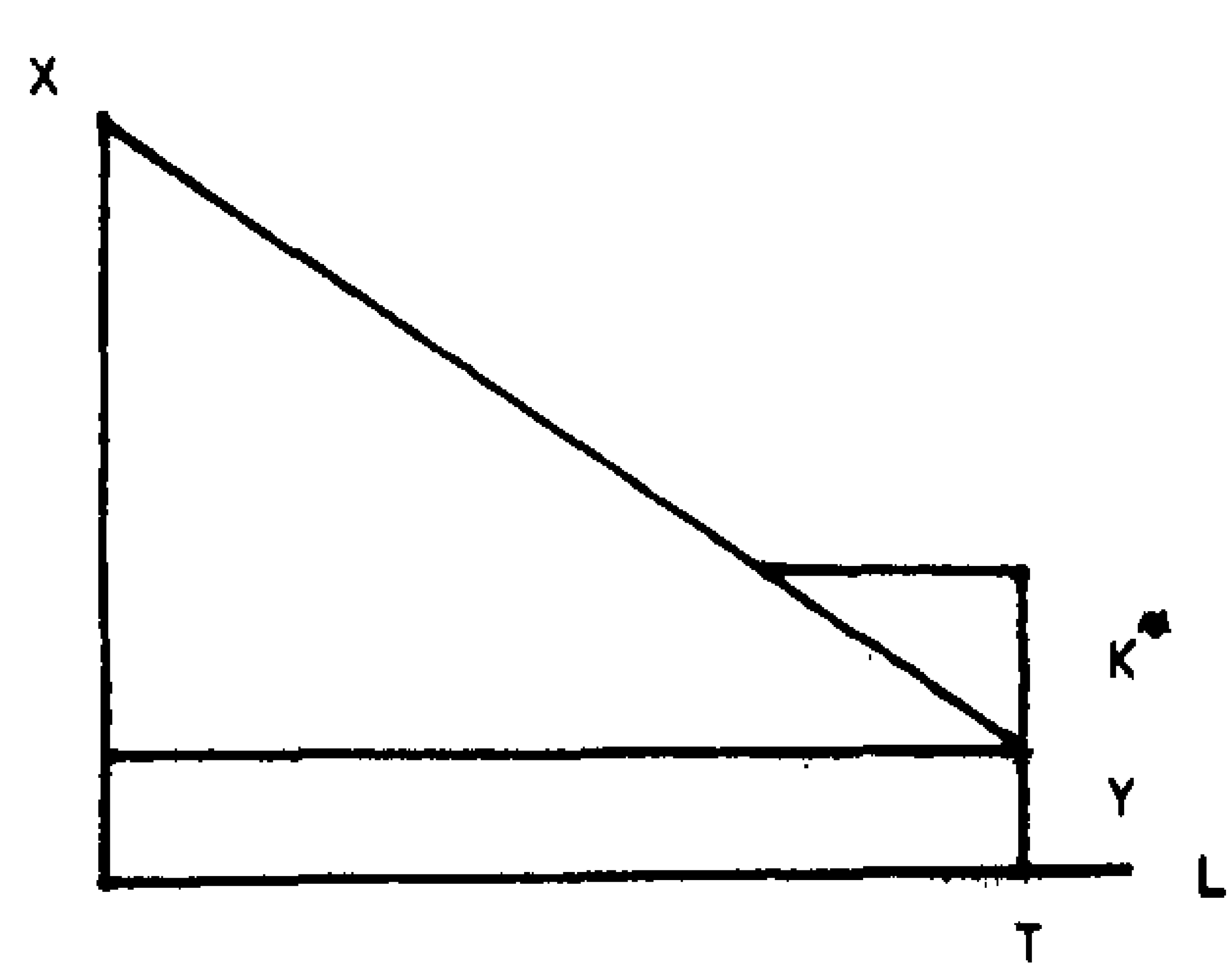
$$(26) \quad H^*(W_2, Y + K^*) = \frac{M^*}{W_2}.$$

$$(27) \quad U(Y + K^* + M^*, T - \frac{M^*}{W_4}) = U^*(W_4, Y).$$

(W_3 and W_5 do not apply to the case where $t = 1$ since the individual will never move on to the tax segment, the slope of which is $W_3(1-t) = 0$).

Observe that the presence of the non-wage income maximum introduces an asymmetry into the analysis. For $Y < M_y + M$, (cases a) and b) above), the earnings maximum M^* is greater than zero, and the budget constraint takes on the same form (with modifications for the size of M^* as Y approaches $M_y + M$), as in Figure 1 (for $t = 1$).

FIGURE 7 : The Budget Constraint Under $M^* = 0$.



For $Y > M_y + M$, (case c) above), $M^* = 0$, and the tax segment begins at $H = 0$ (See Figure 7); thus, W_1 and W_2 are not applicable. In the case of $t = 1$, as analyzed here (or $t > t_o$), only W_4 is relevant, with the implication that the supply curve will be defined only in two ranges, where the wage at which the individual is indifferent between being at the corner or opting out of the system is equal to his reservation wage. This supply curve, in other words, will have a discontinuity at the reservation wage, and an upward-sloping section out of the benefit system. The benefit K^* is, in fact, never received by workers, and is accepted by non-workers only. Thus it becomes an alternative fixed cost of entry relevant to the participation decision. As is known, the effect of a fixed cost is to increase the reservation wage above the shadow price of time at zero hours[20] (in this case, from W_1 to W_4), and to produce a discontinuity of the supply curve at the reservation wage.

We now proceed to illustrate the effects of variation in non-wage income by using the Cobb-Douglas utility function (13). Substituting (14) into (25), (26) and (27) gives, for the particular utility function used here:

$$W_1 = \frac{\alpha(K^* + Y)}{T};$$

$$W_2 = \frac{(1+\alpha)M^* + \alpha(K^* + Y)}{T};$$

and an implicit equation for W_4:

$$W_4\text{:}\ (M^* + K^* + Y)(T - \frac{M^*}{W_4})^{\alpha} = \alpha^{\alpha}(1+\alpha)^{-(1+\alpha)}(Y + W_4 T)^{1+\alpha} W_4^{-\alpha}.$$

Using the Israeli 1971 social security parameters ($K = 6$, $M = 12$ and $M_y = 24$ in IL/day), the relevant parameters and critical wage rates for various daily amounts of non-wage income, are computed (approximately) as follows:

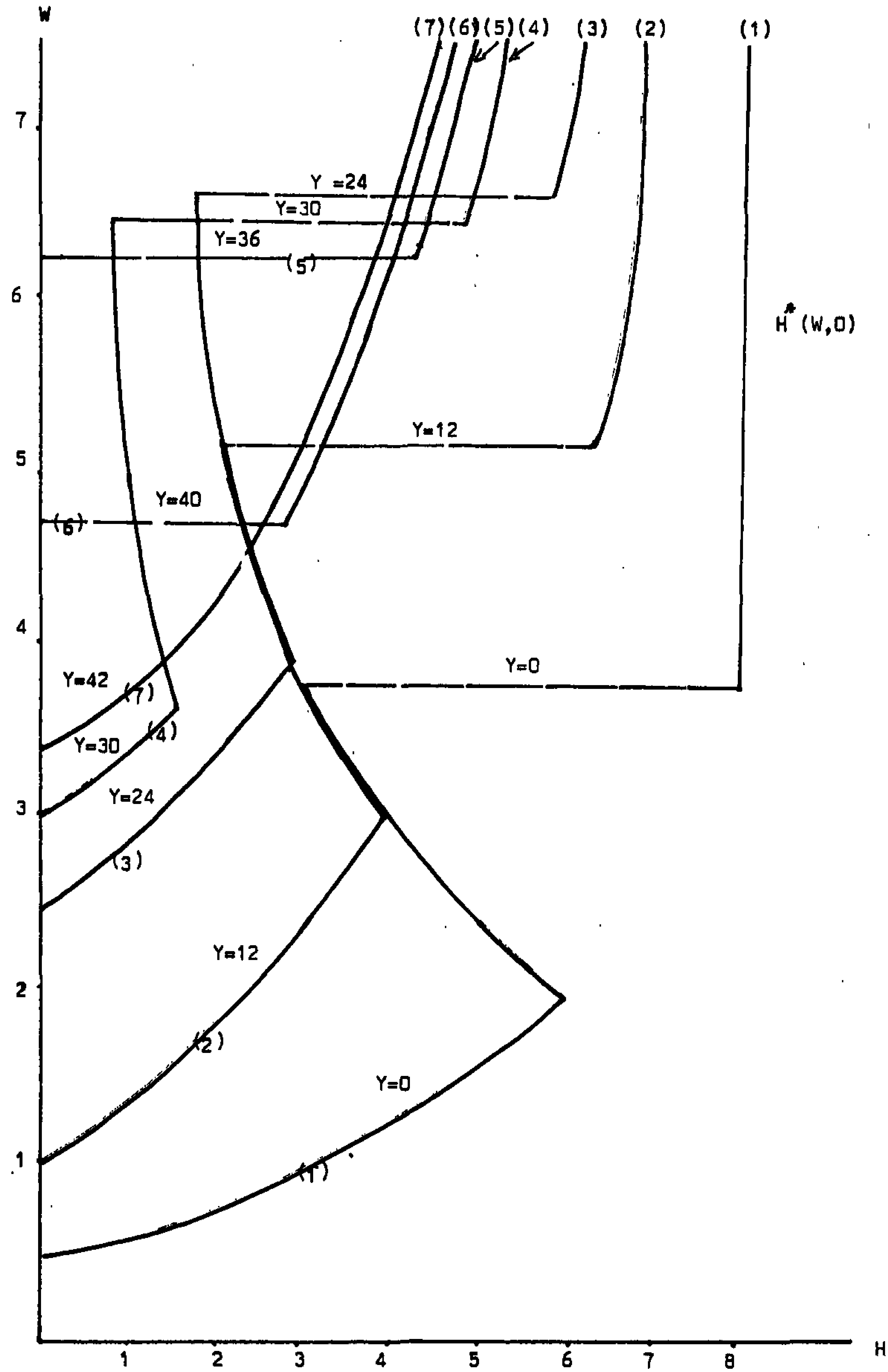
Y	M^*	K^*	W_1	W_2	W_4
0	12	6	.5	2.0	3.8
12	12	6	1.5	3.0	5.3
24	12	6	2.5	4.0	6.6
30	6	6	3.0	3.8	6.4
36	0	6	$(3.5)^a$		6.1
40	0	2	$(3.5)^a$		4.9
42	0	0	$(3.5)^a$		3.5

a) When $M^* = 0$, $W_1 = W_2$ is the shadow price of leisure at $H = 0$, but the reservation wage is W_4.

The corresponding supply curves are depicted in Figure 8. These curves are numbered according to increasing amounts of non-wage income Y. Curve 1 is equivalent to that in Figure 6, where non-wage income equals zero. Curves 2 and 3 are the supply curves for Y equal to $\frac{1}{2}M_y$ and M_y, respectively. The earnings maximum remains constant, i.e., the backward-bending section runs along the same hyperbola; the reservation wage rises due to the higher incomes, however. For Y higher than M_y (Curve 4), the earnings maximum decreases, such that the backward-sloping section is closer to the vertical axis and the opting-out wage W_4 is lower (as compared with Curve 3); K^* remains equal to K. At Curve 5, $M^* = 0$, since non-wage income is equal to the sum of the earnings and non-wage income maxima. The initial upward sloping segment and the corner-solution backward-bending segment disappear, and the supply curve has one discontinuity point at the reservation wage W_4. At $Y > M_y + M$, the social security benefit is reduced, and the reduction in income produces a drop in the reservation wage (Curve 6). Finally, at Curve 7, non-wage income is equal to $(M_y + M + K)$, and $K^* = 0$. The supply curve then takes on the normal form $H^*(W, Y)$, and the system has no effect.

The analysis can be extended in several ways, including the specification of alternative functional forms and development of the implications of relaxing

FIGURE 8 : Effects On Labor Supply Of Variations in Non-Wage Income (Cobb-Douglas Utility and 1971 Israeli Benefit System).



the assumption that hours of work are an increasing function of wages. On a more practical level, the Israeli system of supplementary allowances to the social security benefit, for recipients with low incomes, must be incorporated. This involves the addition of yet another "kink" at the lower right-hand side of the budget constraint, and the derivation of additional critical wages. The basic outlines of the model are not changed, however.

Empirical analysis of the labor supply implications of social security benefits along the lines of this model will be discussed in a subsequent paper.

V. SUMMARY

The model presented above has been developed to analyze the effect of social security income on the supply of labor. The implications of both the increase in income from the program, as well as the implicit tax on earnings are developed, and hypothetical supply curves are derived. It is demonstrated that the effect on labor supply of reductions in the implicit tax rate is indeterminate, so that reductions in the tax rate may produce a decrease rather than an increase in labor supply. Moreover, it is shown that reductions in the tax to a rate above some critical rate will have no effect on the supply of labor.

Finally, if the earnings maximum is zero, either because of a high non-wage income (which is subject to a test in addition to an earnings test), or because there is no exemption of low incomes from the implicit tax in the system, then the effect of the benefits reduces labor supply in a way analogous to the effect of any fixed cost associated with entry into the labor force, by increasing the reservation wage, and inducing a discontinuity of supply at this wage.

The model presented above has been applied to social security income. It is, however, applicable to any income maintenance program which contains income benefits and an implicit tax on earnings.

APPENDIX: Proofs.

(i) $\frac{\partial W_3}{\partial t} > 0$:

Differentiating (6) implicitly with respect to the tax rate t gives:

$$H_1^* \left[(1-t) \frac{\partial W_3}{\partial t} - W_3 \right] + H_2^* M = -\frac{M}{W_3^2} \cdot \frac{\partial W_3}{\partial t},$$

where $H_1^* = \frac{\partial H^*}{\partial (W_3(1-t))} > 0$;

$H_2^* = \frac{\partial H^*}{\partial (tM + K)} < 0$, by assumption.

Solving for $\frac{\partial W_3}{\partial t}$ gives, therefore:

$$\frac{\partial W_3}{\partial t} = \frac{W_3 H_1^* - MH_2^*}{(1-t)H_1^* + M/W_3^2} > 0.$$

(ii) $W_1 < W_2$:

Given: $H^*(W_1, K) = 0$

$H^*(W_2, K) = \frac{M}{W_2} > 0$,

since $\frac{\partial H^*}{\partial W} > 0$, by assumption, $H^*(W_1, K) < H^*(W_2, K)$ implies $W_1 < W_2$.

(iii) $W_2 < W_3$:

Given: $H^*(W_2, K) = \frac{M}{W_2}$

$H^*(W_3(1-t), tM + K) = \frac{M}{W_3}$

then, for t = 0, $W_2 = W_3$. Since $\frac{\partial W_3}{\partial t} > 0$, by (i) above, and $\frac{\partial W_2}{\partial t} = 0$, then

if $t > 0$, $W_3 > W_2$.

(iv) $W_2 < W_4$:

Define: $X^* = \bar{Y} + \bar{W}H^*(\bar{W}, \bar{Y})$,

then: $X^*(W_2, K) = M + K$ (Eq. 5).

and $X^*(W_4, 0) > M + K$ (See Fig. 2).

Therefore $X^*(W_4, 0) > X^*(W_2, K)$;

but, $X^*(W_2, K) > X^*(W_2, 0)$ since $\frac{\partial X^*}{\partial \bar{Y}} > 0$ if X is a normal good,

and therefore, combining these results:

$$X^*(W_4, 0) > X^*(W_2, 0).$$

Since clearly $\frac{\partial X^*}{\partial \bar{W}} > 0$, this implies $W_4 > W_2$.

(v) If $t < t_o$, then $W_3 < W_4 < W_5$.

If $t = t_o$, then $W_3 = W_4 = W_5$, by definition.

If $t < t_o$, then at wage W_4 the individual's optimal point is still on the tax segment (the tax segment intersects the indifference curve $U = U^*(W_4, 0)$; see Figure 2). Hence the jump out of the system occurs at $W_5 > W_4$. (An alternative proof can be given, using the result: $\frac{\partial W_5}{\partial t} < 0$; but the formal proof of this result is cumbersome, and is omitted.)

$W_3 < W_4$ for $t < t_o$ is implied by (i) above.

FOOTNOTES

1 Some of the Scandinavian countries, where benefits are independent of earnings, provide exceptions to this practice.

2 See, for example, Pechman, Aaron and Taussig (1968) and Feldstein (1974 b).

3 See Vroman (1971) and Quinn (1975), respectively.

4 An exception is Boskin (1975), who uses panel data from the Michigan Income Dynamics sample to estimate the probability of retirement.

5 See, for example, Pechman, Aaron and Taussig (1968), Brittain (1971), Browning (1975) for the financing aspects of social security; Cagan (1965), Feldstein (1974 a), and Munnell (1974) for the effects on savings; and Cain and Watts (1973), Honig (1973) and (1974), and various volumes of Subcommittee on Fiscal Policy, Studies in Public Welfare (1972/1974), for some recent analyses on the effects of public welfare program benefits.

6 We abstract from restrictions on the demand side which may make it impossible to vary hours of work continuously at a fixed given wage. The analysis is intended to emphasize the economic factors at work on the supply side, rather than the outcomes of both supply and demand factors.

7 The Israeli system of supplementary benefits to aged persons with low incomes is omitted from the analysis at present. The existence of this secondary program does not change the basic outlines of the model, while adding computational complexity.

8 Under the usual assumptions (of monotonicity and quasi-concavity) of the utility function, these first order conditions are not only necessary but also sufficient for an interior solution (i.e., for positive hours of work).

9 We maintain throughout the assumption of an upward-sloping supply curve, which is not unreasonable for the lower part of the wage distribution relevant to the receipt of social security benefits under an earnings test.

10 For a discussion of the application of the indirect utility function to labor supply analysis, see Hanoch (1975).

11 The segmented budget constraint precludes the use of a single function in an empirical estimation of labor supply, since it implies discontinuities in the level and the slope of the supply curve, as shown below.

12 For use of the Cobb-Douglas utility function in labor supply, see Hanoch (1975).

13 (13) is equivalent to a linear homogeneous utility function $U' = (T - H)^{\lambda} X^{1-\lambda}$, where $\lambda = \frac{\alpha}{1+\alpha}$.

14 The numerical illustration of the model is carried out in units of hours per day, which may represent an average over the month or year.

15 Substituting W_4 for W_3 in Eq. (17) gives:

$$W_4 = \frac{\alpha K + (1+\alpha - t_o)M}{(1-t_o)T},$$ so that the value of t_o is given by:

$$t_o = 1 - \frac{\alpha(K + M)}{TW_4 - M}.$$

16 The year 1971 was selected on data considerations. The values of α and T should be determined empirically and the values used above are merely illustrative. They are, however, not unreasonable. A value of $\alpha = 2$ yields the result that, in the absence of social security and other income, the individual allocates one-third, or eight hours, of his time to work. (The inelastic supply curve is a result of the assumption of zero non-wage income. The usual upward-sloping curve appears when non-wage income Y takes on positive values, as seen in (14).)

[17] Private pension income and transfer income are exempt for purposes of calculating the level of the social security benefit. Asset income and earnings of other family members are treated as equivalent in the analysis, and cross-effects in consumption within the family are ignored.

[18] Empirically, the implication of the second income constraint is that the joint distribution of wages and non-wage income is required in order to estimate the aggregate labor supply effect.

[19] An alternative summary expression for the budget constraint, in terms of the original parameters K, M and M_y, is derived by substitution of (23) into (24), and some manipulations; i.e.,

$$X = Y + WH + \mathrm{Max}\left[0, K - \mathrm{Max}\left\{0,\ WH - M + \mathrm{Max}\ (0,\ Y - M_y)\right\}\right] .$$

[20] See Hanoch (1975).

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